Research Article

Outcomes of Tympanoplasty with or without Cortical Mastoidectomy in CSOM with Active Mucosal Disease

Anamika Tripathi, Sudhakar Vaidya, Puneet Bhargava*

Background: Chronic suppurative otitis media (CSOM) with active mucosal disease presents a surgical challenge regarding optimal management approach. The role of cortical mastoidectomy in conjunction with tympanoplasty remains debated, particularly concerning graft uptake and audiological outcomes.

Objective: To compare graft uptake rates and hearing improvement between tympanoplasty alone versus tympanoplasty with cortical mastoidectomy in patients with CSOM and active mucosal disease, and to evaluate the efficacy of different graft materials.

Methods: A comparative observational study was conducted at a tertiary care center involving 98 patients with CSOM and active mucosal disease. Patients underwent either tympanoplasty alone (n=49) or tympanoplasty with cortical mastoidectomy (n=49). Graft materials included temporalis fascia alone or temporalis fascia with conchal cartilage. Primary outcomes were graft uptake at 3 months post-operatively assessed by otoendoscopy and hearing improvement measured by pure tone audiometry.

Results: Graft uptake was significantly superior in the mastoidectomy group (100% with fascia+cartilage, 81.8% with fascia alone) compared to tympanoplasty alone (96.6% with fascia+cartilage, 65% with fascia alone). Mean hearing improvement (pure tone average) was greatest in the mastoidectomy with fascia+cartilage group (17.40 ± 9.61 dB) compared to other groups. Air-bone gap improvement showed similar patterns. All differences were statistically significant (p <0.05).

Conclusion: Cortical mastoidectomy significantly improves both graft uptake and hearing outcomes in CSOM with active mucosal disease. Cartilage addition improves outcomes and should be considered in all cases.

Access this article online

Website: www.cijmr.com

DOI: 10.58999/cijmr.v4i03.289

Keywords: Chronic suppurative otitis media, tympanoplasty, cortical mastoidectomy, graft uptake, hearing improvement

Introduction

Chronic suppurative otitis media (CSOM) represents one of the most prevalent otological conditions worldwide, particularly affecting populations in developing countries where access to early intervention may be limited.[1] The condition is characterized by persistent inflammation of the middle ear and mastoid cavity, often accompanied by intermittent otorrhea and progressive hearing loss.[2] When active mucosal disease is present, the management becomes more complex, requiring careful consideration of surgical approaches to achieve optimal outcomes.

The primary goals of surgical intervention in CSOM include eradication of disease, restoration of hearing, and prevention of complications.[3] Tympanoplasty, first described by Wullstein and Zöllner in the 1950s, has become the standard procedure for reconstructing the tympanic membrane and improving hearing function.[4] However, the role of concurrent cortical mastoidectomy in cases with active mucosal disease remains a subject of ongoing debate in otological practice.

The rationale for performing cortical mastoidectomy alongside tympanoplasty centers on the concept of eliminating the mastoid air cell system as a potential reservoir of infection and inflammation.[5] Proponents argue that failure to address diseased mastoid air cells may lead to persistent inflammation, compromised graft uptake, and suboptimal hearing outcomes.[6] Conversely, others advocate for a more conservative approach, citing the increased surgical time, potential for complications, and questioning whether the additional procedure provides significant clinical benefit.[7]

Department of Otorhinolaryngology, R.D. Gardi Medical College, Ujjain, Madhya Pradesh, India.

Correspondence to: Anamika Tripathi, Department of Otorhinolaryngology, R.D. Gardi Medical College, Ujjain, Madhya Pradesh, India. E-mail: 13annitripathi@gmail.com

Submitted: 09/11/2025 Revision: 22/11/2025
Accepted: 02/12/2025 Published: 20/12/2025

How to cite this article: Tripathi A, Vaidya S, Bhargava P. Outcomes of Tympanoplasty with or without Cortical Mastoidectomy in CSOM with Active Mucosal Disease. Central India Journal of Medical Research. 2025;4(3):14-21.

