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Mohammad Oli Hossain
Assistant Professor, Department of ENT & Head Neck Surgery, Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh

Kazi Mazharul Islam
Medical Officer, DGHS, Dhaka, Bangladesh

Mohammad Azharul Islam
Professor, Department of ENT & Head Neck Surgery, Bangladesh Medical University, Dhaka, Bangladesh

Md. Khizirul Islam
Medical Officer, Department of ENT, Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh

Corresponding Author:
Mohammad Oli Hossain
Assistant Professor, Department of ENT & Head Neck Surgery, Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh

Impact of myringoplasty on hearing threshold in different sizes of tympanic membrane perforation

Mohammad Oli Hossain, Kazi Mazharul Islam, Mohammad Azharul Islam and Md. Khizirul Islam

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Abstract
Background: Myringoplasty is a surgical procedure to repair tympanic membrane (TM) perforations, primarily in chronic suppurative otitis media with intact ossicles. TM perforations disrupt sound conduction and reduce hearing by compromising middle ear aeration and membrane vibration. Hearing loss severity is influenced by perforation size, location, disease duration, and middle ear status. Myringoplasty restores the acoustic barrier, with hearing improvement commonly assessed via air conduction thresholds. The relationship between perforation size and hearing outcomes remains debated, with varying findings across studies regarding the extent of postoperative hearing gain.
Aim of the study: This study aims to evaluate the impact of myringoplasty on hearing thresholds in patients with different sizes of tympanic membrane perforations at a tertiary care hospital in Bangladesh.
Methods: This prospective observational study was conducted over 12 months, from June 2023 to June 2024 at ENT & Head Neck Surgery Department, Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh, involving 60 patients aged 10-60 years with chronic dry central tympanic membrane perforations undergoing myringoplasty. Patients with active discharge, ossicular pathology, prior surgeries, or sensorineural hearing loss were excluded. Perforation size was classified as small (<25%), medium (25-50%), or large (>50%). All patients underwent pre- and post-operative Pure Tone Audiometry. Surgery involved temporalis fascia grafting using the underlay technique. Follow-ups were conducted at 1 week, 1 month, and 3 months. Hearing improvement and graft status were assessed. Data were analyzed using SPSS with statistical significance set at $p<0.05$.
Results: Most patients were aged 18-45 years (76.7%) with a slight male predominance (56.7%). Medium-sized perforations were most common (43.3%). Pre-operative air conduction (AC) thresholds increased with perforation size, averaging 28.6 dB (small), 38.2 dB (medium), and 47.5 dB (large). Post-operative thresholds significantly improved to 15.4 dB, 21.8 dB, and 30.1 dB respectively. The greatest hearing gain was seen in large perforations (17.4 dB), followed by medium (16.4 dB) and small (13.2 dB), all statistically significant ($p < 0.001$). Graft uptake success was highest in small (100%) and lowest in large (75.0%) perforations. Post-operative complications were minimal, with infection being the most frequent (5.0%).
Conclusion: Myringoplasty effectively improves hearing across all perforation sizes, with the greatest gain in large perforations but better post-operative hearing and graft success in smaller ones. Minimal complications confirm its safety. The findings highlight perforation size as a key factor in outcomes, supporting myringoplasty's role in tympanic membrane repair in Bangladesh.

Keywords: Myringoplasty, tympanic membrane perforation, and hearing threshold

Introduction
Myringoplasty, a commonly performed otologic procedure, involves the surgical repair of the tympanic membrane (TM) without ossicular reconstruction. It is primarily indicated in patients with chronic suppurative otitis media (CSOM) presenting with a dry, central perforation and intact ossicular chain, aiming to restore the anatomic integrity of the TM and improve hearing function [1,2]. Chronic perforations of the tympanic membrane can cause conductive hearing loss due to the interruption of normal sound conduction and the inability to maintain the air-filled middle ear cavity, thus reducing tympanic membrane vibration efficiency [3]. Hearing loss associated with tympanic membrane perforation is multifactorial and influenced by several parameters, including the size and location of the perforation,

