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Original Research Article

Our Experience with Total Ossicular Replacement Prosthesis for Ossiculoplasty in Mastoid Surgeries

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Abstract

This study aims to evaluate the hearing improvement in patients undergoing ossiculoplasty with total ossicular replacement prosthesis (TORP). The correlation between posterior canal wall status and hearing outcomes have also been analysed. Preoperative and postoperative audiometry results were analysed alongside patient demographics and complications. Out of 30 patients, 27 patients showed significant hearing improvement with an average of 25dB. Hearing improvement is better at lower frequencies when compared to higher frequencies. Even though presence of posterior canal wall did not show any significant impact on hearing, larger sample size may be needed to generalise this observation. The study highlights the significance of surgical techniques, patient selection, and ossiculoplasty technique in improving auditory outcomes. The findings are particularly relevant in the Indian context, where resource limitations, anatomical variability and high prevalence of complicated cases pose unique challenges.

Keywords: Ossiculoplasty, TORP, Ossicular reconstruction.

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Introduction

Ossiculoplasty is a pivotal surgical intervention aimed at restoring hearing by reconstructing the damaged ossicular chain within the middle ear. This procedure has become a cornerstone in otologic surgery, particularly for patients with chronic otitis media, trauma-induced ossicular disruption, or congenital malformations of the ossicular chain. Extensive ossicular damage often necessitates the use of prosthetic devices, such as total ossicular replacement prosthesis (TORP) and partial ossicular replacement prosthesis (PORP) [1,2,3]. While PORP is suitable for partial reconstruction, TORP is the preferred choice when the ossicular remnants are insufficient for any form of natural repair.

The choice of prosthetic material plays a crucial role in determining the success of ossiculoplasty. Materials such as titanium, Teflon, hydroxyapatite, and autologous ossicles have been extensively studied for their biocompatibility, durability, and acoustic properties [2,3,6]. Titanium prostheses, in particular, are widely favoured due to their lightweight nature and exceptional biocompatibility, which minimizes the risk of extrusion. Hydroxyapatite, a bioactive material, has shown promising results in promoting integration with surrounding tissues, thereby enhancing long-term stability [2,7]. Autologous materials, derived from the patient's own ossicles, are considered the gold standard due to their unmatched biocompatibility; however, their availability is often limited in cases of severe ossicular damage. Despite advancements in prosthetic materials and surgical techniques, several factors influence the outcomes of ossiculoplasty. Prosthesis positioning, the integrity of the middle ear mucosa, and the presence of middle ear aeration are critical determinants of success [5,8,]. In the context of TORP, the absence of a functional stapes superstructure poses additional challenges, as the prosthesis must directly transmit sound vibrations to the footplate of the stapes or the oval window. Achieving optimal alignment of the prosthesis is vital to maximize sound conduction and minimize the risk of postoperative complications.

Posterior canal wall status is another variable that has garnered significant attention. While traditional canal wall-up and canal wall-down approaches have their merits, the integrity of the posterior canal wall can influence middle ear ventilation and, consequently, the long-term outcomes of ossiculoplasty [4,8]. In this study we focused on

evaluating the postoperative hearing improvement after ossiculoplasty and correlation between posterior canal wall status and hearing improvement, with a specific emphasis on understanding how these factors interact to affect auditory rehabilitation.

The Indian demographic presents additional considerations. A higher prevalence of chronic otitis media, coupled with delayed access to specialized otologic care, often results in advanced disease stages at the time of presentation [3,9].

Furthermore, socioeconomic constraints and limited access to high-quality prosthetic materials in rural settings add another layer of complexity to the management of these patients.

Methods

This retrospective study included patients who underwent ossiculoplasty with TORP (Teflon) at a tertiary care centre over the past 2 years.

Inclusion Criteria:

- All patients who underwent ossiculoplasty due to chronic otitis media, trauma, or congenital ossicular defects.
- Availability of preoperative and postoperative audiometry data.

Exclusion Criteria:

- Revision surgeries and reconstruction with other ossiculoplasty materials.
- Profound hearing loss

Data collected included:

- Demographics: Age, gender, ear involved.
- Hearing assessment was done based on puretone audiometry.
- Audiometric measurements: Preoperative and 6months postoperative audiometry done to assess hearing.
- Surgical details: Type of ossiculoplasty, posterior canal wall status (intact or not).
- Complications: Immediate and delayed postoperative issues.
- Follow up duration: 1 year.

Results

The study included 30 patients (18 females, 12 males), with a mean age of 34.2 years (range: 18-50 years). Right ear involvement was observed in 60% of cases.

