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Assessment of hearing outcome after type 1 tympanoplasty

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ABSTRACT

Background: Chronic suppurative otitis media (CSOM) often leads to tympanic membrane perforation and conductive hearing loss. Type I tympanoplasty aims to restore the integrity of the tympanic membrane while improving hearing.
Objective: To assess the hearing outcomes following Type I tympanoplasty using the underlay temporalis fascia graft.
Materials and Methods: A total of 50 patients with tubotympanic CSOM and intact ossicular chain were included in this prospective study. Preoperative and postoperative pure-tone audiometry (PTA) was performed to measure hearing thresholds and air-bone gap (ABG). Graft uptake and postoperative complications were also recorded. Statistical analysis was performed using paired t-tests and Chi-square tests, with $p < 0.05$ considered significant.
Results: The mean preoperative PTA threshold was 43.8 ± 8.9 dB, which improved to 31.5 ± 6.8 dB postoperatively ($p < 0.001$). The mean ABG reduced from 27.1 ± 6.5 dB to 14.0 ± 5.2 dB, yielding a mean hearing gain of 13.1 dB. Graft uptake at 6 months was achieved in 44 patients (88%), and postoperative complications were minimal.
Conclusion: Type I tympanoplasty using underlay temporalis fascia graft is a safe and effective procedure for repairing tympanic membrane perforations, providing significant audiological improvement and high graft success rates. Routine postoperative assessment with PTA is essential for documenting functional outcomes and counseling patients.

Keywords: Chronic suppurative otitis media, Type I tympanoplasty, Temporalis fascia graft, Hearing outcome, Air-bone gap, Pure-tone audiometry.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is a common disorder of the middle ear cleft, characterized by persistent or recurrent tympanic membrane perforation, recurrent ear discharge, and varying degrees of conductive hearing loss. The condition remains a major cause of hearing impairment worldwide, particularly in developing countries, where socioeconomic factors, malnutrition, and limited health awareness contribute to its high prevalence [1,2]. Conductive hearing loss in CSOM results primarily from disruption of the normal sound transmission mechanism, often due to perforation of the tympanic membrane, middle ear pathology, or ossicular chain dysfunction [1,2].Management of CSOM can be conservative or surgical. While small perforations may close spontaneously, chronic perforations with epithelialized edges generally do not heal without intervention. Surgical repair, aimed at restoring middle ear function, is indicated not only to achieve anatomical closure of the tympanic membrane but also to improve hearing and overall quality of life [3]. Tympanoplasty represents the standard surgical approach for repairing tympanic membrane perforations. Depending on the status of the ossicular chain, tympanoplasty may involve grafting the tympanic membrane alone or in combination with ossicular reconstruction (ossiculoplasty), giving rise to various subtypes [4,5].

Type I tympanoplasty, also known as myringoplasty, is performed when the tympanic membrane is perforated but the ossicular chain is intact. The procedure may range from relatively straightforward interventions—such as removal of a retracted membrane or adhesions around the ossicles—to more extensive and time-consuming procedures when combined with mastoidectomy or other adjunctive techniques [6]. Surgical success is generally assessed by both anatomical graft uptake and functional hearing improvement, with studies reporting a mean hearing gain of 10–15 dB and functional success in 70–90 % of cases [7]. Factors that influence post-operative hearing outcomes include the size and site of perforation, status of middle ear mucosa, Eustachian tube function, and the presence of bilateral disease [4,6].

Evaluation of hearing outcomes following Type I tympanoplasty is typically performed using pure-tone audiometry, which provides objective measures of air-conduction thresholds and air-bone gap closure [3,7]. Accurate assessment of these outcomes is essential for surgical audit, patient counseling, and identifying predictors of success or limitations in post-operative hearing improvement [6].Given the high prevalence of CSOM and its significant functional impact, documenting post-tympanoplasty hearing outcomes is vital for optimizing surgical techniques, improving patient satisfaction, and guiding future research in otologic surgery [5]. This study specifically focuses on the functional hearing outcomes in patients undergoing Type I tympanoplasty.

MATERIALS AND METHODS

This was a prospective observational study conducted at the Department of Otolaryngology, Patients aged [15–60 years] presenting with chronic tubotympanic CSOM with a perforated tympanic membrane and intact ossicular chain were considered for inclusion.

Inclusion Criteria

- Patients with CSOM of tubotympanic type.
- Presence of perforation of the tympanic membrane without ossicular damage.
- Air-bone gap ≥ 15 dB on preoperative pure-tone audiometry.
- Patients willing to provide informed consent.

