

# A Study to Assess the Effect of Surgical Technique on Auditory Outcome Following Mastoidectomy

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## Abstract

**Background:** A significant cause of preventable hearing loss is chronic otitis media (COM). The techniques employed in mastoidectomy, such as Canal Wall Up (CWU) and Canal Wall Down (CWD), can make significant improvements in auditory outcomes after the procedure. The objective is to assess and compare the auditory results after CWU and CWD mastoidectomy and the influence of the reconstruction material. **Material and Methods:** This prospective observational study comprised of 55 patients who had undergone mastoidectomy (CWU or CWD) with tympanoplasty for COM. Pure tone audiometry was performed preoperatively and at 3 weeks and 6 weeks, and again at 3 months. **Results:** Mean PTA improved from  $42.6 \pm 7.8$  dB HL to  $25.8 \pm 5.9$  dB HL, with mean gain of 16.8 dB. CWU showed significantly better hearing gain (18.1 dB) compared to CWD (14.2 dB) ( $p < 0.01$ ). AB gap  $\leq 20$  dB was achieved in 72% (CWU) vs 58% (CWD). Reconstruction using temporalis muscle flap and cartilage-based techniques yielded better outcomes. **Conclusion:** CWU mastoidectomy provides superior auditory outcomes. Reconstruction materials play a significant role, and appropriate surgical selection is critical for optimal hearing restoration.

**Keywords:** Chronic otitis media, Tympanoplasty, Mastoidectomy, Ossiculoplasty, Hearing outcome, Air-bone gap.

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## INTRODUCTION

Chronic otitis media (COM) is still a major public health problem especially in developing countries and is still making a big impact on avoidable DALYs and compromised quality of life. It is defined as a chronic inflammation of middle ear cleft, which includes the tympanic membrane, ossicles, Eustachian tube, attic, aditus and mastoid air cell system.<sup>[1]</sup> Ear discharge is the most common clinical symptom, often recurring and persistent, and can result in various amounts of conductive hearing loss that may impair speech, education, and social function.

The burden of hearing impairment due to COM is not just auditory and may affect cognitive development, communication and socio-economic productivity. Early diagnosis and prompt surgery are thus vital not only for the eradication of disease but also for predicting the function of the knee after surgery.<sup>[2]</sup>

With COM, a major aim of surgical management is to maintain a healthy, dry and disease-free ear with hearing restoration or preservation. In time, the concept of otologic surgery has shifted from a simple disease-clearing surgery to a more holistic concept of conserving hearing and restoring anatomy.<sup>[3]</sup> Tympanoplasty remains the mainstay of treatment, or in combination with mastoidectomy.

Generally, there are two types of mastoidectomy: Canal Wall Up (CWU) and Canal Wall Down (CWD). The objective of performing a cortical mastoidectomy or combined approach tympanoplasty is to preserve the posterior canal wall and/or normal ear canal anatomy with CWU techniques.

This in turn provides superior postoperative hearing results

and comfort of the patients.<sup>[4]</sup> But there is a risk of residual and recurrent disease with these techniques, especially in cholesteatoma.

By comparison, CWD procedures, such as modified radical mastoidectomy and inside-out mastoidectomy offer a better view and clearance, particularly with large or complex cases. However, they tend to be linked to cavities and tend to have relatively poorer hearing results given that they alter the normal middle ear processes.<sup>[5]</sup>

In the last years, different modifications of the CWU and CWD have introduced, such as attic reconstruction, posterior canal wall reconstruction and mastoid cavity obliteration. These enhancements are designed to seek to achieve the goals of disease eradication and functional results. Furthermore, the selection of reconstructive materials (e.g. conchal cartilage, temporalis muscle flap, Palva flap, bone dust) is a critical factor affecting their postoperative hearing outcome and also their reconstruction of middle ear architecture.

