Original Article

Hearing Evaluation After Myringoplasty in Underlay Technique

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Abstract

Background: Chronic suppurative otitis media (CSOM), particularly the inactive mucosal variety, remains a significant cause of hearing impairment in Bangladesh. Myringoplasty is a commonly performed surgical procedure to restore the integrity of the tympanic membrane and improve hearing. This study aimed to evaluate hearing outcomes following myringoplasty using the underlay technique.

Objective: To evaluate hearing improvement and factors influencing outcomes following underlay myringoplasty in CSOM patients.

Materials and Methods: This cross-sectional study was conducted at Ad-din Women's Medical College and Hospital, Dhaka, over a 24-month period from January 2023 to December 2024. Forty patients aged 15–45 years with central perforation of the tympanic membrane due to inactive mucosal CSOM were selected based on strict inclusion and exclusion criteria. All patients underwent myringoplasty using the underlay technique with autologous temporalis fascia. Hearing improvement was assessed through pure tone audiometry, measuring air conduction thresholds and air-bone gap preoperatively and at the 5th and 9th postoperative weeks.

Results: The overall graft take rate was 92.5%. Hearing gain (defined as an improvement in air conduction threshold) was observed in 70% of patients. The mean preoperative air conduction threshold and air-bone gap were 37.27 ± 8.96 dB and 26.01 ± 2.27 dB, respectively, which improved to 27.41 ± 5.67 dB and 17.56 ± 1.70 dB postoperatively. Greater hearing gain was noted in patients with small perforations and posterior sites, whereas subtotal perforations had comparatively less gain. No statistically significant association was found between hearing improvement and age, sex, or habitat.

Conclusion: Myringoplasty using the underlay technique is effective in achieving a high rate of graft uptake and significant hearing improvement. Factors such as size and site of perforation influence the audiological outcomes. These findings can guide surgical decision-making and patient counseling in managing CSOM.

Keywords: Myringoplasty; Tympanoplasty; Graft uptake; Temporalis fascia graft.

Introduction

Tympanic membrane (TM) perforation is commonly caused by acute or chronic middle ear infections, trauma, or iatrogenic factors. Chronic otitis media (COM) is particularly prevalent in Bangladesh and is a major contributor to TM perforation, presenting with symptoms such as deafness, ear discharge, and conductive hearing loss. The extent of hearing loss depends largely on the size and location of the perforation as well as the integrity of the ossicular chain. A perforation reduces the effective vibratory surface of the TM, disturbs the mechanical connection to the malleus, and decreases the pressure differential across the membrane, resulting in impaired sound transmission.[1]

There is a quantitative relationship between the size and location of the perforation and the degree of hearing loss. Small perforations involving less than 10% of the TM

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may result in minimal hearing loss (10–15 dB below 3 kHz), while larger perforations cause more widespread loss, particularly at higher frequencies due to direct sound transmission to the round and oval windows. Posterior and superior perforations tend to result in greater hearing deficits compared to anterior or inferior ones. Non-marginal perforations with intact ossicles typically lead to 10–30 dB of hearing loss.[2] Despite these impairments, up to 80% of TM perforations may close spontaneously without surgical intervention.[3]

Myringoplasty is the surgical repair of a perforated TM aimed at restoring the integrity of the membrane and improving hearing. Historically, Marcus Banzer first attempted TM closure in 1640 using a ring of elkhorn wrapped in pig bladder.[4] The term "myringoplasty" was introduced by Berthold in 1878 after achieving membrane closure with a full-thickness skin graft. However, widespread success was limited until the advent of the operating microscope in the 1950s by Wullstein and Zoellner.[5] Since then, advancements in technique and grafting materials have significantly improved outcomes.

For surgical purposes, the TM is divided into four quadrants: anterior, posterior, superior, and inferior. Perforations are categorized based on their size—small, medium, or large—and their anatomical location, often described relative to the malleus handle. Most central perforations occur in the pars tensa and may be classified as anterior, posterior, inferior, or subtotal.

A wide variety of autologous graft materials have been used successfully in myringoplasty, including temporalis fascia, perichondrium, cartilage, and adipose tissue. These can be harvested via transcanal, postaural, or endaural approaches. Graft placement can be achieved using underlay, overlay, or inlay techniques, depending on the location and extent of the perforation.[6]

Reported success rates of TM closure and hearing restoration vary widely. In adults, closure rates range from 60–99%, while in children, the range is 35–94%.[7] One study found that smaller perforations had a higher closure rate (74%) compared to larger ones (56%).[8] Another study reported a mean hearing gain of 8.0 dB and a closure rate of 97%.[9] Furthermore, there is a clear correlation between preoperative perforation size and postoperative hearing improvement. A study reported mean air conduction audiometric gains of –4.0 dB for 0–20% perforations, –5.0 dB for 21–40%, –9.1 dB for 41–60%, –10.8 dB for 61–80%, and –13.3 dB for 81–100%, with an overall success rate of 80.8% (105/130).10 Interestingly, none of the studied characteristics, including hole size, significantly predicted surgical success, although larger perforations tended to show greater hearing gain postoperatively.[10]

Favorable outcomes are often associated with central dry perforations, a functional eustachian tube, and absence of active middle ear or upper respiratory tract infections. With the integration of microsurgical techniques, myringoplasty has become a routine procedure in modern otologic practice.