Graft material selection represents another critical factor influencing surgical outcomes. Temporalis fascia has been the gold standard graft material for tympanoplasty due to its accessibility, biocompatibility, and proven efficacy.[8] However, in cases with active mucosal disease or previous surgical failures, the addition of cartilage support has gained popularity due to its resistance to resorption and structural stability.[9,10] The comparative efficacy of these graft materials in different surgical contexts requires further elucidation.

Recent literature has provided conflicting evidence regarding the optimal surgical approach for CSOM with active mucosal disease. While some studies demonstrate superior outcomes with combined procedures,[11,12] others question the necessity of routine mastoidectomy.[13,14] This heterogeneity in findings may be attributed to variations in patient selection criteria, surgical techniques, follow-up periods, and outcome measures employed across different studies.

The present study aims to address these knowledge gaps by providing a comprehensive comparative analysis of graft uptake rates and hearing outcomes in patients undergoing tympanoplasty with or without cortical mastoidectomy for CSOM with active mucosal disease. Additionally, we evaluate the differential impact of graft material choice on surgical outcomes within each surgical approach.

Materials and Methods

Study Design and Setting

This prospective comparative observational study was conducted at the Department of Otorhinolaryngology, C.R. Gardi Hospital, Ujjain, associated with R.D. Gardi Medical College, Ujjain, a tertiary care center in central India. The study protocol was approved by the Institutional Ethics Committee of R.D. Gardi Medical College prior to patient enrollment.

Study Population and Sample Size

The study was conducted over a period of 18 months (15 months for data collection and 3 months for analysis) between 2023-2025. A total of 98 patients diagnosed with CSOM and active mucosal disease were enrolled in the study. Power analysis indicated that this sample size provided adequate statistical power to detect clinically meaningful differences between groups.

Inclusion and Exclusion Criteria

Inclusion criteria comprised patients aged 10-70 years of both genders presenting with CSOM characterized by active mucosal disease with central perforation of the pars tensa, no history of previous ear surgery, and a documented history of ear discharge exceeding 3 months duration.

Exclusion criteria included presence of nasal polyps, marginal, total, or attic perforations, evidence of cholesteatoma, history of blood-tinged discharge, acute otitis externa, patient refusal for surgical intervention, inability to maintain regular follow-up, and intraoperative findings necessitating modified radical mastoidectomy or atticotomy procedures.

Surgical Allocation and Randomization

Patients were allocated to one of two surgical groups through a pragmatic randomization approach. One surgical team exclusively performed tympanoplasty procedures, while a second team conducted tympanoplasty with cortical mastoidectomy. This allocation method ensured consistency in surgical technique within each group while maintaining equipoise between interventions. Ultimately, 49 patients underwent tympanoplasty alone while 49 received tympanoplasty with cortical mastoidectomy.

Surgical Techniques

All procedures were performed under general anesthesia or local anesthesia with sedation using 2% xylocaine with adrenaline, depending on patient factors and surgeon preference. Surgeries were conducted by senior otolaryngologists with extensive experience in middle ear procedures.

Tympanoplasty Procedure

The surgical approach utilized a postauricular incision placed 0.5 to 1.0 cm behind the postauricular groove. Following soft tissue dissection and exposure of the external auditory canal, temporalis fascia was harvested from the temporalis muscle. Meatotomy was performed to improve visualization and access. The margins of the tympanic membrane perforation were carefully freshened to promote healing. Tympanomeatal flap elevation was achieved through 12 o'clock and 6 o'clock incisions, with careful preservation of the tympanic annulus.

