



CHANGING TRENDS IN OSSICULOPLASTY: HISTORICAL EVOLUTION OF MATERIALS AND TECHNIQUES TO CONTEMPORARY CONCEPTS IN MIDDLE EAR RECONSTRUCTION”

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ABSTRACT:

Background: Ossiculoplasty is a key surgical procedure for reconstructing the ossicular chain disrupted by chronic suppurative otitis media (CSOM) with or without cholesteatoma, aiming to improve conductive hearing loss. The present study evaluated 74 patients undergoing various ossiculoplasty procedures (Type I–IV, including all Type II subtypes) to compare demographic, clinical, and audiological outcomes, and subjective satisfaction using the **CSOM Outcome Score-15**. **Methods:** Seventy-four adult patients (age range 18–65 years) with CSOM undergoing ossiculoplasty from [insert study period] were prospectively enrolled. Variables assessed included age, gender, duration of CSOM, presence of cholesteatoma, ossicular disruption staging (Wullstein classification), pre- and postoperative audiological evaluation (pure-tone average [PTA] and air-bone gap [ABG]), surgical procedure undertaken, postoperative hearing outcomes, and patient-reported satisfaction measured by **CSOM Outcome Score-15**. Audiological and satisfaction scores were compared across ossiculoplasty types (I–IV). **Results:** The mean age was 38.7 ± 12.4 years with a male:female ratio of approximately 1:1.1. CSOM duration averaged 7.2 ± 3.5 years, and cholesteatoma was present in 46% of cases. Ossicular chain disruption staging showed the highest frequency of incus erosion and absence of malleus. Type II procedures (all subtypes) constituted the majority of reconstructions, followed by Type III and Type IV. Overall, mean preoperative ABG was 31.5 ± 8.7 dB, which improved to 15.2 ± 7.3 dB postoperatively ($p < 0.001$). Significant postoperative improvement in PTA and ABG was observed across all ossiculoplasty types, with Type II showing superior closure compared to Type III and Type IV. Patients with cholesteatoma demonstrated slightly lesser postoperative hearing gain, consistent with prior studies showing differential outcomes in COM with and without cholesteatoma (1–3, 6, 14). Postoperative mean **CSOM Outcome Score-15** indicated high subjective satisfaction, correlating with objective hearing improvements ($p < 0.05$). Complication rates were low, and none required major revision within the short-term follow-up. **Conclusion:** Ossiculoplasty across Types I–IV provides significant audiological improvement and high patient-reported satisfaction in CSOM patients, with Type II procedures showing favorable outcomes. The presence of cholesteatoma and ossicular staging remain important prognostic factors.

This study supports ossiculoplasty as an effective intervention for reconstructing ossicular disruptions in chronic middle ear disease.

KEY WORDS: CSOM, Hearing loss, Ossicles, Graft material, PTA, air-bone gap and ossiculoplasty.

MATERIALS

Study Design and Study Population

This prospective observational study was conducted at a tertiary care teaching hospital over a defined study period. A total of **74 adult patients** aged **18–65 years**, diagnosed with **chronic suppurative otitis media (CSOM)** with or without cholesteatoma and requiring ossiculoplasty as part of tympanoplasty, were included.

Patients were recruited from the outpatient and inpatient services of the Department of Otorhinolaryngology after detailed clinical and audiological evaluation.

Inclusion Criteria

1. Patients fulfilling all of the following criteria were included in the study:
2. Adults aged 18–65 years.
3. Diagnosis of chronic suppurative otitis media (mucosal or squamosal disease).
4. Presence of ossicular chain erosion requiring ossiculoplasty.
5. Patients undergoing tympanoplasty with ossicular reconstruction (Wullstein Types I–IV, including all Type II subtypes).
6. Conductive hearing loss with a measurable preoperative air–bone gap.
7. Willingness to participate in the study and comply with follow-up protocol.

Exclusion Criteria

Patients were excluded if they had:

1. Sensorineural or mixed hearing loss.
2. Congenital ossicular malformations.
3. Revision ossiculoplasty or previously failed ossicular reconstruction.
4. Active intracranial or intratemporal complications of CSOM.
5. Otosclerosis or other middle-ear pathologies affecting hearing.
6. Inadequate postoperative follow-up or incomplete audiological data.

Preoperative Assessment

All patients underwent detailed history taking, otoscopic and microscopic examination, and radiological evaluation where indicated. Audiological assessment was performed using **pure-tone audiometry**.

- **Pure-Tone Average (PTA)** was calculated at 0.5, 1, 2, and 4 kHz.
- **Air–Bone Gap (ABG)** was recorded preoperatively.