The primary goals of myringoplasty are to restore TM integrity, improve hearing, and facilitate hearing aid use when necessary. This cross-sectional study was conducted at several tertiary hospitals in Dhaka to evaluate the hearing status of patients with CSOM before and after undergoing myringoplasty. The findings aim to provide insight into the factors influencing surgical outcomes and assess the effectiveness of myringoplasty as a hearing restoration procedure. Ethical considerations were rigorously observed, and the study attempts to address existing limitations and gaps in previous research.

Materials and Methods

This cross-sectional study was conducted at Ad-din Women's Medical College and Hospital, Dhaka, over 24 months (January 2023–December 2024). A total of 40 patients aged 15–45 years with inactive mucosal CSOM and central tympanic membrane perforation undergoing underlay myringoplasty were included through purposive, non-random sampling. Exclusion criteria included attic-antral disease, ossicular abnormalities, inner ear pathologies, prior ear surgeries, or need for additional procedures. Data were collected via structured questionnaires and clinical examinations. Investigations included pure tone audiometry, X-ray mastoid, and PNS. Surgery was performed using the postaural underlay technique with temporalis fascia. Follow-up was weekly for the first month, then at weeks 5 and 9. Hearing thresholds were measured pre- and post-operatively at 500, 1000, 2000, and 4000 Hz. Surgical success was defined as an intact, mobile tympanic membrane and dry ear. Data were analyzed using SPSS v22. T-tests were used for statistical analysis with significance set at $p < 0.05$.

Results

This cross-sectional study was carried out to assess the hearing of forty (40) patients who underwent myringoplasty using the underlay technique between 24 months (January 2023 to December 2024) at Ad-din Women's Medical College and hospitals.

Of the forty patients, nineteen were male and twenty one were female.

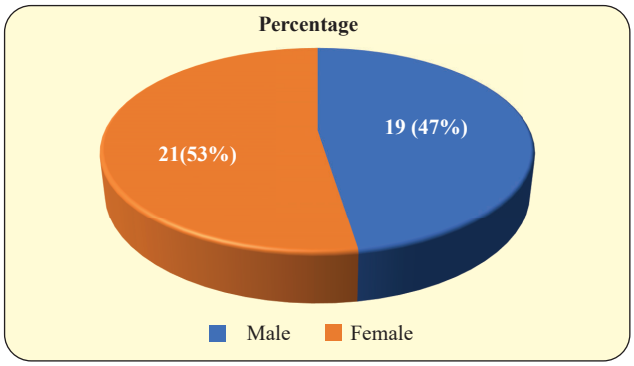

Figure-1: Sex distribution of the patient with Myringoplasty

The patient ranged in age from 15 to 45 years. Majority of patients were male 21 (53%) and female were 19 (47%).

Table -1: Age distribution in different sex group of the patient with myringoplasty (n=40)

Age	Male (%)	Female (%)	Total (%)
15-20 years	3 (15.8)	0 (0)	3 (7.5)
21-25 years	3 (15.8)	5 (23.8)	8 (20)
26-30 years	5 (26.3)	6 (28.6)	11 (27.5)
31-35 years	4 (21.1)	3 (14.3)	7 (17.5)
>35 years	4 (21.1)	7 (33.3)	11 (27.5)

Data was presented as a number with a percentage in parentheses

The table displays the distribution of sex groups of different age group in the different age categories, as well as the number and percentage of people in each group. Of the total 40 participants, most of them belonged to the 26-30 years and >35 years age groups, whereas the 15-20 years age group is smaller than the other groups (Table 1).

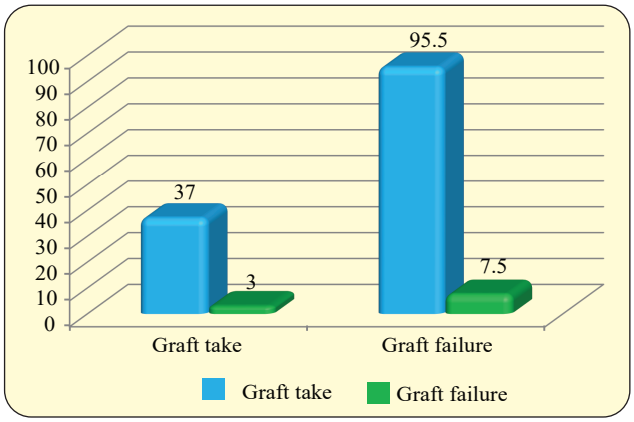

Figure-2: Graft take rate (n=40)

The figure shows that overall graft was taken in 37 out of 40 cases (92.5%) and graft failure in 3 cases (7.5%).