Middle ear exploration included assessment of ossicular chain integrity and mobility through round window reflex testing. In cases of ossicular discontinuity or fixation, appropriate reconstruction was performed. Granulation tissue, when present, was meticulously removed to create a healthy recipient bed. The harvested temporalis fascia graft was positioned using the underlay

technique, either alone or in combination with conchal cartilage for additional support. Gel foam was placed to secure graft position, followed by repositioning of the tympanomeatal flap and layered closure of the surgical site.

Cortical Mastoidectomy Technique

In patients undergoing combined procedures, cortical mastoidectomy was performed through the same postauricular approach. The mastoid cortex was exposed and anatomical landmarks including MacEwen's triangle were identified. The boundaries of the mastoidectomy included the tegmen tympani superiorly, sigmoid sinus posteriorly, posterior bony external auditory canal anteriorly, and the digastric ridge inferiorly.

Systematic drilling proceeded from superficial to deep structures using a saucerization technique. All diseased mastoid air cells were removed while preserving critical anatomical structures. The posterior canal wall was thinned to improve middle ear visualization and access. The sigmoid sinus plate was carefully drilled along the posterior aspect of the mastoid cavity, and mastoid tip cells were thoroughly cleared. Complete eradication of diseased tissue was confirmed before proceeding with tympanic membrane reconstruction using identical techniques to the tympanoplasty-only group.

Graft Material Selection

Graft material selection was based on surgeon preference and intraoperative findings. Options included temporalis fascia alone or temporalis fascia reinforced with conchal cartilage. In the mastoidectomy group, 11 patients received temporalis fascia alone while 38 received the combination graft. Among patients undergoing tympanoplasty alone, 20 received temporalis fascia and 29 received the combination graft.

Postoperative Care and Follow-up

All patients received standardized postoperative care including intravenous ceftriaxone for 24 hours followed by oral antibiotics for 7 days. Antihistamines were prescribed as clinically indicated. Patients returned for suture removal at postoperative day 7, with oral antibiotics continued based on clinical assessment. Gel foam removal was performed at 2 weeks postoperatively.

Comprehensive otorhinolaryngological examination using otoendoscopy was performed at 3 months postoperatively to assess graft uptake and middle ear status. Pure tone audiometry was conducted to evaluate hearing outcomes, with results compared to preoperative measurements.

Outcome Measures

Primary outcomes included graft uptake rate at 3 months postoperatively, defined as complete graft integration without residual perforation, and hearing improvement measured by changes in pure tone average (PTA) and air-bone gap (ABG) from preoperative to postoperative assessments.

Secondary outcomes comprised analysis of surgical complications, disease patterns in mastoid air cells among patients undergoing mastoidectomy, and comparative assessment of different graft materials within each surgical approach.

Statistical Analysis

Data compilation was performed using Microsoft Excel, with statistical analysis conducted using IBM SPSS version 21.0. Continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Comparison of normally distributed continuous variables between groups utilized Student's t-test, while nominal categorical data were analyzed using Chi-square tests. Statistical significance was defined as $p < 0.05$. All analyses were performed in consultation with institutional biostatisticians.

Results

Demographics and Baseline Characteristics

The study cohort comprised 98 patients with ages ranging from 13 to 70 years (mean 33.67 ± 12.19 years, median 30.50 years). The age distribution of cases is shown in Table 1 and Figure 1. The most frequently represented age group was 21–30 years (36.7%), followed by 31–40 years (28.6%). Female patients predominated (61.2 *vs* 38.8% male). Disease laterality showed equal distribution between right and left ears (38.8 each), with bilateral involvement in 22.4% of cases. Gender distribution is presented in Table 2 and Figure 2.

