

Assessment of Hearing Recovery in Patients Undergoing Inlay Tympanoplasty

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Abstract

Introduction: Tympanoplasty is a commonly performed surgical procedure aimed at repairing perforations of the tympanic membrane, primarily to restore hearing and prevent recurrent infections. Over the years, various modifications to the technique have been introduced to improve outcomes, particularly for patients with central perforations. This study searches the outcomes of a modified tympanoplasty technique in a cohort of 375 patients.

Methods: This retrospective case series evaluated the outcomes of a modified tympanoplasty technique in 375 patients (ages 10-60) with central perforations. Conducted from January 2010 to July 2016 at the National Institute of ENT, Tejgaon, Dhaka, Shaheed Suhrawardy Medical College Hospital, Dhaka, and various private hospitals equipped with micro ear surgery facilities, the study involved preoperative and postoperative audiological testing, clinical examinations, and radiological assessments. Data analysis was performed using SPSS with descriptive statistics to summarize demographics and surgical outcomes.

Results: In this study of 375 patients undergoing modified tympanoplasty, the largest group was aged 21-30 years (29.33%). A high success rate was observed for tympanic membrane closure, with 96% achieving closure. Most patients (73.6%) underwent tympanoplasty alone, while 26.4% had additional cortical mastoidectomy. The majority experienced mild hearing improvement (75% with 10 dB gain), and complications included otomycolosis (69.7%) and graft failure (15.15%).

Conclusion: The Inlay technique produces early Healing of tympanic membrane perforation & is effective on adults as well as children. The technique modification introduced here reduced surgery time. Simple minimal scarring for all types of perforation in tubotympanic or COM of mucosal type & hence can be accepted as a routine procedure in day-to-day practice.

Introduction:

Hearing loss is a significant health concern globally, affecting millions and leading to social, emotional, and economic burdens. Tympanic membrane perforations are common causes of conductive hearing loss, often resulting from chronic otitis media (COM), trauma, or infections¹. Tympanoplasty, a surgical procedure designed to repair perforations and improve hearing, is a cornerstone in otologic surgery. Among various techniques, inlay tympanoplasty has gained interest due to its potential

for minimal invasiveness, reduced operative time, and favorable hearing outcomes^{2,3}. Evaluating hearing recovery in patients undergoing this procedure is critical for understanding its efficacy and optimizing patient care. COM, a chronic inflammatory condition of the middle ear and mastoid cavity, is a primary indication for tympanoplasty. Globally, its prevalence is higher in developing regions, with significant morbidity associated with recurrent infections and hearing impairment⁴.

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Successful management requires not only disease control but also effective restoration of hearing. While different tympanoplasty techniques, including underlay and overlay methods, have been explored, inlay tympanoplasty offers distinct advantages in specific clinical scenarios⁵. Inlay tympanoplasty, originally described by Nissen in the mid-20th century, differs fundamentally from other approaches in the placement of the graft. It involves positioning the graft medially within the perforation margin rather than over or under the remnant tympanic membrane⁶. This technique is associated with reduced epithelial migration and graft lateralization, complications more commonly encountered with overlay tympanoplasty. Furthermore, endoscopic-assisted inlay tympanoplasty has enhanced surgical precision, particularly in cases involving narrow external auditory canals⁷.

Studies comparing inlay and traditional tympanoplasty approaches suggest comparable, if not superior, outcomes in selected patients. Hearing recovery, the primary goal of tympanoplasty is influenced by multiple factors, including perforation size and location, middle ear status, and ossicular chain integrity^{8,9}. Inlay tympanoplasty, particularly effective for small to medium central perforations with intact ossicular chains, demonstrates favorable audiometric outcomes. Air-bone gap (ABG) closure, a key measure of surgical success, is frequently reported as satisfactory in patients undergoing inlay tympanoplasty¹⁰.

Graft material selection is a pivotal aspect of tympanoplasty. Autologous grafts, including temporalis fascia, tragal perichondrium, and fat, are commonly preferred due to their biocompatibility and availability¹¹. Innovations in synthetic graft materials have been explored, but long-term evidence regarding their durability and effectiveness remains mixed¹². Inlay tympanoplasty facilitates optimal graft placement with enhanced contact at the perforation margin, promoting healing and sound conduction. Patient factors, including age, comorbidities, and Eustachian tube function, significantly affect tympanoplasty outcomes. Pediatric patients present unique challenges due to anatomical differences and higher rates of middle ear dysfunction; however, inlay tympanoplasty has demonstrated promising results in this population¹³. In adults with stable middle ear conditions, the

technique offers high success rates with minimal recurrence of perforation. Nevertheless, large perforations, anterior perforations, and ossicular discontinuity are limitations where alternative techniques may be preferable¹⁴.

