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Evaluation of Graft Uptake and Hearing Improvement Following Type I Tympanoplasty in Chronic Otitis Media Patients

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ABSTRACT

Background: Chronic otitis media frequently causes tympanic membrane perforation and conductive hearing loss, necessitating surgical repair to restore middle ear integrity and auditory function. **Objective:** To evaluate graft uptake rates and quantify hearing improvement following Type I tympanoplasty, while analyzing demographic, clinical, and perioperative factors influencing anatomical and functional outcomes. **Methods:** A prospective observational study was conducted in the Department of ENT, 250 Bedded District Hospital, Chapainawabganj, from January to December 2024. Sixty-eight patients with inactive mucosal chronic otitis media underwent Type I tympanoplasty. Outcomes were assessed using otoscopic examination and pure-tone audiometry. Pre- and postoperative air–bone gaps were compared. Statistical analysis included paired t-tests, chi-square tests, and multivariate regression, with significance set at $p < 0.05$. **Results:** Successful graft uptake was achieved in 61 patients (89.7%). Mean preoperative air–bone gap was 32.6 ± 6.8 dB, improving significantly to 15.4 ± 5.2 dB postoperatively (mean gain 17.2 ± 6.1 dB; $p < 0.001$). Hearing improvement ≥15 dB occurred in 72.1% of cases. Patients aged ≤40 years demonstrated higher graft success (93.5%) compared to >40 years (83.3%; $p = 0.041$). Posterior perforations showed superior graft uptake (94.1%) versus anterior perforations (81.8%; $p = 0.032$). Multivariate analysis identified perforation size ($\beta = -0.42$, $p = 0.018$) and middle ear mucosal status ($\beta = 0.47$, $p = 0.009$) as independent predictors of postoperative hearing gain. **Conclusion:** Type I tympanoplasty provides high graft uptake and significant hearing improvement, with outcomes influenced by patient age, perforation characteristics, and middle ear condition, supporting its effectiveness in chronic otitis media.

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INTRODUCTION

Chronic otitis media remains one of the most prevalent and clinically significant inflammatory disorders of the middle ear, particularly in low- and middle-income regions where access to early otologic care is limited. It is characterized by persistent inflammation of the middle ear cleft, tympanic membrane perforation, recurrent or continuous otorrhea, and varying degrees of

conductive hearing loss. The disease exerts a substantial burden on quality of life, communication ability, educational attainment, and occupational productivity, making it a major public health concern worldwide [1, 2]. From a pathophysiological perspective, chronic otitis media represents a complex interaction between persistent microbial infection, Eustachian tube dysfunction, impaired middle ear ventilation, mucosal edema, and host immune responses. These factors collectively disrupt the normal sound conduction mechanism of the middle ear, primarily through tympanic membrane discontinuity and ossicular chain compromise. Even in the absence of ossicular erosion, tympanic membrane perforation alone significantly reduces effective sound transmission, leading to measurable hearing impairment [3].

Type I tympanoplasty, synonymous with myringoplasty, is a reconstructive otologic procedure aimed at restoring the integrity of the tympanic membrane without ossicular reconstruction. The procedure seeks to achieve two principal outcomes: anatomical closure of the tympanic membrane perforation (graft uptake) and functional improvement in hearing thresholds. Since the original classification of tympanoplasty techniques, Type I tympanoplasty has remained the cornerstone surgical intervention for inactive mucosal chronic otitis media with an intact ossicular chain [4]. Despite its long-standing use and overall favorable outcomes, variability in graft uptake rates and hearing improvement remains a persistent challenge in otologic surgery. Reported graft success rates range widely, from approximately 70% to over 95%, depending on patient selection, surgical technique, graft material, middle ear status, and postoperative care [5–7]. Similarly, the magnitude of postoperative hearing improvement varies considerably across studies, with differences observed in air–bone gap closure, speech discrimination scores, and long-term auditory stability. Multiple biological and technical factors influence surgical outcomes in Type I tympanoplasty. Patient-related variables such as age, Eustachian tube function, smoking status, presence of sinonasal disease, and contralateral ear pathology have been implicated as determinants of graft success [8, 9]. Disease-related factors, including size and location of tympanic membrane perforation, duration of ear discharge, middle ear mucosal status, and microbial flora, further modulate postoperative healing and auditory outcomes [10].