All patients presented with otorrhea (100%), while other symptoms included otalgia (30.6%), subjective

Table 1: Age distribution of the cases

Age group	*No. of patients (n)*	*%*
<=20 years	13	13.3
21–30 years	36	36.7
31–40 years	28	28.6
41–50 years	11	11.2
>50 years	10	10.2
Total	98	100.0

Table 2: Gender distribution of the cases

Gender	*No. of patients (n)*	*%*
Male	38	38.8
Female	60	61.2
Total	98	100.0

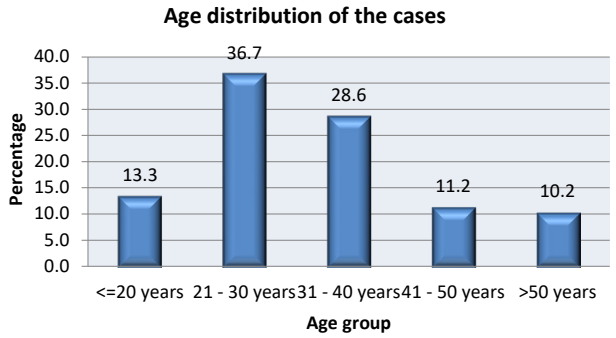

Fig. 1: Age distribution of the cases

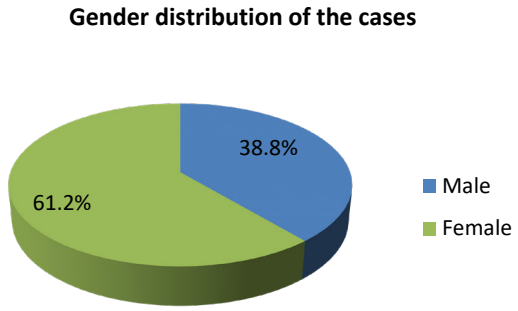

Fig. 2: Gender distribution of the cases

hearing loss (18.3%), and itching or tinnitus (11.2%). No patients reported vertigo or facial weakness. Perforation characteristics varied, with medium central perforations being most common (41.8%), followed by large central perforations (30.6%), subtotal perforations (21.4%), and small central perforations (6.1%).

Preoperative Hearing Assessment

Preoperative audiological evaluation revealed predominantly conductive hearing loss in both groups (85.7% in mastoidectomy group, 91.8% in tympanoplasty-only group), with mixed hearing loss comprising the remainder. Mean preoperative pure tone averages varied significantly between subgroups, ranging from 36.45 ± 6.70 dB in the tympanoplasty-only with temporalis fascia group to 49.11 ± 13.19 dB in the mastoidectomy with fascia-cartilage combination group.

Graft Uptake Outcomes

Graft uptake rates demonstrated significant differences between surgical approaches and graft materials. In the cortical mastoidectomy group, patients receiving temporalis fascia with conchal cartilage achieved 100% graft uptake, while those receiving temporalis fascia alone achieved 81.8% uptake with 18.2% experiencing residual perforation and 9.1% developing postoperative discharge.

Among patients undergoing tympanoplasty without mastoidectomy, those receiving combination fascia-cartilage grafts achieved 96.6% uptake with only 3.4% residual perforation. In contrast, patients receiving temporalis fascia alone demonstrated 65% graft uptake, with 35% experiencing residual perforation, 20% developing postoperative discharge, and 5% forming granulation tissue.

Hearing Outcomes

Pure Tone Average Improvement

The greatest hearing improvement was observed in the mastoidectomy group receiving fascia-cartilage grafts (17.40 ± 9.61 dB improvement), followed by the tympanoplasty-only group with fascia-cartilage grafts (13.84 ± 7.93 dB). Patients receiving temporalis fascia alone showed more modest improvements: 12.03 ± 6.84 dB in the mastoidectomy group and 9.80 ± 6.58 dB in the tympanoplasty-only group. Pure tone average comparisons by surgery and graft material are summarized in Table 3 and Figure 3.