Methods:

This study was a retrospective case series conducted to evaluate the outcomes of a modified tympanoplasty technique in patients with central perforations, ranging from small to large and subtotal sizes. The primary goal of the surgery was to achieve a dry ear, an intact tympanic membrane, an aerated middle ear space, and improved hearing in all age groups.

The study was a retrospective case series, conducted over a period from January 2010 to July 2016. The sample consisted 375 patients, with an age range of 10 to 60 years. A convenience sampling technique was employed for patient selection. The study was conducted at the National Institute of ENT, Tejgaon, Dhaka, Shaheed Suhrawardy Medical College Hospital, Dhaka, and various private hospitals that are equipped with micro ear surgery facilities. Data collection included several steps. First, a detailed patient history was obtained, which included symptoms, prior treatments, and any relevant medical conditions. This was followed by a comprehensive clinical examination, focusing on the ear canal, tympanic membrane, and middle ear.

Audiological testing was conducted preoperatively to assess baseline hearing levels. Postoperative hearing tests were performed at 2 weeks, 12 weeks, and 24 weeks to evaluate hearing recovery. Additionally, radiological tests, including X-rays of both mastoids in Towne's view, were conducted to assess the mastoid and middle ear structures. Data analysis was performed using the SPSS statistical software (version 20.0). The analysis employed a descriptive statistical approach to summarize and interpret the data. Frequencies and percentages were used to describe the demographic characteristics of the patients, including age distribution and the distribution of postoperative outcomes, such as tympanic membrane closure and hearing gain.

Inclusion criteria:

- Tubotympanic variety chronic suppurative otitis media (CSOM)
- Small to large and subtotal perforations of the tympanic membrane

- Patients with written informed consent for participation in the study

Exclusion criteria:

- Attico-antral variety of CSOM (involving the attic and antrum of the middle ear)
- Severe to profound sensorineural hearing loss (SNHL)

Results:

Table 1: Age Distribution of the Participants (n=375)

Age	Number	Percentage
10-20	80	21.33
21-30	110	29.33
31-40	82	21.87
41-50	60	16.00
51-60	43	11.47

The largest group of participants falls within the 21-30 age range, comprising 110 individuals (29.33% of the total). This is followed by the 10-20 age group with 80 individuals (21.33%) and the 31-40 age group with 82 participants (21.87%). The 41-50 age group includes 60 participants (16.00%), while the smallest group is the 51-60 age range, consisting of 43 participants (11.47%).

Table II: Postoperative Tympanic Membrane Closure Outcomes (n=375)

Outcome	Number	Percentage
Tympanic membrane closure	360	96.00
Tympanic membrane failure	15	4.00

A significant majority of patients, 360 (96.00%), achieved successful tympanic membrane closure, indicating a high success rate for the procedure. In contrast, 15 patients (4.00%) experienced tympanic membrane failure, suggesting a relatively low incidence of complications related to graft failure or other postoperative issues.

Table III: Types of Mastoid Exploration Performed (n=375)

Procedure	Number	Percentage
Cortical mastoidectomy with tympanoplasty	99	26.4
Only tympanoplasty	276	73.6

A total of 99 patients (26.4%) underwent cortical mastoidectomy in conjunction with tympanoplasty, a procedure often indicated in cases of more extensive middle ear disease or cholesteatoma. The majority of patients, 276 (73.6%), only underwent tympanoplasty, suggesting that most cases did not require additional mastoid exploration.

Table IV: Postoperative Hearing Gain After 6 Weeks (n=375)

Hearing Gain (dB)	Number	Percentage
10	243	75.00
20	57	17.59
30	18	5.56
>30	6	1.85

The majority of patients, 243 (75.00%), experienced a hearing gain of 10 dB, indicating a significant proportion of individuals achieved mild to moderate improvement. A smaller group, 57 patients (17.59%), showed a 20 dB hearing gain, while 18 patients (5.56%) had a 30 dB improvement. Only 6 patients (1.85%) demonstrated a hearing gain of greater than 30 dB. These results suggest that the majority of patients experienced a notable improvement in hearing, with a small proportion showing exceptional recovery.