Exclusion Criteria

- Patients with cholesteatoma or ossicular erosion.
- Previous middle ear surgery.
- Patients with sensorineural hearing loss.
- Co-existing chronic systemic illness affecting hearing outcomes.

Preoperative Assessment

All patients underwent a detailed history and otoscopic examination. Preoperative hearing assessment was performed using pure-tone audiometry (PTA) at frequencies of 500 Hz, 1 kHz, 2 kHz, and 4 kHz, and air-bone gap (ABG) was calculated. The size and location of the tympanic membrane perforation were documented. Routine hematological and biochemical investigations were performed to ensure patient fitness for surgery.

Surgical Technique

All surgeries were performed under local or general anesthesia depending on patient preference and age. Type I tympanoplasty was performed using the underlay technique with temporalis fascia graft. The steps included:

1. Postauricular or endaural incision to harvest the temporalis fascia.
2. Elevation of tympanomeatal flap and removal of any granulation tissue.
3. Graft placement using underlay technique beneath the remaining tympanic membrane remnant and annulus.
4. Repositioning of tympanomeatal flap and packing of the external auditory canal with gelfoam. Patients were monitored intraoperatively for complications such as bleeding or graft displacement.

Postoperative Care

Patients received oral antibiotics, analgesics, and nasal decongestants for 5–7 days. Ear packing was removed after 7–10 days, and patients were followed up at 1, 3, and 6 months postoperatively. At each visit, otoscopic examination was performed to assess graft uptake and any signs of infection.

Outcome Measures

The primary outcome was postoperative hearing improvement, measured by PTA and ABG closure at 6 months. Secondary outcomes included graft success rate and incidence of postoperative complications. Functional success was defined as:

- Air-bone gap closure ≤ 20 dB
- Hearing gain ≥ 10 dB at two consecutive frequencies.

Statistical Analysis

Data were entered into [SPSS version 25]. Continuous variables, such as preoperative and postoperative hearing thresholds, were expressed as mean ± standard deviation (SD). Categorical variables, such as graft uptake rate, were expressed as number and percentage. Paired t-test was used to compare preoperative and postoperative hearing thresholds, and Chi-square test was used for categorical comparisons. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 50 patients were included in the study. The mean age of the participants was 35.4 ± 10.2 years. Among them, 28 patients (56%) were male and 22 patients (44%) were female. The right and left ears were equally affected, with 25 patients (50%) each. Regarding the size of the perforation, 12 patients (24%) had small perforations (<25% of tympanic membrane), 18 patients (36%) had medium perforations (25–50%), and 20 patients (40%) had large perforations (>50%) (Table 1).Preoperative and postoperative hearing thresholds were assessed using pure-tone audiometry (PTA) at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. The mean preoperative hearing thresholds ranged from 40.5 ± 8.2 dB at 500 Hz to 47.2 ± 8.5 dB at 4000 Hz. Postoperatively, significant improvement was observed at all frequencies, with mean thresholds decreasing to 28.3 ± 6.5 dB at 500 Hz and 34.1 ± 7.0 dB at 4000 Hz. The average hearing threshold across 0.5–4 kHz improved from 43.8 ± 8.9 dB preoperatively to 31.5 ± 6.8 dB postoperatively ($p < 0.001$) (Table 2, Figure 1).The air-bone gap (ABG) closure demonstrated substantial improvement after surgery. The mean ABG decreased from 25.2 ± 6.4 dB to 12.1 ± 5.3 dB at 500 Hz, 26.0 ± 5.9 dB to 13.4 ± 4.9 dB at 1000 Hz, 28.1 ± 6.7 dB to 14.9 ± 5.1 dB at 2000 Hz, and 29.0 ± 7.1 dB to 15.6 ± 5.4 dB at 4000 Hz. The mean ABG across all tested frequencies reduced from 27.1 ± 6.5 dB preoperatively to 14.0 ± 5.2 dB postoperatively, corresponding to a mean hearing gain of 13.1 dB ($p < 0.001$) (Table 3, Figure 2).The graft uptake rate at 6 months postoperatively was 88% (44/50 patients). Postoperative complications were minimal, with 3 patients (6%) developing infection, 3 patients (6%) showing residual perforation, and 2 patients (4%) experiencing minor complications such as hematoma or ear discharge (Table 4).