Table 3: Mean pure tone average comparison according to type of surgery and graft material

Pure tone average	*With cortical mastoidectomy*				*Without cortical mastoidectomy*				*p*
	Type of graft				*Type of graft*				
	Temporalis fascia		*Temporalis fascia + conchal cartilage*		*Temporalis fascia*		*Temporalis fascia + conchal cartilage*		
	Mean	*Standard Deviation*	*Mean*	*Standard Deviation*	*Mean*	*Standard Deviation*	*Mean*	*Standard Deviation*	
Preop PTA (dB) Ear	38.58	7.31	49.11	13.19	36.45	6.70	41.59	14.38	0.000
Post OP PTA (dB)	26.55	5.22	31.71	10.29	26.65	4.24	27.74	9.00	0.000
PTA improvement	12.03	6.84	17.40	9.61	9.80	6.58	13.84	7.93	0.000

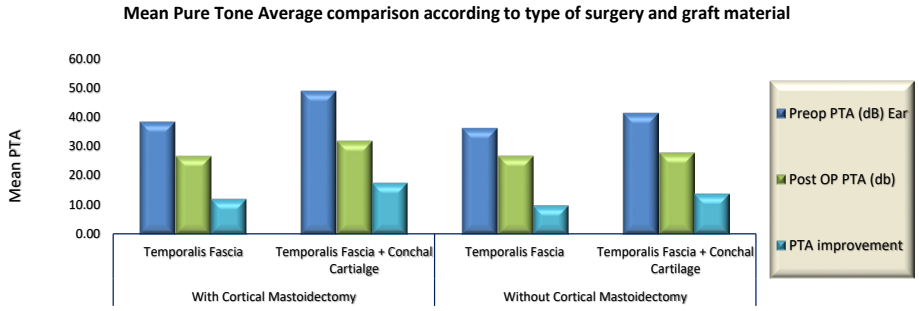

Fig. 3: Mean pure tone average comparison according to type of surgery and graft material

Table 4: Mean air bone gap comparison according to type of surgery and graft material

Air bone gap	*With cortical mastoidectomy*				*Without cortical mastoidectomy*				*p*
	Type of graft				*Type of graft*				
	Temporalis fascia		*Temporalis fascia + conchal cartilage*		*Temporalis fascia*		*Temporalis fascia + conchal cartilage*		
	Mean	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	
Preop ABG (dB) Ear	27.13	6.59	33.12	9.06	23.82	7.26	25.96	8.02	0.000
Post OP ABG(dB)	15.57	5.17	16.56	6.84	15.97	5.43	12.82	5.64	0.000
ABG improvement	11.55	7.63	16.57	7.98	7.85	7.69	13.14	7.13	0.000

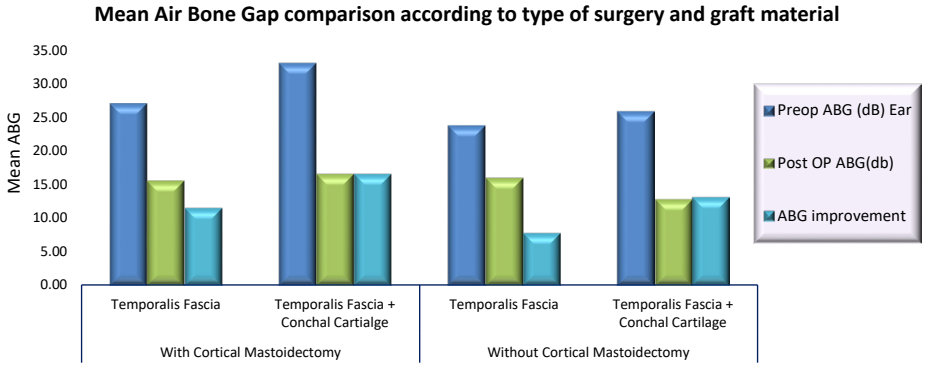

Fig. 4: Mean air bone gap comparison according to type of surgery and graft material

Air-Bone Gap Improvement

Similar patterns emerged for air-bone gap closure. The mastoidectomy with fascia-cartilage group achieved the greatest improvement (16.57 ± 7.98 dB), followed by the tympanoplasty-only with fascia-cartilage group (13.14 ± 7.13 dB). The mastoidectomy with fascia-only group improved by 11.55 ± 7.63 dB, while the tympanoplasty-only with fascia-only group showed the least improvement (7.85 ± 7.69 dB). Air-bone gap comparisons are provided in Table 4 and Figure 4.

