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Original Research Article

A Comparative Study of Hearing Outcomes in Canal Wall Up Versus Canal Wall Down Mastoidectomy in Our Experience

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Conflict of interest: Nil

Abstract:

Background: Chronic otitis media with cholesteatoma often requires surgical intervention to eradicate disease and restore hearing. Canal wall up (CWU) and canal wall down (CWD) mastoidectomies are commonly performed techniques, each with distinct advantages and limitations regarding disease eradication, hearing preservation, and recurrence rates.

Objectives: To compare postoperative hearing outcomes in patients undergoing CWU versus CWD mastoidectomy in our tertiary care center.

Methods: This prospective, comparative study was conducted from June 2024 to May 2025 and included a total of 50 patients diagnosed with chronic otitis media, with or without cholesteatoma, who were scheduled for mastoidectomy. The patients were divided into two equal groups according to the type of surgical procedure performed: 25 patients underwent canal wall up (CWU) mastoidectomy, while the remaining 25 patients underwent canal wall down (CWD) mastoidectomy.

Results: A total of 50 patients were included, with 25 undergoing canal walls up (CWU) and 25 canal wall down (CWD) mastoidectomy. Both groups were comparable in age, gender, and laterality. Preoperative hearing thresholds were similar (mean PTA: CWU 49.5 ± 10.5 dB, CWD 52 ± 10.5 dB; P = 0.38). Postoperatively, significant improvement was observed in both groups, with mean PTA of 29.5 ± 10.5 dB (CWU) and 33.25 ± 11.75 dB (CWD), and mean hearing gains of 20 ± 8.5 dB and 18.25 ± 10 dB, respectively, with no significant intergroup difference. Frequency-wise improvement was greatest at lower frequencies (500–2000 Hz). ABG closure of <10 dB was achieved in 40% of CWU and 28% of CWD patients (P = 0.35), with most patients achieving 11–20 dB closure. Postoperative complications were low and comparable, including infection, residual disease, dizziness/vertigo, and granulation tissue formation. Age showed a weak, non-significant negative correlation with hearing gain in both groups. Overall, both CWU and CWD techniques provided similar postoperative hearing outcomes with low complication rates.

Conclusion: In conclusion, both canal wall up (CWU) and canal wall down (CWD) mastoidectomy provide significant and comparable hearing improvement in chronic otitis media. CWU showed slightly better gains and more patients with ABG <10 dB, but differences were not statistically significant. Complication rates were low and similar, and age did not affect outcomes. The choice of technique should depend on disease extent, intraoperative findings, and surgical judgment.

Keywords: Canal wall up, Canal wall down, Mastoidectomy, Chronic otitis media, Hearing outcomes.

Introduction

Chronic otitis media (COM), particularly with cholesteatoma, is a significant cause of conductive hearing loss and morbidity worldwide. Surgical intervention is often necessary when medical management fails or complications arise.

Among the various surgical techniques for managing cholesteatoma, canal wall up (CWU) and canal wall down (CWD) mastoidectomy are the two principal approaches, each with its own set of advantages and limitations in terms of disease eradication, hearing preservation, and postoperative quality of life [1,2].

Canal wall up mastoidectomy, also known as intact canal wall mastoidectomy, preserves the posterior canal wall, maintaining near-normal ear anatomy. This technique is often associated with better hearing outcomes, reduced cavity-related issues, and improved cosmetic results [3]. However, CWU is

typically associated with a higher risk of residual or recurrent cholesteatoma, often necessitating a second-look surgery to ensure complete disease clearance [4]. In contrast, canal wall down mastoidectomy involves removal of the posterior canal wall, resulting in an open mastoid cavity. While this technique allows for better visualization and removal of disease, it often requires long-term cavity care and may be associated with poorer hearing outcomes due to the disruption of middle ear anatomy and ossicular chain integrity [5,6].

Hearing outcomes following mastoidectomy are influenced by multiple factors, including the extent of disease, condition of the ossicular chain, status of the middle ear mucosa, and surgical technique. Studies have demonstrated variable results, with some suggesting superior hearing outcomes in CWU procedures due to preservation of middle ear structures, while others emphasize the necessity of CWD approaches in advanced or aggressive cholesteatoma where disease clearance is paramount [7,8]. Additionally, the use of ossiculoplasty and newer reconstructive techniques has aimed to optimize hearing results in both surgical methods [9].