Table 1. Demographic Characteristics of Study Participants

Parameter	Number of Patients	Percentage (%)
Age (years), mean ± SD	35.4 ± 10.2	-
Sex		
Male	28	56
Female	22	44
Side of perforation		
Right ear	25	50
Left ear	25	50
Perforation size		
Small (<25% TM)	12	24
Medium (25–50% TM)	18	36
Large (>50% TM)	20	40

Table 2. Preoperative and Postoperative Pure-Tone Audiometry (PTA)

Frequency (Hz)	Preoperative Hearing Threshold (dB), Mean ± SD	Postoperative Hearing Threshold (dB), Mean ± SD	p-value
500	40.5 ± 8.2	28.3 ± 6.5	<0.001
1000	42.1 ± 7.9	30.7 ± 6.8	<0.001
2000	45.3 ± 9.1	32.9 ± 7.2	<0.001
4000	47.2 ± 8.5	34.1 ± 7.0	<0.001
Average (0.5–4 kHz)	43.8 ± 8.9	31.5 ± 6.8	<0.001

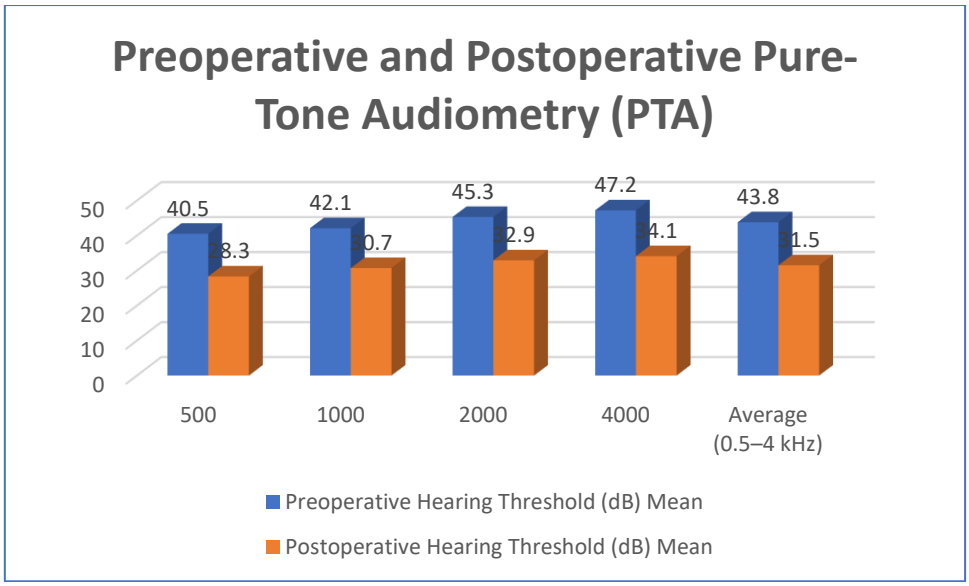

Figure 1 Preoperative and Postoperative Pure-Tone Audiometry (PTA)

Table 3. Air-Bone Gap (ABG) Closure

ABG Parameter	Preoperative (dB), Mean ± SD	Postoperative (dB), Mean ± SD	Hearing Gain (dB)	p-value
500 Hz	25.2 ± 6.4	12.1 ± 5.3	13.1	<0.001
1000 Hz	26.0 ± 5.9	13.4 ± 4.9	12.6	<0.001
2000 Hz	28.1 ± 6.7	14.9 ± 5.1	13.2	<0.001
4000 Hz	29.0 ± 7.1	15.6 ± 5.4	13.4	<0.001
Mean ABG (0.5–4 kHz)	27.1 ± 6.5	14.0 ± 5.2	13.1	<0.001