Postoperative Hearing Levels

Final postoperative hearing levels were comparable across most groups, ranging from 26.55 ± 5.22 dB in the mastoidectomy with temporalis fascia group to 31.71 ± 10.29 dB in the mastoidectomy with fascia-cartilage group. This suggests that while absolute hearing levels were similar, the improvement achieved varied significantly based on preoperative hearing levels and surgical approach.

Intraoperative Findings and Complications

Among patients undergoing cortical mastoidectomy, ossicular erosion was identified in a subset of cases. Malleus erosion occurred in 13.2% of cases, incus erosion in 15.8%, and stapes erosion in 2.6%. These findings were reported exclusively in the mastoidectomy group receiving fascia-cartilage grafts, likely reflecting the more

severe disease burden in this population.

Postoperative complications were generally limited and predominantly involved residual perforation and discharge. The highest complication rates occurred in the tympanoplasty-only group receiving temporalis fascia alone, with 35% residual perforation rate and 20% discharge rate. No major complications such as facial nerve injury, sensorineural hearing loss, or intracranial complications were reported.

Statistical Significance

All comparisons between surgical approaches and graft materials demonstrated statistically significant differences ($p = 0.000$) for both graft uptake rates and hearing improvement measures. These findings provide robust statistical support for the clinical observations.

Discussion

Principal Findings

This comparative observational study provides compelling evidence supporting the use of cortical mastoidectomy in conjunction with tympanoplasty for patients with CSOM and active mucosal disease. The results demonstrate significantly improved graft uptake rates and superior hearing outcomes when mastoidectomy is performed, particularly when combined with temporalis fascia-conchal cartilage grafts.

Graft Uptake Analysis

The 100% graft uptake rate achieved in the mastoidectomy group with fascia-cartilage grafts represents an exceptional outcome that compares favorably with published literature. This finding supports the hypothesis that elimination of the mastoid air cell reservoir of infection creates optimal conditions for graft integration and healing. The substantial difference compared to tympanoplasty alone (96.6% with fascia-cartilage, 65% with fascia alone) underscores the clinical significance of this surgical decision.

The marked difference in graft uptake between different graft materials, particularly in the tympanoplasty-only group, highlights the importance of graft selection. The 31.6% difference in uptake rates between fascia-cartilage combination (96.6%) and fascia alone (65%) in this group suggests that cartilage support provides crucial structural integrity in the absence of complete disease eradication.

Hearing Improvement Patterns

The hearing improvement patterns observed in this study align with theoretical expectations and clinical experience. The superior outcomes in the mastoidectomy group likely reflect both improved graft uptake (ensuring tympanic membrane integrity) and more complete disease eradication (reducing ongoing inflammation that could impair ossicular function).

The finding that absolute postoperative hearing levels were similar across groups, despite varying degrees of improvement, suggests that the surgical procedures successfully addressed the conductive component of hearing loss regardless of approach. However, the greater improvement achieved in the mastoidectomy groups indicates more severe baseline disease burden, consistent with the clinical rationale for selecting more extensive surgical procedures.

Comparison with Published Literature

These findings align with several recent comparative studies examining similar questions. Sharma et al. [11] reported comparable graft uptake rates favoring mastoidectomy, while Bajaj et al.[12] demonstrated similar hearing improvement patterns. However, the absolute success rates achieved in this study, particularly the 100% graft uptake in the mastoidectomy with fascia-cartilage group, exceed many published series, suggesting excellent surgical technique and patient selection.