Table V: Postoperative Complications (n=375)

Complication	Number	Percentage
Graft failure	15	15.15
Otomycosis	69	69.70
Myringitis	15	15.15

Otomycosis, a fungal infection of the ear, was the most common complication, affecting 69 patients (69.70%). Both graft failure and myringitis occurred in 15 patients each (15.15%), representing less common but significant issues that can affect postoperative recovery.

Discussion:

The majority of participants in this study were young adults, with the largest group in the 21-30 age range, comprising 29.33% of the total participants. This is consistent with previous research suggesting that tympanoplasty is commonly performed in this age

group due to the higher prevalence of chronic otitis media and other middle ear diseases in younger adults¹⁵. The distribution of age groups highlights the importance of early intervention and the need for surgical treatment in patients within these age ranges to prevent long-term hearing impairment. Tympanic membrane closure is one of the key indicators of the success of tympanoplasty.

The study found that 96% of the patients achieved successful closure of the tympanic membrane, a result consistent with the findings of other studies, where success rates of tympanoplasty have ranged from 85% to 98%^{16,17}. This high success rate indicates that tympanoplasty is an effective procedure for achieving tympanic membrane closure in most cases. The low rate of tympanic membrane failure (4%) in this study reflects the importance of careful surgical technique, including proper graft selection and placement¹⁸. In terms of postoperative hearing gain, the majority of patients (75%) experienced a hearing gain of 10 dB, a result that is considered clinically significant for improving the quality of life¹⁹. The study also found that 17.59% of patients had a 20 dB hearing improvement, and 5.56% had a 30 dB improvement, which is consistent with previous reports on the range of hearing recovery after tympanoplasty^{14,17}. However, only a small proportion (1.85%) demonstrated a hearing gain greater than 30 dB. This suggests that while the majority of patients experience moderate improvement, substantial hearing restoration may be less common.

The factors influencing hearing recovery include the size of the perforation, the condition of the middle ear, and the presence of any underlying conditions such as cholesteatoma or otitis media with effusion²⁰. The results of this study underscore the importance of considering these factors when predicting hearing outcomes after tympanoplasty. The study found that the majority of patients (73.6%) underwent tympanoplasty alone, while 26.4% underwent cortical mastoidectomy combined with tympanoplasty. The higher proportion of patients receiving tympanoplasty alone is consistent with the findings of other studies that report tympanoplasty as the primary treatment for tympanic membrane perforations without extensive middle ear pathology²¹.

Cortical mastoidectomy is typically reserved for cases involving chronic otitis media or cholesteatoma, where the disease has spread to the mastoid²².

Postoperative complications, including graft failure, otomycosis, and myringitis, were also observed in this study. The most common complication was otomycosis, which affected 69.70% of the patients. Otomycosis is a fungal infection that can occur following tympanoplasty, particularly in patients with a history of recurrent ear infections²³. The high incidence of otomycosis in this study may reflect the humid environment within the ear canal post-surgery, which can promote fungal growth. The management of otomycosis typically involves antifungal treatment, and its recurrence may be prevented with improved postoperative care, including regular ear cleaning and drying²⁴.

Graft failure was observed in 15 patients (15.15%), while variable complication rates reported in a literature²⁵. Graft failure can occur due to several factors, including poor graft take, infection, or excessive tension on the graft during healing. This complication emphasizes the need for meticulous surgical technique and careful postoperative care to optimize healing and prevent graft failure. Myringitis, is an inflammation of the tympanic membrane. This condition is often associated with infection or irritation of the tympanic membrane post-surgery and can lead to discomfort and delayed healing²⁶.

Conclusion:

The Inlay technique produces early Healing of tympanic membrane perforation & is effective on adults as well as children. The technique modification introduced here reduced surgery time. Simple minimal scaring for all types of perforation in tubotympanic or COM of mucosal type & hence can be accepted as a routine procedure in day-to-day practice.

Recommendations:

Based on the findings of this study, it is recommended that tympanoplasty, particularly the modified technique used, should be considered a reliable surgical intervention for patients with tubotympanic variety chronic suppurative otitis media and central perforations. For optimal outcomes, it is essential to carefully select patients who do not have severe sensorineural hearing loss or attico-antral variety CSOM. Future studies with larger sample sizes and longer follow-up periods would help further validate the long-term efficacy of this surgical approach in improving both tympanic membrane closure and hearing recovery.

Conflict of interest: None declared

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