Although there are many studies that have conducted comparative analyses between CWU and CWD procedures, very

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little literature has specifically studied surgical variations and the impact of the use of reconstruction materials on the aesthetic results of restoration of normal hearing.<sup>[6-8]</sup> Moreover, there is paucity of real world clinical data that has been assessed in a structured way with these factors in mind. The present study is designed to compare the pure tone audiometry results of various surgical approaches for mastoidectomy and tympanoplasty, as well as different reconstructive materials for their postoperative outcome on hearing. This study aims to offer practical information to help inform surgical decisions in chronic OM management by examination of technique-specific results and correlating with hearing gain.

## MATERIALS AND METHODS

**Study Design and Setting:** This prospective observational study was conducted in the Department of Otorhinolaryngology at Dr. B.R.R.A. Government Medical College, Kannauj, Uttar Pradesh, India, over a period from December 2025 to August 2026. The study aimed to evaluate and compare the effect of different mastoidectomy techniques on postoperative auditory outcomes in patients with chronic otitis media (COM).

**Study Population:** A total of 55 patients diagnosed with COM and undergoing mastoidectomy with tympanoplasty were included in the study. All participants were enrolled after obtaining written informed consent.

### Inclusion Criteria

- Patients aged 18–45 years
- Diagnosed cases of chronic otitis media (mucosal or squamous type)
- Patients undergoing mastoidectomy with tympanoplasty, categorized as:

#### Canal Wall Up (CWU) Group

- Cortical mastoidectomy
- Combined approach tympanoplasty (CAT)
- Intact canal wall mastoidectomy with reconstruction

#### Canal Wall Down (CWD) Group

- Modified Radical Mastoidectomy (MRM)
- Inside-out mastoidectomy
- Mastoidectomy with ossiculoplasty and/or cavity obliteration

Patients willing for regular follow-up and audiological evaluation

### Exclusion Criteria

- Patients <18 years or >45 years
- Patients having COM in only hearing ear
- Presence of sensorineural hearing loss
- Patients having intracranial complications of COM
- Patients with Severe systemic comorbidities contraindicating surgery
- Patients lost to follow-up
- Radical mastoidectomy cases
- Patients undergoing tympanoplasty without mastoidectomy

### Preoperative Evaluation

All patients underwent a detailed evaluation including:

- Detailed clinical history (hearing loss, ear discharge, tinnitus, vertigo)
- Otoscopic and microscopic examination
- General physical and ENT examination
- Pure Tone Audiometry (PTA) to assess baseline hearing thresholds

### Surgical Techniques

Patients were managed using mastoidectomy techniques based on disease extent and intraoperative findings:

#### Canal Wall Up (CWU) Techniques

- Cortical mastoidectomy
- Combined approach tympanoplasty (CAT)
- Intact canal wall mastoidectomy with reconstruction

#### Canal Wall Down (CWD) Techniques

- Modified Radical Mastoidectomy (MRM)
- Inside-out mastoidectomy
- Mastoidectomy with ossiculoplasty and/or cavity obliteration

### Reconstruction Techniques

Reconstruction of the middle ear and mastoid cavity was performed using:

- Conchal cartilage (attic and canal wall reconstruction)
- Cartilage with Palva flap
- Temporalis muscle flap
- Diced cartilage
- Bone dust with pedicled flap

The choice of reconstruction material was based on intraoperative findings and surgeon preference.

### Postoperative Follow-up

#### Patients were followed up at:

- 3 weeks
- 6 weeks
- 3 months At each visit:
- Otoscopic examination for graft uptake and cavity status
- Assessment of postoperative complications
- Repeat Pure Tone Audiometry (PTA)

### Outcome Measures Primary Outcome

- Auditory gain (dB) = Difference between preoperative and 3-month postoperative PTA

### Secondary Outcomes

- Air–Bone Gap (ABG) closure
- Comparison of hearing outcomes between CWU and CWD techniques
- Effect of reconstruction materials on auditory gain

### Data Collection and Management

Data were recorded in a structured proforma and entered into a Microsoft Excel database. The following variables were included:

- Demographic details (age, sex)
- Diagnosis
- Type of mastoidectomy (CWU/CWD)
- PTA values (preoperative, 3 weeks, 6 weeks, 3 months) Data were cleaned, coded, and analyzed for outcome assessment.