the duration of the disease, the condition of the ossicular chain, and the presence of middle ear pathology [4]. Among these factors, the size of the perforation is considered a critical determinant in pre- and post-operative hearing thresholds. Larger perforations typically result in greater sound conduction impairment due to reduced effective vibratory area of the TM and greater middle ear sound energy loss [5]. Conversely, smaller perforations may have a limited impact on sound conduction, although they still pose a risk of recurrent infections and long-term hearing deterioration [6]. Myringoplasty plays a significant role in hearing improvement by re-establishing the acoustic barrier of the middle ear. The success of the procedure is typically assessed through anatomical closure of the perforation and the corresponding improvement in air conduction thresholds [7]. Numerous studies have reported significant postoperative hearing gains in patients undergoing myringoplasty, with variations depending on the preoperative size and location of the TM perforation [8, 9].The correlation between perforation size and postoperative auditory outcomes, however, remains an area of active investigation. Some studies have demonstrated that patients with small and medium-sized perforations achieve better hearing improvement than those with larger perforations, due to the more favorable surgical outcomes and less extensive damage to the surrounding middle ear structures [10]. In contrast, other reports suggest that large perforations, when successfully grafted, can result in a more dramatic hearing gain due to the greater baseline hearing loss before surgery [11]. These inconsistencies highlight the need for more detailed, context-specific analyses. The literature also varies in terms of methodologies for assessing perforation size, with some using quadrant involvement, while others adopt percentage-based area measurements of the TM [12]. These variations may influence the comparability of studies and the generalizability of findings. Furthermore, audiometric assessment pre- and post-myringoplasty provides valuable insights into the extent of functional hearing improvement and may reveal patterns that assist in prognostication and surgical planning [13].This study aims to evaluate the impact of myringoplasty on hearing thresholds in patients with different sizes of tympanic membrane perforations at a tertiary care hospital in Bangladesh.

Methodology and Materials

This was a prospective observational study conducted at the ENT & Head Neck Surgery Department, Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh over a period of 12 months from June 2023 to June 2024. The study included 60 patients diagnosed with chronic tympanic membrane perforation undergoing myringoplasty.

Inclusion Criteria

- Patients aged between 10 and 60 years.
- Presence of dry central tympanic membrane perforation for at least 6 weeks.
- Air-conduction hearing loss confirmed on Pure Tone Audiometry (PTA).
- Normal middle ear mucosa on otoscopic examination.
- Consent to undergo myringoplasty and follow-up audiological evaluation.

Exclusion Criteria

- Patients with active ear discharge or cholesteatoma.
- Previous ear surgeries.
- Mixed or sensorineural hearing loss.
- Presence of ossicular chain pathology.
- Perforation due to trauma or systemic diseases (e.g., tuberculosis, autoimmune disorders).
- Patients lost to follow-up before post-operative audiometry.

Data Collection Procedure

After obtaining informed consent, a detailed history and clinical examination were performed. Otoscopic and oto-microscopic examinations were used to assess the location and size of the perforation.

Perforation Size Classification

Perforations were categorized into:

- **Small:**<25% of tympanic membrane surface area
- **Medium:** 25-50% of the tympanic membrane
- **Large:**>50% of the tympanic membrane

Pre-operative Evaluation Included:

- Otoscopy and microscopy
- Tuning fork tests
- Pure Tone Audiometry (500, 1000, 2000, 4000 Hz)
- Eustachian tube function assessment (if available)

Surgical Procedure

All surgeries were performed by experienced ENT surgeons under local or general anesthesia. A temporalis fascia graft was used in all cases. The most common approach was the postaural or endaural route based on the size and site of perforation.

Steps Included

- Elevation of the tympanomeatal flap
- Freshening of perforation margins
- Placement of the graft using the underlay technique
- Closure of incision and standard post-operative care

Patients were prescribed antibiotics and advised on ear precautions. Suture removal was done on days 7-10.

Post-operative Follow-up

Patients were followed up at 1 week, 1 month, and 3 months post-operatively. Otoscopic evaluation was done at each visit. Repeat Pure Tone Audiometry was performed at 3 months post-operatively to assess hearing improvement.

Outcome Measures

Primary Outcome

- Change in hearing threshold (air conduction and air-bone gap in dB HL) before and after myringoplasty.

Secondary Outcome

- Graft uptake status (successful, partial, or failed)
- Post-operative complications (e.g., infection, graft displacement)

Data Analysis

Data were entered and analyzed using SPSS (Version 26.0). Descriptive statistics (mean, standard deviation, frequency, percentage) were used for demographic and clinical variables. Paired t-tests were applied to compare pre- and post-operative hearing thresholds. One-way ANOVA was

used to assess hearing improvement across different perforation sizes. A p-value <0.05 was considered statistically significant.