Cortical mastoidectomy (intact posterior canal wall) was done in 5patients where there was ossicular erosion without cholesteatoma and 25 patients underwent modified radical mastoidectomy with ossicular reconstruction in the presence of cholesteatoma.

The majority of cases involved patients from rural areas, highlighting the need for accessible otologic surgical expertise.

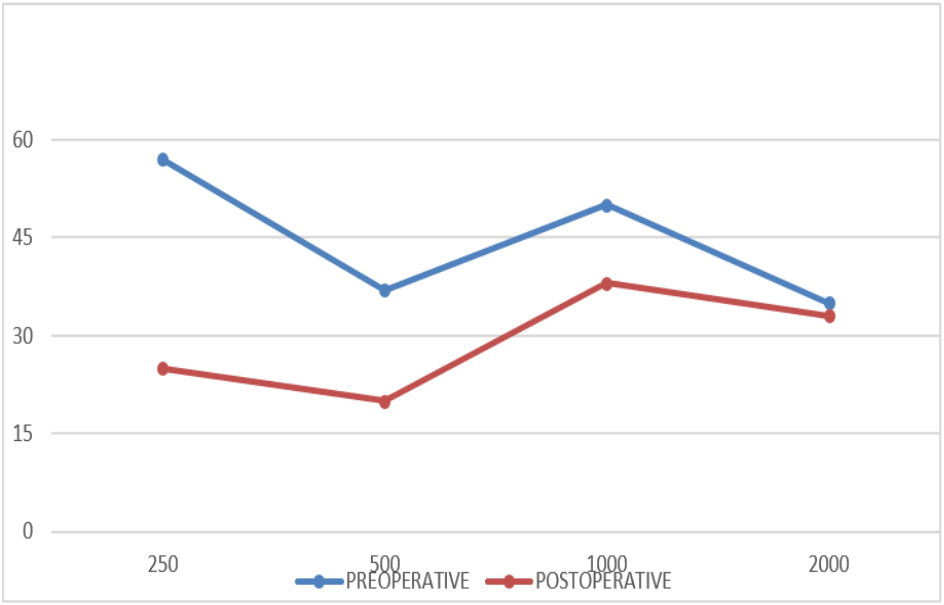

Figure 1: Preoperative vs. Postoperative Hearing Loss at 250,500,1000 and 2000Hertz respectively

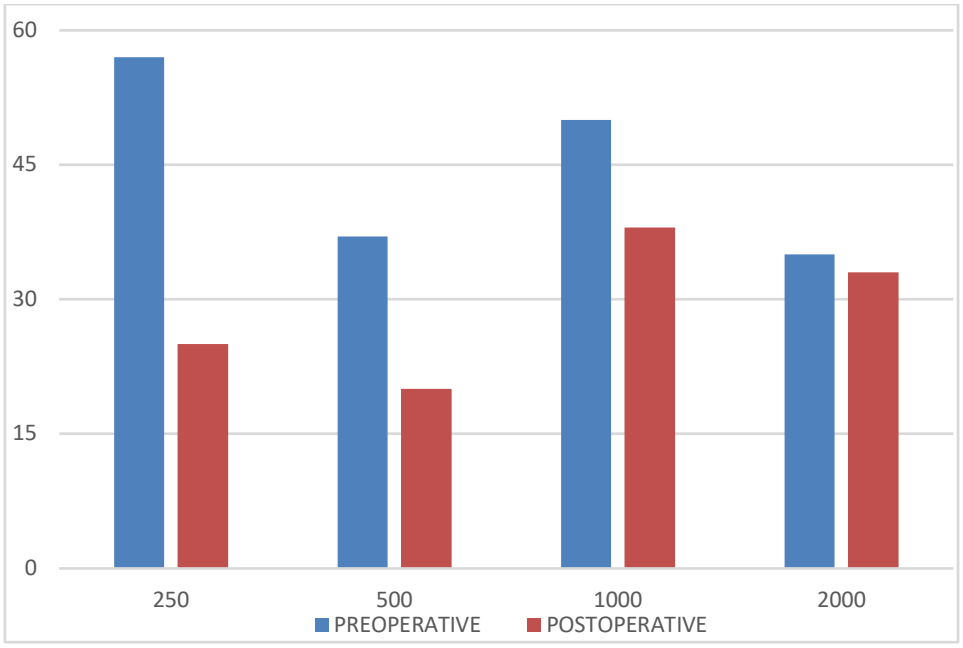

Figure 2: Histogram of preoperative and postoperative audiometry comparison at 250,500,1000 and 2000Hertz

