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Original Research Article **Otorhinolaryngology**

Clinical and Audiological Outcomes Following Tympanic Membrane Repair in Adult Patients

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Abstract

Background: Tympanic membrane perforation can result in hearing impairment, recurrent ear discharge, and other otologic symptoms. Tympanic membrane repair aims to restore membrane integrity and improve auditory function. This study evaluated the clinical and audiological outcomes following tympanic membrane repair in adults. ***Methods:*** This prospective observational study was conducted at the Department of Otorhinolaryngology, Narsingdi Sadar Hospital, Bangladesh, from January to December 2025. Thirty consecutive adults with tympanic membrane perforation undergoing repair were included. Clinical outcomes, graft uptake, postoperative complications, pure-tone average (PTA), and air-bone gap (ABG) were assessed at final follow-up. ***Results:*** Successful graft uptake was achieved in 27 (90.0%) patients, while 25 (83.3%) had complete resolution of ear discharge. Mean PTA improved from 39.1 ± 8.6 dB to 28.0 ± 7.1 dB, while mean ABG decreased from 26.2 ± 6.3 dB to 14.8 ± 5.2 dB (both $p<0.001$). PTA improvement of ≥10 dB occurred in 76.7% of patients, and 63.3% achieved a postoperative ABG of ≤10 dB. Overall, 66.7% had excellent and 23.3% had good outcomes; no poor outcomes were observed. ***Conclusion:*** Tympanic membrane repair provided favorable clinical and audiological outcomes with high graft uptake, significant hearing improvement, and low postoperative morbidity in adults.

Keywords: Tympanic membrane perforation, Tympanoplasty, Myringoplasty, Graft uptake, Hearing improvement, Pure-tone audiometry, Air-bone gap.

INTRODUCTION

The tympanic membrane (TM), or eardrum, is a thin, delicate tissue layer that receives sound waves and transmits vibrations to the cochlea [1]. It separates the external and middle ear and is oval-shaped, measuring approximately 9–10 mm vertically and 8–9 mm horizontally. Its primary functions are sound transmission, protection of the middle ear, and maintenance of normal auditory function [2].

Tympanic membrane perforation (TMP) may result from inflammation, trauma, or iatrogenic injury. Although it represents a full-thickness defect, the TM has a remarkable capacity for spontaneous regeneration [3]. TMPs commonly occur secondary to otitis media, cholesteatoma, and ear barotrauma [4]. They may be acute or chronic; acute perforations often heal spontaneously within months, whereas chronic perforations may require surgical repair with myringoplasty or tympanoplasty. Small, asymptomatic perforations may not require treatment, while symptomatic cases can cause tinnitus, vertigo, conductive hearing loss, otorrhea, and facial paralysis. The severity of these clinical manifestations may be associated with the size and duration of the perforation [5, 6].

Advances in tissue engineering have introduced various materials and novel approaches for TM repair. Growth factors have demonstrated effectiveness in treating both acute and chronic perforations; however, their use as exogenous agents has certain limitations [7, 8]. Myringoplasty is a commonly performed surgical procedure for closing TMPs using graft materials such as temporalis fascia, cartilage perichondrium, allografts, xenografts, and alloplasts. Temporalis fascia and cartilage perichondrium have remained among the most widely used graft materials, while fat graft myringoplasty has also been successfully utilized [9].

Global studies evaluating clinical and audiological outcomes following tympanic membrane repair have reported high rates of perforation closure,

significant improvement in hearing, and favorable postoperative recovery following myringoplasty and regenerative treatments. These findings support myringoplasty as a safe, effective, and minimally invasive treatment option for appropriately selected patients, with clinical and audiological outcomes comparable to those of type I tympanoplasty [10,11].

Studies from Bangladesh have also demonstrated significant hearing improvement following underlay myringoplasty. Comparative studies have reported favorable graft uptake and hearing outcomes with temporalis fascia and sliced tragal cartilage grafts, supporting their effectiveness as reliable graft materials for TM repair [12,13].