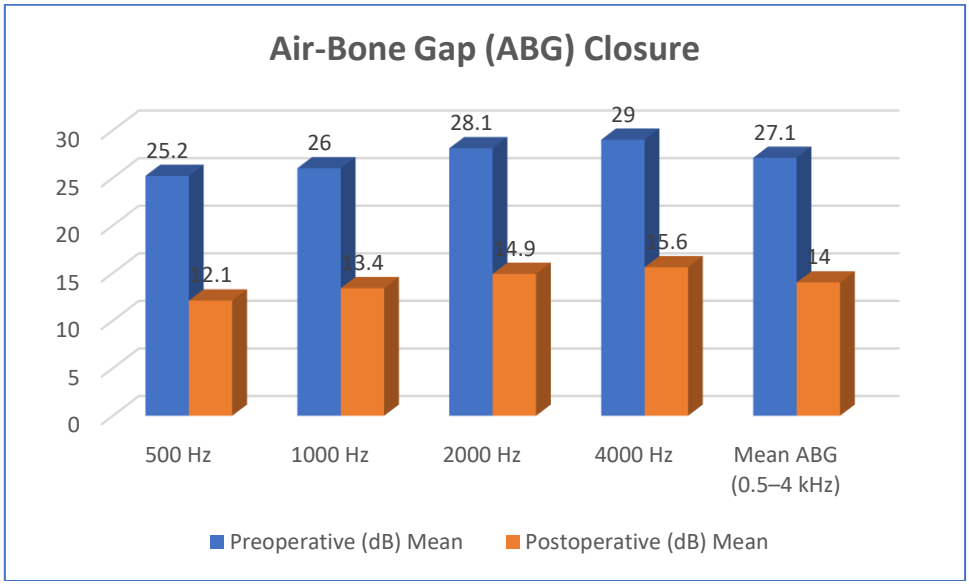

Figure 2 Air-Bone Gap (ABG) Closure

Table 4. Graft Uptake and Postoperative Complications

Outcome	Number of Patients (n=50)	Percentage (%)
Graft uptake at 6 months	44	88
Postoperative infection	3	6
Residual perforation	3	6
Other complications (hematoma/ear discharge)	2	4

DISCUSSION

In the present study, Type I tympanoplasty using an underlay temporalis fascia graft demonstrated significant functional improvement in hearing, with notable reduction in air-bone gap (ABG) and a high graft success rate of 88 % at 6 months.

Our mean ABG closure of ~13 dB and overall hearing gain aligns closely with other published literature. A comparable retrospective study by Batni et al.[8] reported an 88 % graft uptake rate and a mean hearing gain of 14.55 dB, with a reduction in mean ABG of 11.94 dB at 1 year post-operatively in patients undergoing Type I tympanoplasty with temporalis fascia underlay technique. These results are in harmony with our findings, supporting the efficacy of the underlay temporalis fascia graft in achieving both anatomical closure and functional hearing improvement.Several other studies have also reported similar functional outcomes. In a large retrospective review of tympanoplasty cases, the mean ABG improved from about 26.3 ± 8.1 dB pre-operatively to 14 ± 10.41 dB post-operatively, with over 86 % of patients demonstrating significant hearing improvement, indicating that tympanoplasty reliably improves conductive hearing loss. [9]This supports our observation of significant audiological benefit following surgery.In the prospective comparative study by Mallikarjun et al.[10], Type I tympanoplasty with temporalis fascia showed favorable hearing outcomes similar to our results, with significant post-operative improvement in pure-tone thresholds and ABG closure. Furthermore, Saha et al.[11] reported an overall hearing gain of approximately 10 dB following Type I tympanoplasty and showed that factors such as perforation size and bilateral disease influence final hearing results. Although our study did not stratify outcomes by perforation size or bilateral involvement, the overall functional improvement remains in the reported range.While our study focused solely on temporalis fascia, variations in graft materials have also been evaluated. For example, a comparative analysis showed no significant difference in hearing improvement between fascia grafting with and without anterior tucking, although graft uptake was better with the tucking technique.[12]Other studies comparing temporalis fascia with alternative materials, such as perichondrium or cartilage, have highlighted nuanced differences; for instance, ABG improvements were similar across graft types, although graft uptake rates varied. [13]These findings suggest that while different graft materials may yield comparable hearing outcomes, choice of graft may influence anatomical results.Our study reinforces existing evidence that Type I tympanoplasty using temporalis fascia underlay yields significant audiological improvement with a high rate of graft success. The mean hearing gain and ABG closure seen in our patients are consistent with reported outcomes in multiple published studies. Importantly, functional success rates vary across populations and surgical techniques, underscoring the relevance of continued evaluation and refinement of tympanoplasty procedures.

CONCLUSION

Type I tympanoplasty using the underlay temporalis fascia graft is a safe and effective procedure for the repair of tympanic membrane perforations with an intact ossicular chain. The surgery resulted in significant improvement in hearing thresholds and air-bone gap closure, with a high graft uptake rate of 88 %. Postoperative complications were minimal and manageable. Our findings are consistent with published literature, confirming the reliability of this technique in restoring both anatomical integrity and functional hearing. Routine assessment with pure-tone audiometry is essential to document functional outcomes and guide postoperative counseling. Overall, Type I tympanoplasty provides predictable and satisfactory audiological results in patients with chronic tubotympanic CSOM.

Limitations

This study was limited by its single-center design and relatively small sample size, which may affect the generalizability of the results. Follow-up was limited to 6 months, so long-term hearing outcomes and graft durability could not be fully assessed. Additionally, we did not stratify results based on perforation size, site, or Eustachian tube function, which are known factors influencing postoperative hearing outcomes.

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