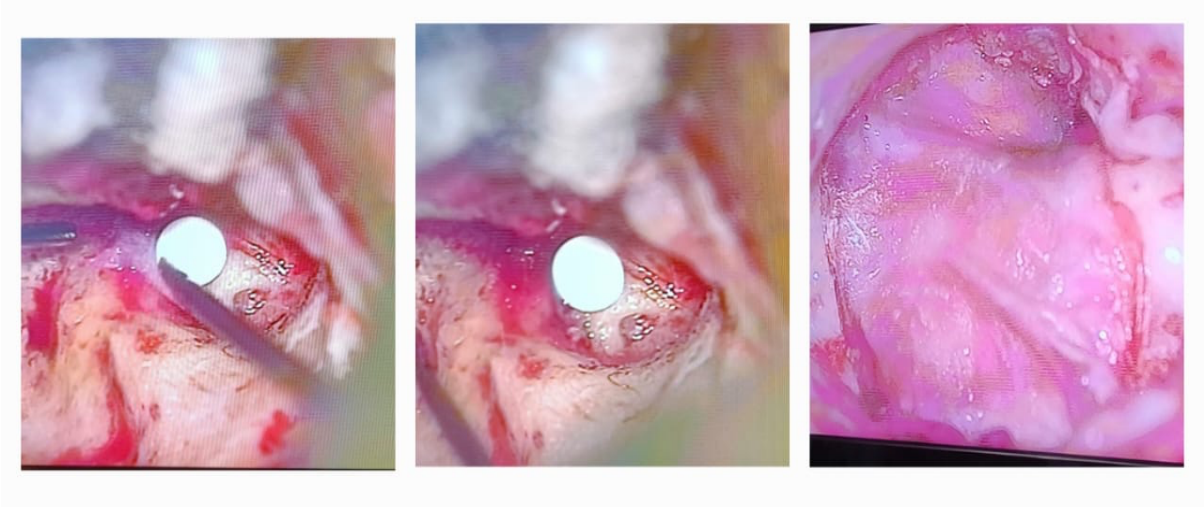

Figure 3: showing Intraoperative images of TORP placement and grafting.

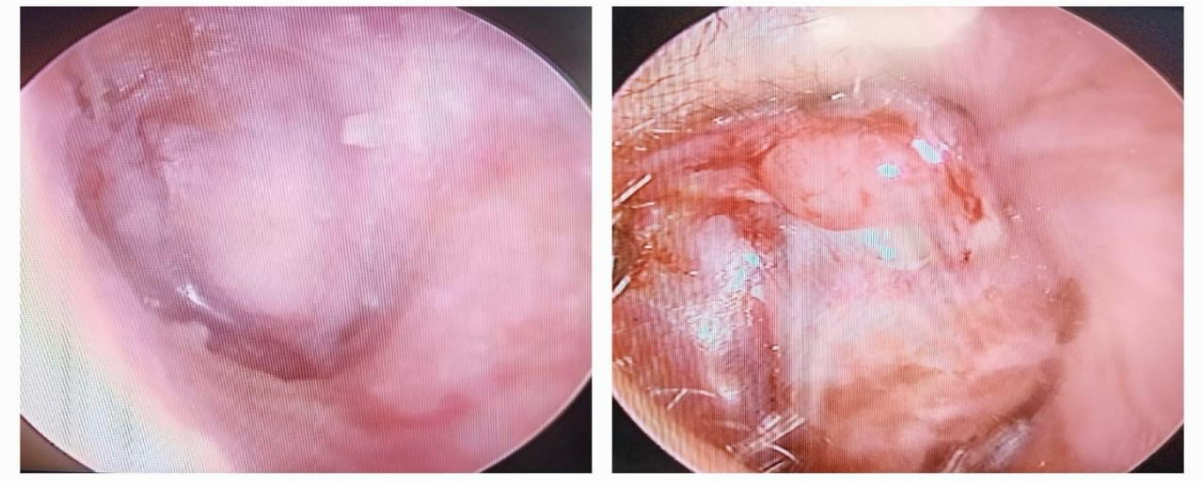

Figure 4: Postoperative endoscopic images of Neo tympanum with healthy healed cavity.