However, despite these favorable findings, comprehensive evidence evaluating both clinical and audiological outcomes following TM repair in adult patients in Bangladesh remains limited. Therefore, this study aims to evaluate postoperative TM healing, hearing improvement, and overall clinical and audiological outcomes in adult patients undergoing tympanic membrane repair.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Otorhinolaryngology, Narsingdi Sadar Hospital, Narsingdi, Bangladesh, from January to December 2025. The study evaluated the clinical and audiological outcomes of adult patients undergoing tympanic membrane repair for tympanic membrane perforation.

Study Participants and Sample Size

The study included adult patients aged 18 years or older with tympanic membrane perforation who underwent tympanic membrane repair during the study period. A total of 30 consecutive eligible patients were enrolled. Patients were included if they had a clinically confirmed tympanic membrane perforation, were scheduled for tympanic membrane repair, and provided informed consent for participation and postoperative follow-up. Patients with cholesteatoma or unsafe chronic otitis media, significant pre-existing sensorineural hearing loss, ossicular abnormalities requiring additional reconstructive procedures, or those requiring procedures other than tympanic membrane repair were excluded. Patients with incomplete postoperative clinical or audiological follow-up were also excluded.

Clinical Assessment and Data Collection

Baseline demographic and clinical data were collected using a structured data collection form. The recorded variables included age, sex, affected ear, duration of symptoms, presenting symptoms, and characteristics of the tympanic membrane perforation.

Otoscopy was performed to confirm the presence and characterize the type and size of the perforation. Perforations were classified as central, subtotal, or marginal. Based on the estimated proportion of the tympanic membrane involved, perforations were categorized as small (<25%), medium (25–50%), or large (>50%).

Patients underwent tympanic membrane repair according to the standard surgical practice of the Department of Otorhinolaryngology. The surgical technique and graft material were selected according to the characteristics of the perforation and the treating surgeon's clinical assessment.

Assessment of Clinical Outcome

Patients were evaluated postoperatively during scheduled follow-up visits. Graft status, tympanic membrane healing, residual or recurrent perforation, resolution of ear discharge, and postoperative complications were documented.

Successful graft uptake was defined as complete healing and closure of the tympanic membrane perforation without residual or recurrent perforation at the final follow-up. Resolution of ear discharge was categorized as complete resolution, occasional residual discharge, or persistent discharge.

Postoperative complications, including transient otorrhea, wound infection, altered taste sensation, facial nerve injury, and severe postoperative infection, were recorded.

Audiological Assessment

Pure-tone audiometry was performed before surgery and at the final postoperative assessment. Air- and bone-conduction thresholds were recorded according to standard audiological procedures. The pure-tone average (PTA) was calculated from the relevant speech-frequency thresholds. The air-bone gap (ABG) was calculated as the difference between the mean air-conduction and bone-conduction thresholds.

Audiological improvement was assessed by comparing preoperative and postoperative PTA and ABG values. A PTA improvement of ≥10 dB was considered substantial improvement, 5–9 dB as moderate improvement, and <5 dB as limited improvement. Postoperative ABG was categorized as ≤10 dB, 11–20 dB, or >20 dB.

Assessment of Overall Outcome

The overall clinical and audiological outcome was assessed at the final postoperative follow-up based on graft uptake, clinical improvement, and audiological improvement:

- **Excellent:** Complete graft uptake, complete resolution of ear discharge, and substantial

hearing improvement (PTA improvement ≥10 dB and/or postoperative ABG ≤10 dB).

- **Good:** Successful graft uptake with substantial clinical improvement and moderate hearing improvement (PTA improvement 5–9 dB and/or postoperative ABG 11–20 dB), without persistent significant ear discharge.
- **Fair:** Graft uptake with partial clinical improvement and limited hearing improvement (<5 dB PTA improvement and/or postoperative ABG >20 dB), with or without mild residual symptoms.
- **Poor:** Persistent or recurrent tympanic membrane perforation, persistent ear discharge, or absence of meaningful clinical and audiological improvement.