Results

The study assessed the impact of myringoplasty on hearing improvement across different sizes of tympanic membrane perforations in 60 patients. The majority of patients were aged between 18-45 years (76.7%), with a slight male predominance (56.7%) (Table 1). Medium-sized perforations were most common (43.3%), followed by small (30.0%) and large (26.7%) perforations (Table 2). Pre-operatively, the mean air conduction (AC) threshold increased with perforation size: 28.6 ± 4.2 dB in small, 38.2 ± 5.7 dB in medium, and 47.5 ± 6.4 dB in large perforations (Table 3). Post-operative thresholds significantly improved across all groups, with mean AC thresholds reduced to 15.4 ± 3.1 dB, 21.8 ± 3.6 dB, and 30.1 ± 5.2 dB for small, medium, and large perforations respectively (Table 4). The average hearing improvement was highest in large perforations (17.4 dB), followed by medium (16.4 dB) and small (13.2 dB), with all improvements being statistically significant ($p < 0.001$) (Table 5). Graft uptake was successful in 100% of small, 92.3% of medium, and 75.0% of large perforations, indicating better surgical outcomes in smaller defects (Table 6). Post-operative complications were minimal, with infection being the most common (5.0%) (Table 7).

Table 1: Demographic Profile of Participants

Variables	Frequency (n)	Percentage (%)
Age Group (years)		
<18	5	8.33
18-30	22	36.67
31-45	24	40.00
>45	9	15.00
Sex		
Male	34	56.67
Female	26	43.33
Affected Ear		
Right	31	51.67
Left	29	48.33
Duration of Symptoms		
<6 months	12	20.00
6-12 months	21	35.00
>12 months	27	45.00
Smoking Habit		
Yes	19	31.67
No	41	68.33

Table 2: Distribution of Patients Based on Size of Perforation

Size of Perforation	Number of Patients (n)	Percentage (%)
Small (<25%)	18	30.00
Medium (25-50%)	26	43.33
Large (>50%)	16	26.67

Table 3: Pre-operative Hearing Thresholds by Size of Perforation

Size of Perforation	AC Threshold (dB HL)	AB Gap (dB)	Degree of Hearing Loss
	Mean±SD	Mean±SD	
Small	28.6 ± 4.2	19.4 ± 3.1	Mild
Medium	38.2 ± 5.7	27.6 ± 4.8	Mild-Moderate
Large	47.5 ± 6.4	34.9 ± 5.2	Moderate

Table 4: Post-operative Hearing Thresholds by Size of Perforation

Size of Perforation	AC Threshold (dB HL)	AB Gap (dB)	Degree of Hearing Loss
	Mean±SD	Mean±SD	
Small	15.4 ± 3.1	6.8 ± 2.1	Normal-Mild
Medium	21.8 ± 3.6	10.2 ± 2.9	Mild
Large	30.1 ± 5.2	15.3 ± 3.8	Mild-Moderate

Table 5: Comparison of Pre- and Post-operative Hearing Thresholds

Size of Perforation	Pre-op AC (dB HL)	Post-op AC (dB)	Mean Improvement (dB)	p-value
	Mean±SD	Mean±SD		
Small	28.6 ± 4.2	15.4 ± 3.1	13.2	<0.001
Medium	38.2 ± 5.7	21.8 ± 3.6	16.4	<0.001
Large	47.5 ± 6.4	30.1 ± 5.2	17.4	<0.001

Table 6: Graft Uptake and Surgical Outcomes by Perforation Size

Size of Perforation	Successful (n, %)	Partial (n, %)	Failed (n, %)
Small	18 (100%)	0 (0%)	0 (0%)
Medium	24 (92.3%)	2 (7.7%)	0 (0%)
Large	12 (75.0%)	2 (12.5%)	2 (12.5%)

Table 7: Post-operative Complications

Type of Complication	Number of Cases (n)	Percentage (%)
Infection	3	5.00
Graft Displacement	2	3.33
Residual Perforation	2	3.33
Conductive HL Worsening	0	0.00
Others (Otalgia, etc.)	1	1.67