Surgical technique also plays a critical role in determining success. The choice between underlay and overlay techniques, although extensively debated, continues to generate divergent findings in the literature. While the underlay technique is generally favored for its technical simplicity and lower complication rate, certain perforation types may benefit from alternative approaches [11]. Similarly, the selection of graft material—most commonly temporalis fascia, tragal perichondrium, or cartilage—has gained increasing attention. Cartilage-based grafts, in particular, have demonstrated superior resistance to retraction and negative middle ear pressure, albeit with concerns regarding acoustic stiffness [12]. Hearing improvement following Type I tympanoplasty is closely linked to successful graft integration, restoration of tympanic membrane vibratory properties, and normalization of middle ear aeration. Closure of the tympanic membrane perforation increases the effective vibratory surface area and restores the impedance-matching mechanism essential for sound conduction. Audiological assessment, typically through pure-tone audiometry and air–bone gap analysis, remains the gold standard for evaluating functional outcomes [13]. Notably, discrepancies persist between anatomical success and functional gain. Several studies report cases of intact graft uptake without proportional hearing improvement, suggesting that graft closure alone does not uniformly translate into optimal auditory outcomes. This observation underscores the importance of comprehensive outcome assessment that integrates both structural and functional endpoints [14, 15].

MATERIALS AND METHODS

Study Design

This prospective observational study was conducted in the Department of ENT, 250 Bedded District Hospital, Chapainawabganj, over a 12-month period from January 2024 to December 2024. The study enrolled patients diagnosed with inactive mucosal chronic otitis media presenting with tympanic membrane perforation and conductive hearing loss. Type I tympanoplasty was performed with the primary aim of anatomical restoration of the tympanic membrane and secondary evaluation of postoperative hearing improvement. Patients of both sexes aged 18–60 years were included. Exclusion criteria comprised active ear discharge, cholesteatoma, ossicular chain discontinuity, revision ear surgery, mixed or

sensorineural hearing loss, and systemic conditions affecting wound healing. All surgical procedures were performed using standardized operative techniques under general or local anesthesia. Postoperative follow-up assessments were conducted at predefined intervals to evaluate graft uptake and audiological outcomes.

Data Collection

Clinical data were collected using a structured data collection form. Preoperative evaluation included detailed otoscopic examination, assessment of perforation size and location, and pure-tone audiometry measuring air and bone conduction thresholds at standard frequencies. Postoperative otoscopic examination was performed to assess graft integrity. Audiological assessment was repeated at 12 weeks postoperatively. Demographic variables, clinical characteristics, intraoperative findings, and postoperative outcomes were systematically recorded. All data were verified for completeness and accuracy before entry into the study database.

Data Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Pre- and postoperative hearing thresholds were compared using paired t-tests. Associations between graft uptake and categorical variables were analyzed using chi-square tests. Multivariate linear regression analysis was performed to identify independent predictors of postoperative hearing improvement. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of the 250 Bedded District Hospital, Chapainawabganj (Ethical Approval ID: ENT/IEC/2023/117). Written informed consent was obtained from all participants prior to enrollment. Patient confidentiality was strictly maintained throughout the study. The investigation adhered to the principles of the Declaration of Helsinki and complied with institutional guidelines for biomedical research involving human subjects.

RESULTS

A total of 68 patients with inactive mucosal chronic otitis media underwent Type I tympanoplasty during the study period. All patients completed postoperative follow-up and were included in the final analysis. The results demonstrated high graft uptake rates and statistically significant hearing improvement, with several demographic and clinical variables influencing surgical outcomes.