Table-2: Hearing Improvement in Successful Cases

	Frequency	Percentage
Hearing gain	28	70
No improvement	12	30

The table shows that hearing gain occurred in 28 patients (70%), while no improvement was observed in 12 patients (30%) (Table 3.2).

Table-3: Hearing Improvement After Myringoplasty in the Patient of Different Age Group

Age Group	Hearing status		P-value
	Hearing gain	No improvement	
≤26 years	8	3	0.81
>26 years	20	9	

Chi-square test

Regarding hearing improvement, no significant difference was observed between the younger and older age groups (p = 0.81).

Table-4: Hearing Improvement After Myringoplasty in the Patient of Different Habitant

Habitant	Hearing status		P-value
	Hearing gain	No improvement	
Rural	10	5	**0.72**
Urban	18	7	

Chi square test

There was no statistically significant difference in hearing gain among the different habitation groups (p = 0.72).

Table-5: Hearing Threshold and Air Bone Gap (ABG) Of the Patient Before and After Myringoplasty

Hearing Thresholds	Male (n=19) Mean±SD	Female (n=21) Mean±SD	Total (n=40) Mean±SD
Preoperative			
Air conduction threshold	35.21±9.11	39.12±8.63	37.27±8.96
Air bone gap	25.62±2.58	26.36±1.94	26.01±2.27
Postoperative (5th WK)			
Air conduction threshold	29.65±6.44	32.88±6.47	31.35±6.58
Air bone gap	21.52±2.25	20.22±1.52	20.84±1.99
Postoperative (9th WK)			
Air conduction threshold	25.12±5.17	29.49±5.40	27.41±5.67
Air bone gap	18.15±1.66	17.03±1.59	17.56±1.70

Data was presented as Mean±SD

Underlay myringoplasty resulted in significant hearing improvement, as demonstrated by decreased air conduction thresholds and reduced air-bone gap (ABG) in both genders. The most substantial gains were observed between the preoperative period and the 5th week, with smaller but continued improvements by the 9th week. Gender-related differences were noted: males exhibited better absolute air conduction thresholds postoperatively, whereas females showed slightly lower ABG at the 5th and 9th weeks, indicating a more favorable recovery of conductive function.

Table-6: Average Improvement of Hearing (Mean ABG) In Different Sizes of Perforation

Size	Total (%)	Mean	SD
Small	5 (12.5)	18.17	2.53
Medium	11 (27.5	17.38	1.35
Large	9 (22.5)	16.83	1.51
Subtotal	15 (37.5)	17.94	1.73

Data was presented as Mean±SD

In terms of hearing, myringoplasty appears to be beneficial for all sizes of perforations. Although the group differences are slight and may not be clinically significant, the mean ABG improvement is slightly better for tiny holes. These results show that the degree of hearing improvement is not significantly influenced by the size of the perforation, demonstrating the general effectiveness of the underlay technique.

Table-7: Average Improvement of Hearing (Mean ABG) In Different Size of Perforation

Size	Total (%)	Mean	SD
Anterior	10 (25)	13.53	1.34
Posterior	6 (15)	14.86	2.38
Inferior	6 (15)	14.09	1.06
Subtotal	18 (45)	14.48	1.54

Data was presented as a number with a percentage in parentheses

The differences in mean ABG improvement across locations are minimal (ranging only about 1.3 dB), suggesting that perforation location exerts limited influence on postoperative hearing outcomes. The consistently low standard deviations further indicate uniform surgical success across all locations.

Discussion

Myringoplasty has evolved significantly over the past five decades, primarily due to advancements in microsurgical techniques, operating microscopes, and the proliferation of trained ENT specialists. This study, conducted at Ad-din Women's Medical College and Hospital, Dhaka, between January 2023 and December 2024, evaluates the anatomical and audiological outcomes of myringoplasty in 40 patients with the inactive mucosal type of chronic otitis media (COM), aiming to contribute to the growing body of evidence supporting the efficacy of the procedure.

The overall graft success rate in our study was 92.5% (37 out of 40 cases), which is consistent with several earlier studies. Virtanen reported a graft take rate of 91.2%[11], while Ugo Fisch and Kotecha reported rates of 86% and 82%, respectively[11]. This high success rate may be attributed to meticulous surgical technique, patient selection based on strict inclusion and exclusion criteria, and the use of temporalis fascia as the graft material via the underlay method.