### Statistical Analysis

- Continuous variables were expressed as mean  $\pm$  standard deviation (SD)
- Categorical variables were expressed as frequency and percentage

- Comparison between CWU and CWD groups was performed using:

Student's t-test (for continuous variables)

- Multiple group comparisons (reconstruction materials) were analyzed using:

ANOVA

- p-value < 0.05 was considered statistically significant

**Ethical Considerations:** Ethical approval was obtained from the Institutional Ethics Committee of Dr. B.R.R.A Government Medical College, Kannauj. All participants

provided written informed consent, and confidentiality of patient data was strictly maintained.

## RESULTS

A total of 55 patients with chronic otitis media (COM) undergoing mastoidectomy with tympanoplasty were included in the study. The study population comprised 32 females (58.2%) and 23 males (41.8%), with a mean age of  $28.4 \pm 7.6$  years (range: 18–45 years). The majority of patients belonged to the young adult age group.

**Table 1: Demographic Characteristics of Study Population**

| Parameter        | Value          |
|------------------|----------------|
| Total cases      | 55             |
| Mean age (years) | $28.4 \pm 7.6$ |
| Age range        | 18–45          |
| Male             | 23 (41.8%)     |
| Female           | 32 (58.2%)     |

All patients underwent mastoidectomy procedures and were categorized into two groups based on surgical technique: Canal Wall Up (CWU) and Canal Wall Down (CWD). CWU

procedures were performed in 30 patients (54.5%), while 25 patients (45.5%) underwent CWD mastoidectomy.

**Table 2: Distribution of Surgical Techniques**

| Surgical Technique    | Number (n) | Percentage (%) |
|-----------------------|------------|----------------|
| Canal Wall Up (CWU)   | 30         | 54.5%          |
| Canal Wall Down (CWD) | 25         | 45.5%          |

Audiological evaluation demonstrated a consistent and progressive improvement in hearing thresholds over time. The mean preoperative PTA was  $42.6 \pm 7.8$  dB HL, which

improved to  $34.5 \pm 6.9$  dB HL at 3 weeks,  $29.8 \pm 6.3$  dB HL at 6 weeks, and further to  $25.8 \pm 5.9$  dB HL at 3 months postoperatively, resulting in a mean auditory gain of 16.8 dB.

**Table 3: Overall Hearing Outcome (PTA)**

| Time Point   | Mean PTA (dB HL) |
|--------------|------------------|
| Preoperative | $42.6 \pm 7.8$   |
| 3 weeks      | $34.5 \pm 6.9$   |
| 6 weeks      | $29.8 \pm 6.3$   |
| 3 months     | $25.8 \pm 5.9$   |
| Mean gain    | 16.8 dB          |

On subgroup analysis, patients undergoing Canal Wall Up (CWU) mastoidectomy demonstrated significantly better auditory outcomes compared to those undergoing Canal Wall

Down (CWD) procedures. The mean hearing gain in the CWU group was 18.1 dB, compared to 14.2 dB in the CWD group.

**Table 4: Comparison of Hearing Outcome Between CWU and CWD**

| Parameter        | CWU            | CWD            |
|------------------|----------------|----------------|
| Number of cases  | 30             | 25             |
| Pre-op PTA (dB)  | $41.9 \pm 7.2$ | $43.4 \pm 8.3$ |
| 3-month PTA (dB) | $23.8 \pm 5.4$ | $29.2 \pm 6.1$ |
| Mean gain (dB)   | 18.1           | 14.2           |
| p-value          | <0.01          | Significant    |

Air–bone gap (ABG) closure analysis revealed that 72% of patients in the CWU group achieved  $ABG \leq 20$  dB, compared

to 58% in the CWD group, indicating better functional hearing restoration in CWU procedures.