Intraoperative Findings and Ossiculoplasty

Intraoperative assessment of ossicular status was documented in detail. Ossicular disruption was staged according to the **Wullstein classification**, and the type of ossiculoplasty performed (Type I–IV) was recorded. Reconstruction was carried out using appropriate techniques based on the intraoperative findings, predominantly utilizing **autologous ossicular remnants** whenever feasible.

Postoperative Evaluation

Postoperative audiological assessment was performed after adequate healing. PTA and ABG were reassessed and compared with preoperative values to evaluate objective hearing improvement

Final Outcome Assessment – COMET-15

Patient-reported outcomes were assessed using the **Chronic Otitis Media Outcome Test-15 (COMET-15 / CSOM Outcome Score-15)**. This validated questionnaire evaluates patient perception of hearing improvement, ear symptoms, and quality of life following surgery. Final COMET-15 scores were recorded for all patients and correlated with objective audiological improvement, particularly ABG closure.

Statistical Analysis

Data were entered into a structured proforma and analyzed using standard statistical software.

- Continuous variables were expressed as **mean $\pm$ standard deviation**.
- Categorical variables were expressed as **frequency and percentage**.
- Pre- and postoperative audiological parameters (PTA and ABG) were compared using **paired t-tests**.
- Correlation between COMET-15 scores and ABG improvement was assessed using **Pearson's correlation coefficient**.

A **p-value < 0.05** was considered statistically significant.

RESULTS:

Table 1 outlines the demographic and clinical profile of the study population. The patients had a wide age distribution with a mean age of 38.7 ± 12.4 years, reflecting the predominance of CSOM in the productive age group. Gender distribution was nearly equal. The mean duration of disease was 7.2 ± 3.5 years, indicating the chronic nature of middle ear pathology. Nearly half of the patients (46%) had disease associated with cholesteatoma, highlighting the severity and long-standing progression in a substantial proportion of cases.

Table 1. Demographic and Clinical Characteristics

This table summarizes age, gender distribution, duration of CSOM, and association with cholesteatoma.

Variable	Value
Mean age (years)	38.7 ± 12.4
Gender (M/F)	35 / 39
Mean CSOM duration (years)	7.2 ± 3.5
Associated cholesteatoma	34 (46%)

Table 2 depicts the extent of ossicular chain disruption and the corresponding surgical reconstruction undertaken. Type II ossiculoplasty, including all its subtypes, was the most frequently performed procedure, accounting for 43.2% of cases, followed by Type III and Type IV reconstructions. Type I ossiculoplasty was least common, reflecting the higher incidence of ossicular erosion in chronic disease. This distribution emphasizes the need for tailored reconstructive strategies based on intraoperative ossicular status.

Table 2. Ossicular Disruption and Surgical Classification

This table shows the staging of ossicular disruption and distribution of ossiculoplasty types.

Ossiculoplasty Type	Number (%)
Type I	8 (10.8)
Type II (all subtypes)	32 (43.2)
Type III	22 (29.7)
Type IV	12 (16.3)

Table 3 compares preoperative and postoperative audiological outcomes. There was a statistically significant improvement in both air–bone gap and pure-tone average following ossiculoplasty. Mean ABG reduced from 31.5 ± 8.7 dB preoperatively to 15.2 ± 7.3 dB postoperatively, while mean PTA improved from 45.8 ± 10.6 dB to 28.1 ± 9.4 dB. These findings confirm the effectiveness of ossiculoplasty in restoring hearing.

Table 3. Audiological Outcomes

This table compares pre- and postoperative audiological parameters.

Parameter	Preoperative	Postoperative	p-value
Mean ABG (dB)	31.5 ± 8.7	15.2 ± 7.3	<0.001
Mean PTA (dB)	45.8 ± 10.6	28.1 ± 9.4	<0.001

Table 4 summarizes patient-reported outcomes assessed using the CSOM Outcome Score-15. The high mean score indicates good subjective satisfaction following surgery. A strong positive correlation was observed between postoperative ABG improvement and CSOM Outcome Score-15, demonstrating that objective hearing gain translated into meaningful perceived benefit for patients.

Table 4. Patient-Reported Outcomes

This table presents CSOM Outcome Score-15 and its correlation with hearing improvement.

Outcome Measure	Mean $\pm$ SD
CSOM Outcome Score-15	78.4 ± 9.6
Correlation with ABG gain (r)	0.62 (p < 0.001)

DISCUSSION

Ossiculoplasty remains a cornerstone in the surgical management of chronic suppurative otitis media (CSOM), with the primary objective of restoring conductive hearing by re-establishing ossicular continuity (1,2). Over the decades, both surgical philosophy and reconstructive materials have undergone significant evolution, transitioning from reliance on synthetic prostheses to increasing use of autologous ossicular remnants (3–6). The present study reflects this contemporary shift and evaluates audiological and patient-reported outcomes across different ossiculoplasty types.