In terms of hearing outcomes, our study showed that 70% of patients experienced a hearing improvement of ≥ 10 dB, which is considered clinically significant. This is in line with the findings of Umapathy, who reported significant hearing gain in 72% of their cases[12], and slightly higher than Makaya's findings, where 62% of patients showed a hearing improvement of over 10 dB[13]. The mean improvement in air conduction thresholds postoperatively was from 37 dB to 27 dB, with an air-bone gap (ABG) closure from 26 dB to 17 dB. These results are comparable with studies by Biswas, who reported an improvement from 34 dB to 24 dB, and an average hearing gain of 10 dB in 60.78% of patients[11].

Other studies have reported a broader range of hearing outcomes. Karela observed hearing improvement in 91.5% of cases[14], while Kotecha reported a 67% improvement rate[15]. Bahmed reported a more optimistic outcome with a 98.5% success rate and a mean ABG reduction of 12.65 dB[16]. In contrast, She in a study from China, found that the underlay technique resulted in a 57.5% improvement rate compared to 71.9% with the over-under technique, with ABG closures of 4.9 dB and 9.7 dB respectively[17]. These variations may be due to differing surgical approaches, graft materials, patient demographics, and inclusion criteria.

Interestingly, in our study, 30% of patients showed no significant hearing improvement despite successful graft uptake. This observation is supported by earlier research suggesting that even with intact ossicular chains, residual fibrosis, middle ear scarring, or ossicular fixation

might limit postoperative hearing outcomes[2,18]. Additionally, preexisting sensorineural components of hearing loss may contribute to suboptimal hearing gain post-surgery.

We found no statistically significant difference in hearing improvement between different age groups (P = 0.81), consistent with Karela., who reported that age had no bearing on surgical success or hearing improvement[14]. Similarly, no significant gender-based difference was noted in our study. Male patients showed a mean ABG improvement of 18.15 dB compared to 17.03 dB in females, which aligns with findings by Karela, who noted no statistically significant difference across gender (P = 0.164)[14].

Urban versus rural habitation did not affect outcomes, suggesting that socio-geographic variables had minimal influence when surgical and postoperative care standards were maintained.

The size and site of tympanic membrane perforation have historically been debated as factors influencing surgical outcomes. In our cohort, the most common perforation size was subtotal (37.5%), followed by medium (27.5%), large (22.5%), and small (12.5%). The mean audiological improvements across these categories were 18.17 dB, 17.38 dB, 16.83 dB, and 17.94 dB respectively. These findings indicate that the size of the perforation did not significantly affect hearing improvement, which is in agreement with Karela (P = 0.198)[14]. However, Lee. suggested that smaller perforations have a higher graft success rate (74.1% vs. 56% for large perforations) and a better audiological outcome, with changes in air conduction thresholds of +7.2 dB for small and +10.2 dB for large perforations.[19]

Regarding perforation site, our series found that anterior perforations had the least audiological improvement (13.53 dB), compared to posterior (14.86 dB), inferior (14.09 dB), and subtotal perforations (14.48 dB). Subtotal perforations often present with more extensive mucosal pathology and ossicular involvement, which may explain the relatively modest improvement despite successful closure. Similar findings have been documented in literature, where subtotal perforations are linked with greater preoperative hearing loss and reduced postoperative gain[2].

Finally, the overall hearing improvement was in line with reports by other authors. For example, one study reported ABG closure within 0–10 dB in 26.3% of patients, 10–20 dB in 34.2%, and 20–30 dB in 39.4%[20]. Similarly, an ABG of less than 20 dB was achieved in 56% of cases in another study[21]. Lee and Paiva & Ramsay observed mean hearing improvements of 8 dB, similar to our findings[18].

Limitations of the study

In light of the study's noteworthy findings, every effort has been made to get over its constraints. Beyond the study's purview, the following restrictions were found. A limited number of cases are studied at a limited number of centers during a brief period. This study's findings could not accurately represent the entire situation. Up to two years following myringoplasty, the tympanic membrane may perforate. Therefore, it is advised that patients be followed up over time.

Conclusion

This cross-sectional study demonstrated that myringoplasty using the underlay technique is an effective surgical procedure for improving hearing in patients with chronic otitis media of the inactive mucosal type. Hearing improvement following successful graft uptake was influenced by specific preoperative factors, particularly the size and site of the tympanic membrane perforation. Patients with smaller perforations experienced more favorable audiological outcomes, while those with subtotal perforations, despite anatomical success, showed comparatively limited hearing improvement. Posterior perforations were associated with better postoperative hearing gain, suggesting that the location of the perforation plays a role in functional recovery. These findings highlight the importance of thorough preoperative assessment of perforation characteristics to better predict postoperative hearing outcomes in myringoplasty.

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