The observed ossicular erosion rates (malleus 13.2%, incus 15.8%, stapes 2.6%) in the mastoidectomy group reflect the disease severity that prompted selection of the more extensive procedure. These rates are consistent with published literature describing ossicular pathology in CSOM with active mucosal disease.[15,16]

Clinical Implications

The results of this study have important implications for surgical decision-making in CSOM management. The significant advantages demonstrated for cortical mastoidectomy suggest that this procedure should be strongly considered in patients with active mucosal disease, particularly when infection control has been challenging or previous tympanoplasty attempts have failed.

The superior performance of fascia-cartilage combination grafts across both surgical approaches supports the routine consideration of cartilage reinforcement, especially in cases with risk factors for graft failure such as active inflammation, previous surgical failures, or large perforations.

Cost-Effectiveness Considerations

While this study did not formally evaluate cost-effectiveness, the superior success rates achieved with

mastoidectomy may translate to reduced need for revision procedures, decreased long-term complications, and improved quality of life outcomes. The 35% failure rate in the tympanoplasty-only group with fascia grafts alone suggests that more than one-third of these patients may require additional surgical intervention, potentially making the more extensive initial procedure cost-effective in the long term.

Technical Considerations

The excellent outcomes achieved in this study likely reflect several technical factors. The systematic approach to disease eradication in the mastoidectomy group, careful attention to graft placement and fixation, and standardized postoperative care protocols all contribute to the observed success rates. The use of otoendoscopy for outcome assessment provides superior visualization compared to otoscopy alone, ensuring accurate evaluation of graft status.

Study Strengths and Limitations

This study benefits from several methodological strengths, including prospective design, standardized surgical techniques, objective outcome measures, and robust statistical analysis. The allocation of different surgical teams to each procedure type ensures consistency in surgical approach while minimizing selection bias.

However, certain limitations must be acknowledged. The single-center design may limit generalizability to other populations or healthcare settings. The relatively short follow-up period (3 months) may not capture late graft failures or long-term hearing stability. The sample size, while adequate for statistical analysis, is modest compared to some large multicenter series.

The pragmatic randomization approach, while practical, may introduce subtle selection biases if patient characteristics influenced team assignment. Additionally, the absence of a formal control group limits our ability to compare surgical outcomes with non-operative management, though ethical considerations make such comparisons challenging in patients requiring surgical intervention.

Future Research Directions

Several areas warrant further investigation based on these findings. Long-term follow-up studies extending beyond 3 months would provide valuable information about graft stability and hearing maintenance over time. Multi-center studies would enhance generalizability and allow for larger sample sizes to detect smaller effect differences.

Cost-effectiveness analyses incorporating direct medical costs, indirect costs from time off work, and quality-adjusted life years would provide important economic data to guide healthcare policy decisions. Investigation of biological markers of mastoid disease activity might help refine patient selection criteria for more extensive surgical procedures.

Advanced imaging techniques such as high-resolution computed tomography or magnetic resonance imaging could potentially predict which patients would benefit most from mastoidectomy, allowing for more precise surgical planning. Similarly, investigation of patient-reported outcome measures would provide important perspectives on functional improvement beyond audiometric data.

Conclusion

This comparative observational study provides robust evidence supporting the use of cortical mastoidectomy in conjunction with tympanoplasty for patients with chronic suppurative otitis media and active mucosal disease. The significantly improved graft uptake rates (100% vs 65-96.6%) and superior hearing outcomes (17.40 ± 9.61 dB vs 7.85-13.84 dB improvement) demonstrated in the mastoidectomy group justify the additional surgical complexity and time required for this approach.

The study also confirms the value of conchal cartilage reinforcement in tympanic membrane reconstruction, with fascia-cartilage combination grafts consistently outperforming fascia alone across both surgical approaches. These findings support a treatment algorithm that considers cortical mastoidectomy as the preferred approach for CSOM with active mucosal disease, with cartilage-reinforced grafts recommended regardless of the surgical approach selected.