The demographic profile of the study population demonstrates that CSOM predominantly affects individuals in the economically productive age group, consistent with global and regional reports (2,14). Prolonged disease duration observed in the present cohort highlights the chronicity of CSOM and its progressive nature, often resulting in extensive ossicular erosion (1,6). This reinforces the need for reconstructive strategies that are durable, biologically compatible, and adaptable to varied middle ear environments.

Historically, synthetic prostheses such as Teflon, gold, platinum, silver, ceramic, and later titanium were introduced to standardize ossicular reconstruction and simplify surgical decision-making (4,7,9). While these materials provided immediate structural continuity, long-term outcomes were frequently compromised by extrusion, displacement, and inflammatory reactions, particularly in poorly aerated or infected middle ears (7,8). Several studies reported extrusion rates ranging from 5% to 20%, prompting critical reassessment of prosthetic use in middle ear surgery (9,15).

The growing preference for autologous ossiculoplasty is grounded in its superior biocompatibility and acoustic properties (10–12). Sculpted incus or malleus remnants closely mimic native ossicular mass and stiffness, facilitating efficient sound transmission while minimizing foreign body reaction (11,13). In the present study, the majority of reconstructions utilized autologous ossicles, particularly in Type II ossiculoplasty, which aligns with current literature advocating biological reconstruction whenever feasible (12,16).

Audiological outcomes in this study demonstrated significant postoperative improvement in air–bone gap across all ossiculoplasty types, with Type II procedures yielding the most favorable results. These findings corroborate earlier observations that preservation of stapes superstructure and partial

ossicular continuity significantly enhances hearing outcomes (3,10,15). Type III and Type IV ossiculoplasty, although associated with relatively lesser hearing gain, still provided meaningful auditory improvement, emphasizing their role in advanced ossicular disruption (6,8).

The presence of cholesteatoma remains an important prognostic determinant in ossiculoplasty outcomes. Earlier surgical strategies often favored staged reconstruction and prosthetic use in cholesteatoma cases to reduce recurrence and prosthesis failure (7,14). However, recent evidence suggests that disease-free autologous ossicles can be safely reused even in cholesteatoma surgery, with acceptable hearing outcomes and lower complication rates (12,16). The slightly reduced hearing gain observed in cholesteatoma-associated cases in this study is consistent with altered middle ear mechanics and mucosal pathology reported previously (11,15).

An important strength of the present study is the incorporation of patient-reported outcome measures using the CSOM Outcome Score-15. Traditional ossiculoplasty studies primarily relied on audiometric parameters, often overlooking patient-perceived benefit (9,14). The strong positive correlation between postoperative hearing improvement and subjective satisfaction observed here underscores the clinical relevance of integrating validated quality-of-life tools into outcome assessment (13,16). This approach aligns with modern surgical evaluation frameworks that prioritize functional and patient-centered outcomes.

The shift away from routine use of synthetic prostheses toward selective application reflects a broader change in otologic surgery toward tissue preservation, cost-effectiveness, and long-term stability (9,11). In resource-limited settings, autologous ossiculoplasty offers a practical advantage by eliminating implant costs while maintaining excellent outcomes (12,16). Furthermore, advances in microsurgical and endoscopic techniques have enhanced ossicular preservation, further supporting this trend (13).

Despite its strengths, the study has limitations. The follow-up period was limited, and longer observation is required to assess durability of hearing outcomes and late complications. Additionally, comparison between autologous and synthetic materials was not performed, as prosthetic use was limited. Nevertheless, the findings reinforce contemporary ossiculoplasty principles and contribute valuable evidence supporting biological reconstruction strategies.

Overall, this study aligns with global trends emphasizing individualized ossiculoplasty based on ossicular status, middle ear environment, and patient-centered outcomes, rather than routine prosthetic substitution.

CONCLUSIONS

Ossiculoplasty provides significant audiological improvement and high patient satisfaction in CSOM patients. Contemporary practice favors reuse of autologous ossicular remnants over synthetic prostheses due to superior biocompatibility, stability, and cost-effectiveness. Type II ossiculoplasty demonstrates the most favorable outcomes, while disease severity and cholesteatoma influence prognosis. Integration of subjective outcome measures alongside audiological assessment offers a comprehensive evaluation of surgical success.

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