Excellent and good outcomes were considered satisfactory, whereas fair and poor outcomes were considered unsatisfactory.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were summarized using frequencies and percentages. Preoperative and postoperative PTA and ABG values were compared using the paired-samples t-test. Associations between categorical variables, including perforation characteristics and graft uptake, were assessed using the chi-square test or Fisher's exact test, as appropriate. A two-sided p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the appropriate institutional authority before commencement of the study. Written informed consent was obtained from all participants. Patient confidentiality was maintained throughout data collection, analysis, and reporting, and participation was voluntary.

RESULTS

A total of 30 adult patients with tympanic membrane perforation who underwent tympanic membrane repair in the Department of Otorhinolaryngology, Narsingdi Sadar Hospital, Narsingdi, Bangladesh, during the period from January to December 2025 were included in the study.

Baseline Characteristics of the Study Participants

Table 1 presents the demographic and baseline clinical characteristics of the study participants. The mean age of the patients was 36.7 ± 10.2 years, with the majority belonging to the 31–40 years age group (40.0%). Male patients predominated (56.7%), with a male-to-female ratio of approximately 1.3:1. Right-sided disease was observed in 46.7% of patients, while 36.7% had left-sided and 16.7% had bilateral involvement. The mean duration of symptoms was 4.1 ± 2.6 years. Among the 35 affected ears, central perforation was the most common type (71.4%).

Table 1: Demographic and baseline clinical characteristics of the study participants (n=30)

Characteristics	Frequency (%) / Mean ± SD
Age (years)	**36.7 ± 10.2**
18–20	1 (3.3)
21–30	8 (26.7)
31–40	12 (40.0)
41–50	6 (20.0)
>50	3 (10.0)
Sex	
Male	17 (56.7)
Female	13 (43.3)
Affected ear	
Right	14 (46.7)
Left	11 (36.7)
Bilateral	5 (16.7)
Duration of symptoms (years)	**4.1 ± 2.6**
Type of perforation*	
Central	25 (71.4)
Subtotal	7 (20.0)
Marginal	3 (8.6)

**Perforation type was calculated based on 35 affected ears.*

Preoperative Clinical Findings

As shown in Table 2, hearing impairment was the most common presenting symptom, reported by 28 (93.3%) patients, followed by recurrent ear discharge in 21 (70.0%) patients. Tinnitus and aural fullness were reported by 30.0% and 23.3% of patients, respectively. Earache was relatively less common, being reported by 16.7% of the participants.

Table 2: Presenting symptoms among the study participants (n=30)

Presenting symptom	Frequency (%)
Hearing impairment	28 (93.3)
Recurrent ear discharge	21 (70.0)
Tinnitus	9 (30.0)
Aural fullness	7 (23.3)
Earache	5 (16.7)
No active discharge at presentation	24 (80.0)

Multiple responses were possible.

Characteristics of Tympanic Membrane Perforation

The characteristics of tympanic membrane perforations are summarized in Table 3. Central perforation was the predominant type, accounting for 25 (71.4%) of the 35 affected ears, whereas subtotal and marginal perforations accounted for 20.0% and 8.6%, respectively. Regarding perforation size, medium-sized perforations involving 25–50% of the tympanic membrane were most frequent (51.4%), followed by large perforations (>50%) in 25.7% of ears.

Table 3: Characteristics of tympanic membrane perforation (n=35 ears)

Characteristic	Frequency (%)
Type of perforation	
Central	25 (71.4)
Subtotal	7 (20.0)
Marginal	3 (8.6)
Size of perforation	
Small (<25%)	8 (22.9)
Medium (25–50%)	18 (51.4)
Large (>50%)	9 (25.7)

Clinical Outcome Following Tympanic Membrane Repair

The postoperative clinical outcomes are presented in Table 4. Successful graft uptake was achieved in 27 (90.0%) patients, while residual or recurrent perforation was observed in 3 (10.0%) patients. Complete resolution of ear discharge was reported by 25 (83.3%) patients, whereas 4 (13.3%) experienced occasional discharge and 1 (3.3%) had persistent discharge. Overall, 27 (90.0%) patients demonstrated improvement in their clinical symptoms following tympanic membrane repair.