The results contribute significantly to the evidence base guiding surgical decision-making in CSOM management and support individualized treatment strategies based on disease characteristics and patient factors. While further research with longer follow-up periods and larger sample sizes would strengthen these conclusions, the current findings provide clear guidance for optimizing surgical outcomes in this challenging patient population.

The implications extend beyond individual patient care to influence training curricula for otolaryngology residents, healthcare resource allocation decisions, and the development of clinical practice guidelines. As healthcare systems worldwide grapple with the burden of chronic ear disease, these findings support investment in

surgical training and infrastructure capable of delivering comprehensive mastoid surgery when indicated.

In summary, this study establishes cortical mastoidectomy with cartilage-reinforced tympanoplasty as the optimal surgical approach for chronic suppurative otitis media with active mucosal disease, providing both superior anatomical and functional outcomes compared to more limited surgical interventions.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

This research received no external funding.

References

1. Khairkar M, Deshmukh P, Maity H, Deotale V. Chronic suppurative otitis media: a comprehensive review of epidemiology, pathogenesis, microbiology, and complications. Cureus. 2023;15(4):e37441.
2. Teele DW, Klein JO, Rosner B. Epidemiology of otitis media during the first seven years of life in children in greater Boston: a prospective cohort study. J Infect Dis. 1989;160(1):83-94.
3. Wullstein H. Theory and practice of tympanoplasty. Laryngoscope. 1956;66(8):1076-93.
4. Zöllner F. The principles of plastic surgery of the sound-conducting apparatus. J Laryngol Otol. 1955;69(10):637-52.
5. Sharma A, Baisakhiya N, Garg LN, Singh G. Evaluation of role of mastoid surgery in the management of safe chronic suppurative otitis media. Indian J Otolaryngol Head Neck Surg. 2016;68(4):434-40.
6. Mishiro Y, Sakagami M, Takahashi Y, Kitahara T, Kajikawa H, Kubo T. Tympanoplasty with and without mastoidectomy for non-cholesteatomatous chronic otitis media. Eur Arch Otorhinolaryngol. 2001;258(1):13-5.
7. Balyan FR, Celikkanat S, Aslan A, Taibah A, Russo A, Sanna M. Mastoidectomy in non-cholesteatomatous chronic suppurative otitis media: is it necessary? Otolaryngol Head Neck Surg. 1997;117(6):592-5.
8. Heermann J, Heermann H, Kopstein E. Fascia and cartilage palisade tympanoplasty: nine years' experience. Arch Otolaryngol. 1970;91(3):228-41.
9. Dornhoffer JL. Cartilage tympanoplasty: indications, techniques, and outcomes in a 1,000-patient series. Laryngoscope. 2003;113(11):1844-56.
10. Zahnert T, Hüttenbrink KB, Mürbe D, Bornitz M. Experimental investigations of the use of cartilage in tympanic membrane reconstruction. Am J Otol. 2000;21(3):322-8.
11. Sharma S, Gupta C, Singh R, Sharma S. Role of cortical mastoidectomy in the management of mucosal chronic suppurative otitis media. Int J Res Rev. 2021;8(7):136-42.
12. Bajaj AR, Sheikh S, Joshi S, Paike B. Benefit of tympanoplasty with or without cortical mastoidectomy in active mucosal otitis media: a comparative study. BJOHNS. 2019;27(1):15-9.
13. McGrew BM, Jackson CG, Glasscock ME. Impact of mastoidectomy on simple tympanoplasty. Laryngoscope. 2004;114(3):506-11.
14. Tos M, Lau T, Plate S. Sensorineural hearing loss following chronic otitis media. Ann Otol Rhinol Laryngol. 1988;97(6):585-93.
15. Austin DF. Ossicular reconstruction. Arch Otolaryngol. 1971;94(6):525-35.
16. House WF, Sheehy JL. Functional restoration in tympanoplasty. Arch Otolaryngol. 1963;78(3):304-10