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Original Article

Evaluation of Hearing Improvement After Type I Tympanoplasty in Tubotympanic Chronic Suppurative Otitis Media: A Prospective Observational Study

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ABSTRACT

Chronic suppurative otitis media (tubotympanic type) commonly causes tympanic membrane perforation and conductive hearing loss. Type I tympanoplasty aims to close the perforation and improve hearing outcomes. **Objective:** To evaluate hearing improvement following Type I tympanoplasty by comparing pre-and postoperative air conduction thresholds and air–bone gap at 3 and 6 months using pure tone audiometry. **Methods:** This prospective observational study was carried out in the Department of Otorhinolaryngology, Hayatabad Medical Complex, Peshawar, between January 2023 and June 2025. A total of 115 patients with Type I tympanoplasty were included. Preoperative and postoperative hearing were evaluated using pure tone audiometry. Preoperative hearing was assessed before surgery, and postoperative hearing was evaluated at 3 and 6 months after Type I tympanoplasty using pure tone audiometry. **Results:** There were 62 (53.9%) males and 53 (46.1%) females with a mean age of 29.6 ± 9.4 SD years. Graft uptake in 106 patients (92.2%) was successful. Preoperative air-bone gap was significantly enhanced (29.2 ± 6.5 dB) to 15.1 ± 5.4 dB after the operation ($p<0.001$). Hearing improvement was seen in 80% of the patients, and the mean improvement in hearing was 12.9 ± 5.8 dB. **Conclusions:** Type I tympanoplasty showed a high graft success rate and led to a large improvement in hearing, while the clinical outcome is poor for tubotympanic chronic suppurative otitis media. The surgery is still a dependable surgical method of restoring hearing in selected cases.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is characterized by tympanic membrane perforation associated with persistent or recurrent middle-ear inflammation and otorrhea, often resulting in conductive hearing loss [1]. Recent epidemiological data demonstrate that CSOM continues to be one of the most important global health issues, with an overall global prevalence of 3.8% or 297 million people, of which 85% are from LMIC [2]. CSOM is a significant health issue of the populations, especially in developing states, where the socioeconomic conditions promote the problems of delayed care and treatment [3]. The tubotympanic (mucosal) or safe type of CSOM is characterized by central perforations of the pars tensa devoid of cholesteatoma or massive mastoid involvement. In this type, elimination of infection and repair of the tympanic membrane integrity to enhance hearing ability are the main objectives of the clinical management. In such cases, Type I tympanoplasty is a standard surgical procedure, which is expected to repair the perforated tympanic membrane with the help of a graft (usually temporalis fascia) and leave the ossicular chain intact [4]. Tympanoplasty is historically measured in terms of anatomical success (e.g., graft uptake) and functional success - most obviously, hearing thresholds would be

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improved in a pure tone audiometric test, and the air-bone gap would be decreased. It has been reported that following the Type I tympanoplasty in tubotympanic CSOM, there are impressive gains in hearing. An example is reported mean hearing increase of >10dB and significant closing of the air-bone gap following surgery [5]. Retrospective reports have shown similar results, with most patients having meaningful audiological improvement with successful graft integration [6]. The size of perforation, length of disease, middle ear condition, and surgical procedure are factors that affect the prognosis of hearing after tympanoplasty. Poorer baseline hearing levels have been commonly linked to larger central perforations and longer periods of disease, which also highlights the need to intervene surgically promptly [7]. Although the majority of the studies are concerned with the pure outcomes of surgery, current studies also concentrate on the holistic evaluation of outcomes, such as health-related quality of life and the subjective improvement of hearing following Type I tympanoplasty [8, 9]. Research based on validated questionnaires has reported significant patient-reported improvements in their communication and psychosocial conditions after tympanoplasty, which supports the clinical importance of enhanced audiological performance on activities of everyday living.

While several studies have reported good anatomical and auditory outcomes after Type I tympanoplasty, there is a lack of local evidence regarding hearing improvement following the procedure in patients with tubotympanic CSOM. Differences in patient demographics, surgical techniques, and follow-up methods also warrant further prospective evidence. Therefore, the study aimed to assess hearing improvement following Type I tympanoplasty in these patients.