Table 4: Clinical outcomes following tympanic membrane repair (n=30)

Clinical outcome	Frequency (%)
Successful graft uptake	27 (90.0)
Residual/recurrent perforation	3 (10.0)
Complete resolution of ear discharge	25 (83.3)
Occasional discharge	4 (13.3)
Persistent discharge	1 (3.3)
Improvement in ear symptoms	27 (90.0)
No significant symptomatic improvement	3 (10.0)

Postoperative Complications

Figure 1 shows the postoperative complications observed among the study participants. The majority of patients, 23 (76.7%), experienced no postoperative complications. Transient postoperative otorrhea was observed in 3 (10.0%) patients, while mild wound infection and temporary altered taste sensation were reported in 2 (6.7%) patients each. No patient developed facial nerve injury or severe postoperative infection.

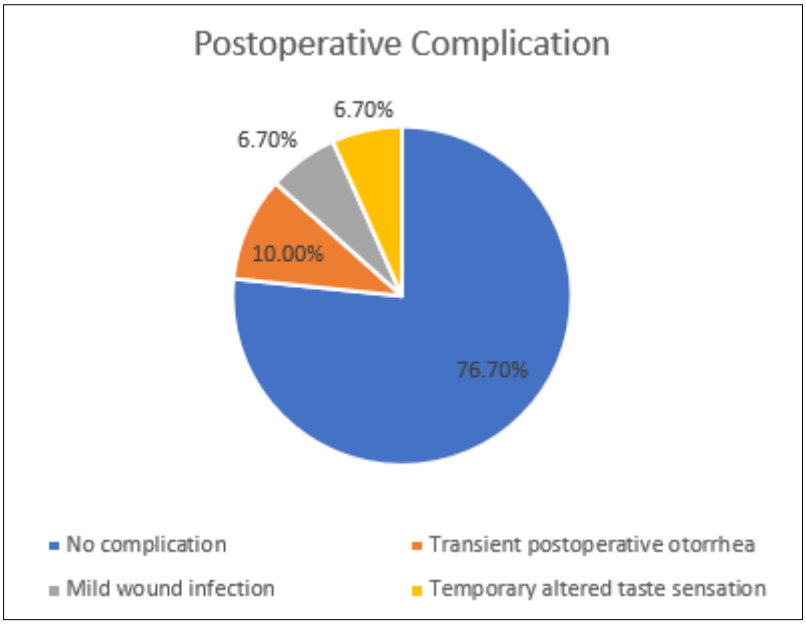

Figure 1: Postoperative complications (n=30)

Audiological Outcomes

The comparison of preoperative and postoperative audiological parameters is shown in Table 5. The mean pure-tone average decreased from 39.1 ± 8.6 dB preoperatively to 28.0 ± 7.1 dB postoperatively, representing a mean improvement of 11.1 ± 5.7 dB. Similarly, the mean air-bone gap decreased from 26.2 ± 6.3 dB to 14.8 ± 5.2 dB, with a mean reduction of 11.4 ± 5.0 dB. Both changes were statistically significant ($p<0.001$).

Table 5: Comparison of preoperative and postoperative audiological parameters (n=30)

Audiological parameter	Preoperative Mean ± SD (dB)	Postoperative Mean ± SD (dB)	Mean change	p-value
Pure-tone average	39.1 ± 8.6	28.0 ± 7.1	11.1 ± 5.7	<0.001
Air-bone gap	26.2 ± 6.3	14.8 ± 5.2	11.4 ± 5.0	<0.001

Paired t-test was used for comparison.