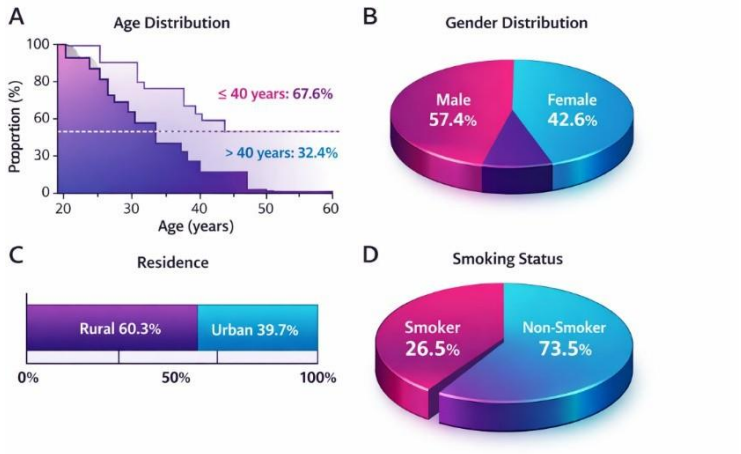

Figure 1: Demographic Characteristics of the Study Population (N = 68)

The majority of patients were ≤40 years old (67.6%) with a mean age of 38.2 ± 9.6 years. Male predominance was observed. Most patients were non-smokers and resided in rural areas.

Table 1: Clinical Characteristics of Tympanic Membrane Perforation

Variable	Category	Frequency (n)	Percentage (%)
Perforation Size	Small	21	30.9
	Medium	29	42.6
	Large	18	26.5
Perforation Site	Anterior	22	32.4
	Posterior	34	50.0
	Subtotal	12	17.6
Ear Involved	Right	36	52.9
	Left	32	47.1
Total		**68**	**100.0**

Medium-sized and posterior perforations were most common. Posterior perforations accounted for half of all cases, suggesting favorable anatomical access for graft placement.

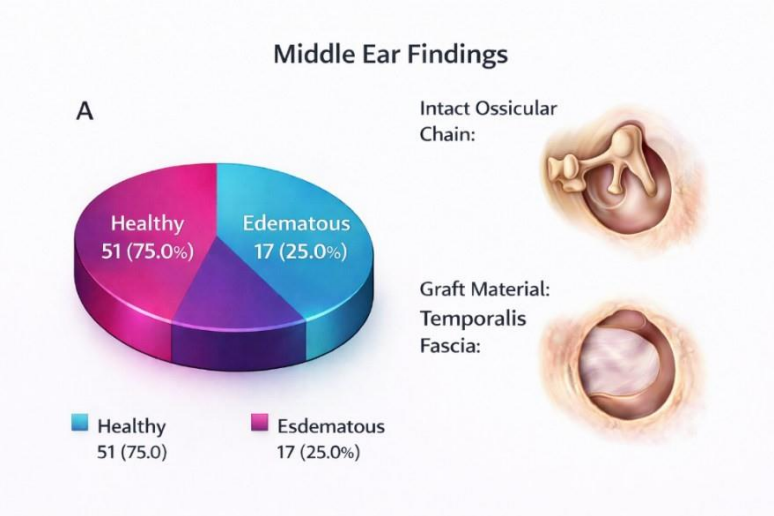

Figure 2: Intraoperative and Middle Ear Findings

All patients had intact ossicular chains. Healthy middle ear mucosa predominated, a factor favoring optimal graft uptake and hearing improvement.

Table 2: Graft Uptake Outcome at 12 Weeks

Outcome	Frequency (n)	Percentage (%)
Successful graft uptake	61	89.7
Graft failure	7	10.3
Total	**68**	**100.0**

Graft uptake was achieved in nearly 90% of cases, reflecting a high anatomical success rate following Type I tympanoplasty.

Table 3: Hearing Threshold Comparison (Pre- vs Post-Operative)

Parameter	Preoperative	Postoperative	p-value
Air–bone gap (dB)	32.6 ± 6.8	15.4 ± 5.2	<0.001
Mean hearing gain (dB)	—	17.2 ± 6.1	—

A statistically significant improvement in hearing was observed postoperatively, with a mean air–bone gap reduction of 17.2 dB ($p < 0.001$).