METHODS

This is an ongoing prospective observational study conducted in the Department of Otorhinolaryngology-Head and Neck Surgery at Hayatabad Medical Complex, Peshawar (a tertiary care referral hospital) from January 2023 to June 2025. A total of 115 patients who were scheduled for Type I tympanoplasty and diagnosed with tubotympanic type chronic suppurative otitis media were enlisted. The sample size was determined by an expected proportion of hearing improvement of 80% based on the pooled evidence reported in a systematic review of hearing outcomes following surgery for chronic otitis media [10]. Assuming a 95% confidence level and a 7.5% margin of error, the minimum required sample size was approximately 109 participants. To account for potential incomplete follow-up, 115 patients were recruited. The institutional review board granted ethical permission for the study (Ref #1215, 22-12-2022). Written informed consent was obtained from all participants before inclusion in the study. The confidentiality of the patients was preserved by anonymising the data and restricting its use to research. Patients with conductive hearing loss and central tympanic membrane perforation who were at least 15 years old met the inclusion criteria. Each patient had a dry ear for at least four weeks before surgery. The study excluded cases of atticoantral disease and cholesteatoma, ossicular chain pathology, sensorineural or mixed hearing loss, active ear discharge, or a past history of ear surgery. All patients were thoroughly evaluated preoperatively, including otoscopy and microscopy. Pure tone audiometry was conducted in a soundproof booth with a calibrated audiometer [11, 12]. Audiometry was performed after the audiometer was calibrated per institutional/manufacturer instructions. The hearing thresholds for air and bone conduction were assessed at 0.5, 1, 2, and 4 kHz. Pure tone average and air bone gap were determined from these thresholds, and baseline audiometric measurements were obtained. All audiological tests were carried out by audiologists using standardized conditions for hearing tests. All patients underwent Type I tympanoplasty surgeries under general anesthesia. The surgical procedure was performed through a postauricular approach. In all cases, the temporalis fascia was taken to be used as a graft material, and the underlay technique was used. The ossicular chain was evaluated during the procedure, and it was ensured that it was intact and mobile in every patient. No other ossicular reconstruction surgeries were carried out. The patients were followed at regular intervals after surgery at the outpatient unit. Postoperative follow-up was conducted at 3 months and 6 months after surgery. The graft status and healing of the tympanic membrane were evaluated with the use of the otoscopic examination. Audiological assessment with pure tone audiometry was re-administered at three and six months postoperatively to ascertain hearing results. The hearing was evaluated based on a comparison of the preoperative and postoperative averages of the pure tones and air-bone gap.

The data were analyzed using SPSS version 24.0. Percentages and frequencies were used to measure means, and standard deviations were used for continuous variables; categorical variables were presented in terms of frequencies or percentages. Audiological data were compared before and after surgery, with $p<0.05$ being significant.

RESULTS

The male-to-female ratio in the samples was 1.17:1, with 62 (53.9%) males and 53 (46.1%) women. Patients ranged in age from 15 to 55, with a mean age of 29.6 ± 9.4 years. The

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majority of the patients were between the ages of 21 and 30 (Table 1).

Table 1: Demographic Characteristics of the Study Population (n=115)

Variables	n (%)
Gender	
Male	62 (53.9%)
Female	53 (46.1%)
Age, years	
Mean ± SD	29.6 ± 9.4
Range	15–55
Age Group, years	
15–20	18 (15.7%)
21–30	44 (38.3%)
31–40	32 (27.8%)
>40	21 (18.2%)

Preoperative pure tone audiometry demonstrated conductive hearing loss in the study population. The mean air conduction threshold was 41.8 ± 7.6 dB, the mean bone conduction threshold was 12.6 ± 4.1 dB, and the mean air - bone gap was 29.2 ± 6.5 dB. The difference between the threshold of the air conduction and bone conduction for each patient was computed, and then the mean was taken, which is called the air–bone gap (Table 2).

Table 2: Preoperative Audiological Parameters (n=115)

Audiological Parameters	Mean ± SD (dB)
Air conduction threshold	41.8 ± 7.6 dB
Bone conduction threshold	12.6 ± 4.1 dB
Air–bone gap	29.2 ± 6.5 dB

Postoperatively, the overall graft uptake was successful in 106 cases, providing a graft success rate of 92.2%. The residual perforation was observed in 9 (7.8%) cases. The mean postoperative air conduction threshold decreased to 28.9 ± 6.3 dB, and the mean postoperative air-bone gap decreased to 15.1 ± 5.4 dB. The postoperative air–bone gap was calculated individually for each person (subtracting the bone conduction threshold from the air conduction threshold), and the results were then averaged (Table 3).

Table 3: Postoperative Audiological Parameters (n=115)

Audiological Parameters	Mean ± SD (dB)
Air conduction threshold	28.9 ± 6.3 dB
Bone conduction threshold	13.1 ± 4.0 dB
Air–bone gap	15.1 ± 5.4 dB

We performed a paired analysis of the preoperative and postoperative audiological results. Type I tympanoplasty resulted in a statistically significant improvement in air conduction thresholds and air-bone gap ($p < 0.001$). The average hearing gain (preoperative minus postoperative air conduction thresholds) was 12.9 ± 5.8 dB (Table 4).

Table 4: Comparison of Preoperative and Postoperative Audiological Outcomes (n=115)

Parameters	Preoperative Mean ± SD (dB)	Postoperative Mean ± SD (dB)	p-value
Air conduction threshold	41.8 ± 7.6	28.9 ± 6.3	<0.001
Bone conduction threshold	12.6 ± 4.1	13.1 ± 4.0	>0.050
Air–bone gap	29.2 ± 6.5	15.1 ± 5.4	<0.001

Hearing improvement was assessed based on closure of the air–bone gap. Using the predefined study criterion of ≥10 dB reduction in the air–bone gap, 92 (80.0%) patients were classified as having hearing improvement. Minimal improvement (1–9 dB) was seen in 14 (12.2%) patients, while 9 (7.8%) patients showed no improvement (0 dB or worsening) (Table 5). For the purpose of this study, hearing improvement was operationally defined as a reduction in the postoperative air–bone gap of ≥10 dB compared with the preoperative value. This threshold was selected to represent a measurable postoperative change beyond minor variation in audiometric measurements. The distribution of hearing outcomes was analyzed descriptively (Table 5).