Degree of Hearing Improvement

The degree of audiological improvement following surgery is presented in Table 6. A PTA improvement of ≥10 dB was observed in 23 (76.7%) patients, while 5 (16.7%) patients demonstrated an improvement of 5–9 dB. Only 2 (6.7%) patients showed less than 5 dB improvement. Postoperatively, an ABG of ≤10 dB was achieved in 19 (63.3%) patients, whereas 9 (30.0%) had an ABG of 11–20 dB and 2 (6.7%) had an ABG greater than 20 dB.

Table 6: Degree of audiological improvement after tympanic membrane repair (n=30)

Audiological outcome	Frequency (%)
PTA improvement	
≥10 dB	23 (76.7)
5–9 dB	5 (16.7)
<5 dB	2 (6.7)
Postoperative ABG	
≤10 dB	19 (63.3)
11–20 dB	9 (30.0)
>20 dB	2 (6.7)

Association Between Perforation Characteristics and Graft Uptake

The association between the type of tympanic membrane perforation and graft uptake is presented in Table 7. Successful graft uptake was achieved in 24 (96.0%) ears with central perforation compared with 8 (80.0%) ears with subtotal or marginal perforation. Although graft uptake was numerically higher among patients with central perforations, the difference was not statistically significant ($p=0.12$).

Table 7: Association between type of perforation and graft uptake

Type of perforation	Successful uptake, n (%)	Failed uptake, n (%)	p-value
Central (n=25)	24 (96.0)	1 (4.0)	
Subtotal/marginal (n=10)	8 (80.0)	2 (20.0)	0.12
Total (n=35)	**32 (91.4)**	**3 (8.6)**	

Chi-square/Fisher's exact test was used as appropriate.

Overall Clinical and Audiological Outcome

The overall clinical and audiological outcomes of the study participants are presented in Figure 2. An excellent outcome was observed in 20 (66.7%) patients, while 7 (23.3%) patients had a good outcome. Three (10.0%) patients had a fair outcome, and no patient had a poor outcome. Overall, 27 (90.0%) patients achieved a satisfactory outcome, defined as an excellent or good clinical and audiological outcome according to the predefined criteria described in the Methods section.

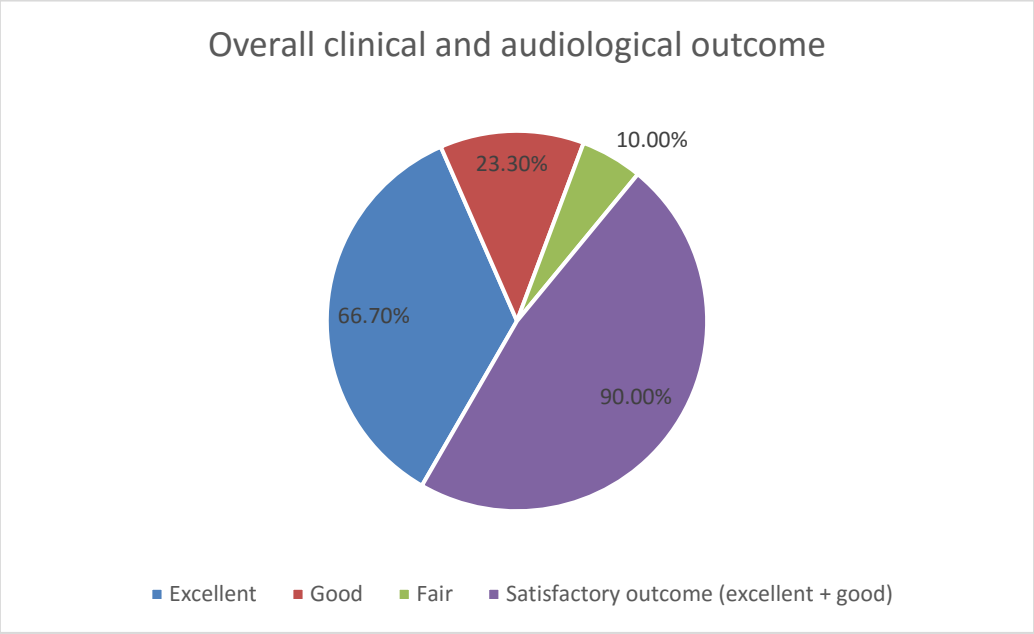

Figure 2: Overall clinical and audiological outcome (n=30)