Key Observations

1. Patients demonstrated significant hearing improvement postoperatively, with an average reduction of hearing loss by 25 dB.
2. Posterior canal wall integrity showed minimal impact on the overall hearing improvement. Both the groups achieved comparable audiometric outcomes. Average postoperative airbone gap was 26.2dB and 29dB with the presence and absence of posterior canal wall respectively.
3. TORP efficacy was influenced more by prosthesis positioning, middle ear aeration, and the absence of adhesions.
4. Post-operative hearing improvement is better at lower frequencies when compared to higher frequencies based on pure tone audiometry. Higher frequencies showed minimal improvement in 50% of cases and almost no improvement in 50% of cases based on audiometry.
5. 6 patients had experienced complications which included 3 patients having no or insignificant hearing gain (1 TORP extrusion with recurrent csom), 2 post aural wound infection,1 facial nerve palsy secondary to involvement of cholesteatoma.
6. No patients had deterioration of hearing postoperatively.

Discussion

The findings of this study align with existing literature on the efficacy of total ossicular replacement prosthesis (TORP) in restoring conductive hearing loss. Studies by Sousa et al. [1] and Martin et al. [2] have demonstrated the potential of TORP in achieving significant hearing improvement, which is consistent with our results, where an average reduction of 25 dB in hearing loss was observed postoperatively. The choice of TORP in cases of extensive ossicular damage, as highlighted by Chavan et al. [3], is further supported by our findings, particularly in patients with insufficient ossicular remnants for partial reconstruction.

The role of prosthetic materials in ossiculoplasty outcomes has been extensively studied. Martin et al. [2] emphasized the advantages of titanium prostheses due to their lightweight nature and biocompatibility, which minimize the risk of extrusion. In our study, Teflon TORP was used, and while it demonstrated efficacy, the material's long-term stability and integration with surrounding tissues warrant further investigation, as suggested by Chavan et al. [3].

The importance of prosthesis positioning and middle ear aeration, as discussed by Motegi et al. [5], was evident in our results, where optimal alignment and ventilation were critical factors influencing hearing outcomes. Posterior canal wall integrity has been a topic of debate in ossiculoplasty literature. Janwal et al. [4] and Motegi et al. [5] have explored the impact of canal wall status on middle ear ventilation and surgical outcomes. Our study found no significant correlation between posterior canal wall integrity and hearing improvement, which is consistent with the findings of Janwal et al. [4]. This suggests that factors such as surgical precision, prosthesis placement, and middle ear aeration may play a more pivotal role in determining outcomes than the status of the posterior canal wall.

Complications in ossiculoplasty, as highlighted by Cox et al. [6], remain a significant concern. In our study, complications such as TORP extrusion, post-aural wound infection, and facial nerve palsy were observed in six patients. These findings underscore the importance of meticulous surgical technique and postoperative care, as emphasized by Beckmann et al. [7]. The extrusion rate in our study (1 case) aligns with the literature, where extrusion rates for TORP range from 5% to 10% [6,7].

Long-term outcomes of ossiculoplasty, as discussed by Yung [8] and Wood et al. [11], highlight the need for sustained follow-up to assess the durability of hearing improvement and the risk of complications such as middle ear fibrosis. In our study, the follow-up duration was limited to one year, which may not capture long-term complications or prosthesis failure. However, the initial results are promising, with significant hearing improvement observed in 27 out of 30 patients.

The Indian demographic presents unique challenges, as noted by Sharma et al. [7] and Patel et al. [8]. The high prevalence of chronic otitis media and delayed access to specialized care often result in advanced disease stages at presentation. In our study, the majority of patients were from rural areas, highlighting the need for accessible otologic surgical expertise and affordable prosthetic options. The findings of Roy et al. [9] and Yu et al. [10] further emphasize the importance of tailored surgical approaches and prosthetic designs suited to regional anatomical variations.

Limitations

1. Small sample size limits the generalizability of results.
2. Retrospective design introduces inherent biases.
3. Further long-term follow-up data is needed to assess sustained hearing improvement and complications such as prosthesis extrusion or middle ear fibrosis, but is limited due to limited access for rural setting population.

Clinical Implications

The study underscores the importance of meticulous surgical planning and technique. Surgeons should focus on proper prosthesis placement and middle ear ventilation rather than relying solely on canal wall integrity to achieve optimal results. Advances in prosthesis materials and emerging technologies, such as 3D printing, offer promising avenues for future innovation. For the Indian demographic, enhanced training programs for rural otologic surgeons and affordable prosthetic options could significantly improve outcomes.

Conclusion

TORP ossiculoplasty is a reliable method for auditory rehabilitation, offering significant improvements in hearing. Posterior canal wall integrity does not significantly influence outcomes, suggesting that other factors such as surgical precision and prosthesis design are more critical. Further multicenter studies with larger cohorts and extended follow-up periods are needed to validate these findings, particularly in resource-constrained settings like rural India.

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