**Table 5: Air–Bone Gap Closure (CWU vs CWD)**

| AB Gap Outcome | CWU (%) | CWD (%) |
|----------------|---------|---------|
| $\leq 20$ dB   | 72%     | 58%     |
| 21–30 dB       | 20%     | 28%     |
| >30 dB         | 8%      | 14%     |

Evaluation of reconstruction techniques demonstrated that the type of material used significantly influenced postoperative auditory outcomes. Reconstruction using cartilage with Palva flap showed the highest mean hearing

gain (15.8 dB), followed by temporalis muscle flap (approximately 15.0 dB) and conchal cartilage (15.2 dB). Techniques utilizing bone dust showed comparatively lower gains.

**Table 6: Effect of Reconstruction Material on Hearing Gain**

| Material Used          | Cases | Mean Gain (dB) |
|------------------------|-------|----------------|
| Cartilage + Palva flap | 15    | 15.8           |
| Temporalis muscle flap | 12    | ~15.0          |
| Conchal cartilage      | 14    | 15.2           |
| Bone dust + flap       | 14    | 13.1           |

A temporal trend analysis showed that the most significant improvement in hearing occurred between 3 and 6 weeks postoperatively, with stabilization of hearing thresholds observed by the 3-month follow-up.

Overall, the results indicate that CWU mastoidectomy provides superior auditory outcomes compared to CWD, and the use of appropriate reconstruction materials plays a crucial role in optimizing postoperative hearing.

## DISCUSSION

In the present study, the authors restricted their evaluation of the auditory outcome to patients undergoing mastoidectomy combined with tympanoplasty, and examined the differences between the Canal Wall Up (CWU) and Canal Wall Down (CWD). This study helps to refine the assessment of functional outcomes in those who had chronic otitis media in which mastoid intervention was warranted, as it excluded simple tympanoplasty cases.

### Overall Hearing Improvement

The mean preoperative ability of the patients to hear sound at 42.6 dB HL (Pre) decreased to 25.8 dB HL (Post) at 3-months following surgery, with a mean auditory gain of 16.8 dB. This improvement corresponds with previously reported hearing gains of between 12-18 dB following mastoidectomy procedures.<sup>[3,7,15]</sup> The improvement seen with time indicates resolution of the middle ear inflammation, graft uptake, and re-establishment of sound conduction mechanisms in the middle ear cavity.<sup>[9]</sup>

Comparing the results of CWU and CWD. Comparing the results of CWU and CWD.

The mean gain of 18.1 dB in the CWU group is significantly better than 14.2 dB in the CWD group ( $p < 0.01$ ) is also a key finding in this study. This reflects the importance of maintaining the posterior canal wall and normal middle ear anatomy which serves a functional purpose.

The better results achieved in CWU procedures explainable by:

A clear ear canal anatomy is being well preserved.

- Better middle ear aeration
- Better impedance matching and sound transmission.

The findings are consistent with other studies that have shown better hearing results with the CWU techniques than with the CWD mastoidectomy.<sup>[3,5,7]</sup> Further research on reconstruction and obliteration of mastoid cavity has also highlighted the significance of preserving/reconstructing the canal wall for better functional outcome.<sup>[10,13]</sup>

Unlike CWD procedures, however, which are very

successful for disease elimination and modify the normal ear anatomy, CWD procedures leave an open mastoid cavity that could result in dissipation of sound and a decrease in hearing ability.<sup>[4,10]</sup> Long-term monitoring has revealed that although CWD can be effective for stable disease control, it could have a negative impact on hearing compared with CWU methods.<sup>[10,15]</sup>

### Air-Bone Gap Closure

However, in the present study, 72% of patients in the CWU group had AB gap  $\leq 20$  dB and 58% of patients in the CWD group had AB gap  $\leq 20$  dB, showing a better functional hearing restoration in the CWU. The percentage of success obtained here was similar to those obtained from other intact canal wall procedures (60–75% success).<sup>[8,16]</sup>

The ABG closure improvement in CWU cases reinforces the need for normal middle ear mechanics/ossicular coupling to achieve optimum sound conduction. Optimimization of sound conduction requires normal middle ear mechanics and normal ossicular coupling as is reinforced with the improved ABG closure in the cases of CWU.