DISCUSSION

This study demonstrated favorable clinical and audiological outcomes following tympanic membrane repair in adults. Successful graft uptake was achieved in 90.0% of patients, while 90.0% reported overall symptomatic improvement and 83.3% achieved complete resolution of ear discharge. The mean PTA improved by 11.1 dB and the mean ABG decreased by 11.4 dB, confirming significant functional benefit after repair.

The graft-uptake rate was comparable to the 86.6% weighted closure rate reported in a large meta-analysis of type I tympanoplasty and to the 82.1% primary closure rate reported following blast-related tympanoplasty [14,15]. However, it was lower than the 98% success rate reported after endoscopic transcanal myringoplasty [16]. Differences in perforation size, etiology, surgical technique, graft material, patient selection, and follow-up duration may explain these variations. The present study included 25.7% large perforations, which are generally more challenging to repair.

The predominance of central perforations in this study was consistent with previously reported clinical series [17,18]. Graft uptake was higher in central than in subtotal or marginal perforations (96.0% versus 80.0%), although the difference was not statistically significant. This finding should be interpreted cautiously because of the small sample size. Previous evidence regarding the influence of perforation location on surgical success remains inconsistent [14,19].

The audiological improvement observed in this study was comparable to the 11.7-dB improvement reported after blast-related tympanoplasty and the 11.6-dB ABG improvement reported after endoscopic myringoplasty [15,16]. Similarly, a large tympanoplasty review documented approximately 12.5 dB of hearing improvement and a postoperative mean ABG of 14 dB [20]. In the current study, 76.7% of patients achieved at least a 10-dB PTA improvement and 63.3% achieved a postoperative ABG of ≤10 dB, indicating clinically meaningful hearing restoration.

Postoperative morbidity was low. Most patients had no complications, and the observed events were

minor and temporary. No facial nerve injury or severe postoperative infection occurred, consistent with the low major-complication rates reported in other tympanoplasty series [15, 20]. Nevertheless, longer follow-up is necessary because graft success may decline over time; one study reported a reduction in success from 95.7% at six months to 87.2% at 24 months [21].

The findings are limited by the small sample size, single-center design, lack of a control group, and absence of detailed analysis of graft material, smoking status, middle-ear mucosa, ossicular status, and long-term recurrence. No directly comparable Bangladeshi study was available among the supplied references. Overall, the results support tympanic membrane repair as an effective procedure for improving graft integrity, controlling otorrhea, and restoring hearing in adults.

CONCLUSION

Tympanic membrane repair demonstrated favorable clinical and audiological outcomes in adult patients with tympanic membrane perforation. Successful graft uptake was achieved in 90.0% of patients, accompanied by substantial symptomatic improvement and complete resolution of ear discharge in most participants. Significant postoperative improvement in both pure-tone average and air-bone gap further confirmed meaningful hearing restoration. Overall, 90.0% of patients achieved a satisfactory outcome, with no poor outcomes and no major postoperative complications observed. Although graft uptake was higher among patients with central perforations than those with subtotal or marginal perforations, the difference was not statistically significant. These findings support tympanic membrane repair as an effective and relatively safe surgical treatment for improving membrane integrity, controlling otorrhea, and restoring hearing in appropriately selected adults. However, the small sample size, single-center design, absence of a control group, and limited follow-up restrict the generalizability of the findings. Larger multicenter studies with longer follow-up are recommended to further evaluate long-term graft stability, recurrence, and factors influencing surgical success.

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