Table 5: Distribution of Hearing Improvement After Type I Tympanoplasty (n=115)

Hearing Outcome (Based on Air–Bone Gap Closure)	n (%)
≥10 dB improvement	92 (80%)
1–9 dB improvement	14 (12.2%)
No improvement (0 dB or worsening)	9 (7.8%)

DISCUSSION

The tubotympanic type of chronic suppurative otitis media is still a common cause of conductive hearing loss, especially in developing nations. Type I tympanoplasty is commonly regarded as the surgical intervention of choice for restoring the integrity of the tympanic membrane and hearing. The current study compared the hearing gains after Type I tympanoplasty and showed significant postoperative audiological benefits, which proved the usefulness of this intervention in tubotympanic CSOM. In this research, a graft uptake rate of 92.2% has been noted, and this is similar to the success rates that have been reported in earlier research with a range of 85-95% [12]. Mangia *et al.* reported a success rate of 88% in grafts, whereas Hamela *et al.* have reported a success rate of over 90% in grafts, especially where temporalis fascia was applied using the underlay technique [13, 14]. The high graft uptake in this study can be explained by the selection of patients, elimination of active infection, and standardization of surgical procedure. The Audiological results indicated statistically significant improvement in postoperative air conduction thresholds and air-bone gap reduction. In our study, the mean hearing gain of 12.9 dB

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was observed, which is consistent with the published literature, with reported hearing gains of 10-15 dB after Type I tympanoplasty. Reynders *et al.* also reported similar improvements but further stated that in the intact ossicular chain, restoration of tympanic membrane continuity alone could significantly improve sound conduction [15]. Recent studies and systematic reviews have also demonstrated substantial postoperative improvement in air conduction and closure of the air-bone gap after Type I tympanoplasty [16, 17]. These data are also consistent with the current study, in which the mean air–bone gap improved from 29.2 ± 6.5 dB preoperatively to 15.1 ± 5.4 dB postoperatively, and 80.0% of the patients showed ≥10 dB hearing gain. These results are consistent with Type I tympanoplasty being a good option for functional hearing restoration in well-selected adults with chronic otitis media. In the present study, 80% of patients experienced the air-bone gap closure of ≥10 dB, which is a positive functional outcome. The result corresponds to that of Al Hamoud *et al.* who indicated high AB gap closure in most of the patients who received Type I tympanoplasty to treat tubotympanic disease [18]. The continuing severity of residual hearing loss in a small percentage of patients could be associated with Eustachian tube dysfunction, alterations in the middle ear mucosa, or subtle stiffness of the ossicles that are not evident during the procedure. The mean bone conduction threshold showed a small increase from 12.6 ± 4.1 dB preoperatively to 13.1 ± 4.0 dB postoperatively; however, this 0.5-dB change was not statistically significant ($p > 0.05$) and is unlikely to represent a clinically meaningful deterioration in cochlear function. Therefore, the findings do not suggest a clinically relevant postoperative sensorineural hearing loss in this cohort. This is consistent with previous reports indicating that sensorineural hearing deterioration is uncommon following appropriately performed tympanoplasty [19,20].

This study has some limitations. Being a single-center study may limit the generalizability of the findings. Outcome assessors were not blinded to pre- and postoperative status, which may have introduced detection bias. Eustachian tube function and the size and location of tympanic membrane perforations were not assessed, limiting evaluation of their effects on hearing and graft outcomes. The 6-month follow-up was insufficient to assess long-term graft integrity and sustained hearing outcomes. Additionally, the ≥10 dB hearing improvement criterion was used as a predefined study measure, but its clinical relevance may require further validation. Patient-reported hearing and quality-of-life outcomes were also not assessed. Future studies should incorporate longer follow-up, standardized assessment of prognostic factors such as Eustachian tube function and perforation characteristics, blinded outcome assessment, and validated patient-reported measures to better identify patients most likely to benefit from Type I tympanoplasty.

CONCLUSIONS

Type I tympanoplasty demonstrated favorable anatomical and functional outcomes in patients with tubotympanic chronic suppurative otitis media. Graft uptake was achieved in 92.2% of patients, while 80.0% demonstrated a clinically significant hearing improvement of ≥10 dB based on air–bone gap closure. Although these findings support Type I tympanoplasty as an effective option for tympanic membrane repair and hearing improvement, 7.8% of patients experienced graft failure and 20.0% did not achieve the predefined threshold for significant hearing improvement. Therefore, outcomes may vary among patients, and the present study does not establish specific predictors of treatment success.

Authors' Contribution

Conceptualization: AN, IA
Methodology: AI
Formal analysis: HN, AI
Writing and Drafting: HN, AI
Review and Editing: AN, IA, HN, AI, MA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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