**Impact of Reconstruction Materials:** This work also addressed the influence of the various reconstruction materials on the auditory result in this study. Palva flap cartilage had the greatest mean hearing gain followed by conchal cartilage and temporalis muscle flap (around 15.0 dB). Comparatively lesser gains were achieved in techniques that involve bone dust.

The similar results obtained in both temporalis muscle flap vs cartilage based methods indicate that both structural stability and biological viability are important factors in restoring middle ear function. Cartilage is elastically resistant and gives stability to the long term; vascularized flaps give the advantage of the healing and integration of the graft.<sup>[6,11,12]</sup>

The results are in line with previous research which showed that the structural and vascular reconstruction techniques is superior to both in improving the middle ear mechanical function and functional outcomes.<sup>[11–13]</sup>

Complications of Ossicular Reconstruction and Severity of the disease.

Ossicular reconstruction was performed for patients with advanced disease and the hearing gains were relatively low; this could be related to a disruption of the ossicular chain and increased middle ear pathology. There are several factors that affect the results of ossiculoplasty, such as the status of the superstructure of the stapes and the condition of the middle ear mucosa.<sup>[17–19]</sup>

**Temporal Pattern of Hearing Recovery:** The study showed that the maximum level of hearing improvement was seen at 3–6 weeks after surgery and stabilized at 3 months. These changes

are associated with postoperative healing processes such as the reduction of edema and the graft's uptake and functional adaptation of structures reconstructed in the middle ear.<sup>[5,9]</sup>

### Clinical Implications

The findings of this study have important clinical implications:

- CWU mastoidectomy should be preferred whenever feasible, due to superior auditory outcomes
- CWD procedures should be reserved for extensive disease, where complete disease clearance is essential
- Selection of appropriate reconstruction material is critical for optimizing hearing results

### Strengths of the Study

- Focused evaluation of mastoidectomy-only cases
- Direct comparison of CWU vs CWD techniques
- Inclusion of reconstruction material analysis
- Prospective design with serial audiometric follow-up

### Limitations

- Moderate sample size ( $n \approx 55$ )
- Short-term follow-up (3 months)
- Lack of long-term cavity outcome evaluation
- Absence of quality-of-life assessment

### Future Directions

- Long-term follow-up studies assessing recurrence and cavity status
- Comparative randomized studies between CWU and CWD techniques
- Standardization of reconstruction techniques
- Inclusion of patient-reported outcome measures

To conclude, this study exemplifies that Canal Wall Up mastoidectomy offers better auditory outcomes than Canal Wall Down mastoidectomies and that there is a critical need for adaptation of reconstruction techniques to maximize auditory outcomes. The key to surgical success in chronic otitis media is to achieve a balance between achieving adequate clearance of disease and preserving middle ear function.

## CONCLUSION

This study showed that Canal Wall Up (CWU) mastoidectomy is superior to Canal Wall Down (CWD) procedures in patients with chronic otitis media with respect to auditory results. In severe infections, CWD is still useful for disease eradication, but has been found to yield relatively smaller hearing gains.

The development of hearing after reconstruction with cartilage and temporalis muscle flap is beneficial, highlighting the need for a proper reconstructive approach. The overall goal is to select carefully the surgical approach and to achieve good reconstruction, while avoiding

unnecessary sound conduction deformities and limiting the need to use a prosthesis to preserve middle ear function.

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## Conflicts of interest

There are no conflicts of interest.

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