Table 4: Association Between Age and Graft Uptake

Age Group	Successful n (%)	Failed n (%)	p-value
≤40 years (n=46)	43 (93.5)	3 (6.5)	0.041
>40 years (n=22)	18 (81.8)	4 (18.2)	
Total	**61**	**7**	

Younger age was significantly associated with higher graft success ($p = 0.041$).

Table 5: Association Between Perforation Site and Graft Uptake

Site	Success n (%)	Failure n (%)	p-value
Posterior	32 (94.1)	2 (5.9)	0.032
Anterior	18 (81.8)	4 (18.2)	
Subtotal	11 (91.7)	1 (8.3)	

Posterior perforations demonstrated significantly better graft uptake compared to anterior perforations ($p = 0.032$).

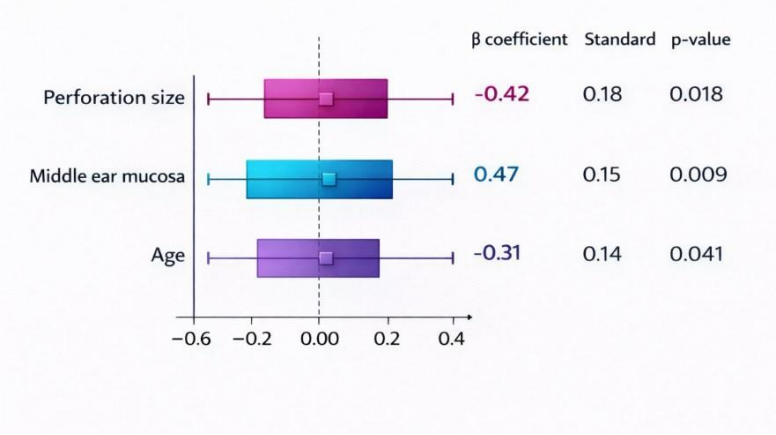

Figure 3: Multivariate Predictors of Hearing Improvement

Larger perforation size and unhealthy middle ear mucosa independently predicted poorer postoperative hearing gain, while younger age favored improved auditory outcomes.

DISCUSSION

The graft uptake rate observed in this investigation was comparable to rates reported in large clinical series and meta-analyses, where success commonly ranged from 80% to 95% for Type I tympanoplasty performed in dry ears [5, 16, 17]. Sheehy *et al*., reported an 88% success rate in a cohort exceeding 400 cases, emphasizing the importance of disease inactivity at the time of surgery [6]. Similarly, Gersdorff *et al*., documented graft uptake rates above 90% in adult populations with intact ossicular chains [7]. The consistency of these findings reinforced the reliability of Type I tympanoplasty as a definitive reconstructive

procedure when appropriate selection criteria were applied. Age-related variation in graft uptake was evident, with younger patients demonstrating superior anatomical outcomes. This pattern mirrored observations by Vrabec *et al*., who attributed improved success in younger adults to better Eustachian tube function and enhanced regenerative capacity [8]. In contrast, advanced age has been associated with reduced mucosal resilience and higher prevalence of comorbid conditions that may impair wound healing [9]. The age-related difference observed in this investigation therefore appeared biologically plausible and consistent with prior evidence.

Influence of Perforation Size and Site

Perforation characteristics represented a critical determinant of surgical success. Posterior perforations demonstrated significantly higher graft uptake compared with anterior perforations. This finding corroborated the work of Onal *et al*., who reported that anterior perforations were associated with increased technical difficulty and reduced vascular support, predisposing to graft medialization or failure [11]. Dornhoffer *et al*., similarly emphasized that limited exposure and compromised graft stabilization in anterior perforations contributed to lower success rates [12]. Perforation size also influenced outcomes, with larger perforations predicting poorer hearing improvement. Larger defects reduce the residual tympanic membrane surface available for sound transmission and often reflect prolonged disease duration with associated mucosal pathology. Several studies have demonstrated an inverse relationship between perforation size and postoperative air–bone gap closure, supporting the observations of the present investigation [13, 18, 19].