Discussion

Myringoplasty, the surgical repair of tympanic membrane perforation, is a commonly performed procedure aimed at restoring the integrity of the tympanic membrane and improving hearing by closing the air-bone gap. The present study assessed the impact of myringoplasty on hearing threshold regarding the size of tympanic membrane perforations among 60 patients, offering insight into the correlation between perforation size and post-operative outcomes in the context of a Bangladeshi tertiary care setting. The demographic findings of the study revealed a predominance of patients in the 18-45 years age group (76.7%), consistent with the peak age of productivity and social engagement when ear-related morbidities are most likely to affect quality of life. A slight male preponderance (56.7%) was observed, similar to the findings by Maroto *et al*. (2010), who noted that males may have higher exposure to environmental or occupational risk factors predisposing them to chronic otitis media [14]. Most patients in our study had medium-sized perforations (43.3%), followed by small (30.0%) and large (26.7%) ones, which aligns with the perforation size distribution observed in similar South Asian populations [15]. The relationship between perforation size and pre-operative hearing loss was evident in this study. Patients with large perforations exhibited significantly greater pre-operative hearing loss (mean AC threshold 47.5 ± 6.4 dB) compared to medium (38.2 ± 5.7 dB) and small perforations (28.6 ± 4.2 dB). This finding supports the well-documented principle that the size of the tympanic membrane perforation is directly proportional to the degree of conductive hearing loss due to greater loss of vibratory surface area and sound energy dispersion [16, 17]. In particular, Ahmad et al. (2013) reported that large central perforations often result in greater sound conduction deficits due to impaired sound pressure transmission through the ossicular chain [5]. Post-operatively, all three groups demonstrated significant improvement in hearing thresholds, with a mean gain of 13.2 dB in small perforations, 16.4 dB in medium perforations, and 17.4 dB in large perforations. While larger perforations showed greater numerical improvement, the post-operative residual hearing loss remained higher compared to small and medium perforations, reinforcing the notion that smaller perforations may yield better outcomes despite smaller gains. These improvements were statistically significant ($p < 0.001$), in agreement with studies by Carr (2015) and Saliba (2011), who also reported significant hearing gains following myringoplasty across different perforation sizes [18,19]. The surgical success rate, measured by complete graft uptake, was 100% in small, 92.3% in medium, and 75.0% in large perforations. This trend is consistent with previous findings suggesting that larger perforations are associated with higher graft failure rates due to technical difficulties, poorer vascularization, and a greater likelihood of Eustachian tube dysfunction [20, 21]. In particular, a retrospective review by Yung (2011) found a significant inverse relationship between graft success and perforation size, especially when cartilage grafts were not used [22]. Post-operative complications in our study were minimal, with only 5% experiencing infections and 3.3% presenting with graft displacement or residual perforation. The low rate of complications could be attributed to meticulous surgical technique and appropriate post-operative care. These findings are comparable to a study by Wasson et al. (2009), who reported complication rates below 10% in their cohort undergoing myringoplasty using temporalis fascia grafts [23]. The choice of graft material and surgical approach also influences outcomes. In our study, the temporalis fascia was the predominant graft material, as is commonly used in South Asian practice due to ease of harvesting and favorable acoustic properties. While this study did not specifically analyze the effect of graft material on hearing outcomes, literature suggests that temporalis fascia provides comparable success rates to cartilage grafts in small-to-medium perforations, but cartilage may offer superior structural stability in large or anteriorly located perforations [24]. Several studies have explored other predictors of myringoplasty outcomes, including age, Eustachian tube function, middle ear mucosa status, and contralateral ear condition [25]. In this study, all patients had a dry ear and healthy middle ear mucosa at the time of surgery, which likely contributed to the high success rate. However, Eustachian tube function and audiological findings in the contralateral ear were not evaluated, which may be considered a limitation. Another important consideration is the duration of follow-up. Our study assessed hearing outcomes at 3 months post-operatively, which reflects early results. Long-term follow-up is necessary to evaluate graft durability, late hearing gains or losses, and the recurrence of perforation. Future studies should incorporate longer follow-up periods and explore patient-reported outcomes, such as improvement in quality of life and reduction in recurrent infections.

Conclusion and Recommendations

This study demonstrates that myringoplasty significantly improves hearing thresholds across all sizes of tympanic membrane perforations, with the greatest hearing gain observed in large perforations (17.4 dB), and followed by medium (16.4 dB) and small (13.2 dB) perforations. Despite larger perforations showing greater improvement, smaller defects achieved better post-operative hearing and higher

graft success rates (100% in small vs. 75% in large perforations). Minimal complications highlight the procedure's safety. These findings affirm that perforation size influences both pre-operative hearing loss and surgical outcomes, supporting myringoplasty as an effective intervention in managing tympanic membrane perforations within the Bangladeshi healthcare setting.

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Ethical approval: The study was approved by the Institutional Ethics Committee.

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