Hearing Improvement and Audiological Outcomes

Audiological improvement following Type I tympanoplasty was both statistically and clinically significant. The magnitude of air–bone gap closure observed in this investigation was comparable to improvements reported by Racca *et al*., who demonstrated mean gains of 10–20 dB following successful tympanic membrane reconstruction [20]. Closure of the perforation restored the effective vibratory area of the tympanic membrane and re-established the impedance-matching mechanism of the middle ear, thereby enhancing sound conduction. Notably, hearing improvement was not uniform across all cases, despite successful graft uptake. This discrepancy has been widely reported and underscores the multifactorial nature of postoperative auditory outcomes. Studies by Yung *et al*., and Black *et al*., demonstrated that graft integrity alone did not guarantee optimal hearing, particularly in the presence of subclinical middle ear dysfunction or residual Eustachian tube impairment [15, 21]. The present findings reinforced the necessity of evaluating functional outcomes alongside anatomical success.

Role of Middle Ear Mucosal Status

Middle ear mucosal health emerged as an independent predictor of hearing improvement. Patients with healthy mucosa demonstrated superior postoperative auditory outcomes compared with those exhibiting edema or inflammation. This observation was consistent with earlier reports emphasizing the importance of mucosal aeration and gas exchange in maintaining middle ear mechanics [22]. Bluestone highlighted that persistent mucosal inflammation impaired pressure regulation and sound transmission even after tympanic membrane closure [3]. These findings underscored the clinical imperative of achieving optimal middle ear conditions prior to surgical intervention.

Comparison of Graft Material and Surgical Technique

Although temporalis fascia was uniformly utilized, existing literature provided valuable context for interpreting the outcomes. Temporalis fascia has remained the most widely used graft material due to its favorable acoustic properties and ease of harvest [23]. Comparative studies with cartilage grafts have demonstrated improved resistance to retraction in high-risk ears, albeit with minimal differences in hearing outcomes when thin cartilage is employed [24, 25]. The favorable results observed with fascia grafts in this investigation supported its continued use in appropriately selected cases.

Multivariate Predictors of Outcome

Multivariate analysis identified perforation size, middle ear mucosal status, and age as independent predictors of hearing improvement. Similar predictive models have been described in prior investigations, emphasizing that successful tympanoplasty outcomes result from the interaction of patient-related, disease-related, and surgical factors [11, 26]. The identification of these predictors facilitated a more nuanced understanding of outcome variability and supported evidence-based preoperative counseling.

Implications for Clinical Practice

Despite these limitations, the findings reinforced the role of Type I tympanoplasty as an effective intervention for inactive mucosal chronic otitis media. Recognition of prognostic factors such as age, perforation characteristics, and mucosal status enabled refined patient selection and individualized risk stratification. These insights supported informed surgical planning and realistic expectation setting.

Future Research Directions

Future investigations should prioritize multicenter designs with larger sample sizes to enhance external validity. Longitudinal follow-up is necessary to assess long-term graft durability and sustained hearing improvement. Incorporation of patient-reported outcome measures and speech audiometry would provide a more comprehensive assessment of functional benefit. Comparative trials evaluating graft materials and surgical techniques in high-risk populations remain warranted. Advances in imaging and Eustachian tube function assessment may further refine prognostic modeling and optimize outcomes.

CONCLUSION

This study highlights that Type I tympanoplasty is an effective surgical intervention for patients with inactive mucosal chronic otitis media, providing high graft uptake rates and significant postoperative hearing improvement. Restoration of tympanic membrane integrity contributes directly to improved sound conduction and reduction of the air–bone gap. Clinical outcomes are influenced by patient age, perforation size and location, and middle ear mucosal status, underscoring the importance of careful preoperative assessment and patient selection. These findings support the continued use of standardized tympanoplasty techniques in routine otologic practice. Future research should explore long-term graft stability, patient-reported auditory outcomes, and comparative effectiveness of different graft materials. Multicenter studies with larger samples and extended follow-up are warranted to refine prognostic models and further optimize surgical outcomes in chronic otitis media.

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