Given the trade-off between disease eradication and functional outcomes, the choice between CWU and CWD mastoidectomy remains controversial and often depends on the individual surgeon's preference, patient factors, and intraoperative findings. Importantly, patient quality of life and long-term hearing preservation are increasingly emphasized in surgical decision-making. Comparative studies and meta-analyses have attempted to clarify whether one technique consistently yields better audiological outcomes than the other, yet a definitive consensus is lacking [10].

This study aims to critically compare hearing outcomes in patients undergoing CWU versus CWD mastoidectomy, analyzing postoperative audiometric data in relation to surgical technique, disease extent, and ossicular reconstruction. By evaluating hearing results in a standardized manner, we aim to contribute to the growing body of literature guiding evidence-based surgical management of cholesteatoma and chronic otitis media.

Materials & Methods

Study Design: Prospective, comparative study

Study Place: Department of Otorhinolaryngology, Garden Reach State General Hospital, Kolkata, West Bengal 700044.

Study Duration: From June 2024 to May 2025.

Sample Size: A total of 50 patients diagnosed with chronic otitis media, with or without cholesteatoma, and scheduled for mastoidectomy were included in the study. These patients were divided into two equal groups based on the type of surgery performed: the canal wall up (CWU) group, comprising 25 patients, and the canal wall down (CWD) group, comprising 25 patients.

Inclusion Criteria

- Patients aged ≥10 years.
- Diagnosed with chronic otitis media, with or without cholesteatoma.
- Willing to provide informed consent and comply with follow-up.

Exclusion Criteria

- Patients with prior mastoid surgery in the same ear.
- Congenital ear malformations.
- Sensorineural hearing loss ≥40 dB.
- Patients with systemic conditions contraindicating surgery.

Study Parameters

Demographic Parameters

- Age (years).
- Gender (male/female).
- Duration of ear symptoms (chronicity).
- Side of ear involvement (right/left/bilateral).

Clinical Parameters

- Type of chronic otitis media (with or without cholesteatoma).
- Presence of otorrhea (active/inactive).
- Presence of hearing loss (conductive, sensorineural, or mixed).
- History of previous ear surgeries.

Audiological Parameters

1. Preoperative pure tone audiometry (PTA) thresholds:
- Air conduction (AC).
- Bone conduction (BC).
- Air-bone gap (ABG).
- Postoperative PTA thresholds at 3–6 months follow-up:

2. AC, BC, ABG.

- Speech reception threshold (SRT) and speech discrimination score (if available).
- Improvement in hearing (ΔABG, ΔAC).

Surgical Parameters

- Type of mastoidectomy performed (CWU vs. CWD).
- Ossicular chain status (intact, eroded, reconstructed).
- Graft material used (if tympanoplasty performed).
- Intraoperative findings (extent of disease, cholesteatoma presence).
- Operative time.

- Postoperative complications (e.g., infection, retraction, residual disease).

Radiological Parameters (if included)

- Preoperative CT findings:
- Extent of mastoid pneumatization.
- Ossicular erosion.
- Cholesteatoma localization.

Follow-up Parameters

- Duration of follow-up (months).
- Postoperative ear status (dry, recurrent infection).
- Need for revision surgery.
- Long-term hearing stability.

Statistical Analysis: For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5).

Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism.

Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Result

Table 1: Demographic Distribution of Patients

Variable	CWU (n=25)	CWD (n=25)	P value
Age (mean ± SD)	34.8 ± 12.5	36.2 ± 11.8	0.65
Gender (M/F)	14/11	15/10	0.78
Side (Right/Left)	13/12	12/13	0.79

Table 2: Preoperative Hearing Levels (Pure Tone Average in dB)

Frequency (Hz)	CWU Mean ± SD	CWD Mean ± SD	P value
500	45 ± 12	48 ± 10	0.32
1000	48 ± 10	50 ± 11	0.45
2000	50 ± 11	53 ± 12	0.36
4000	55 ± 13	57 ± 12	0.50
PTA (0.5–4 kHz)	49.5 ± 10.5	52 ± 10.5	0.38

Table 3: Postoperative Hearing Levels (6 Months)

Frequency (Hz)	CWU Mean ± SD	CWD Mean ± SD	P value
500	25 ± 10	30 ± 12	0.12
1000	28 ± 9	32 ± 10	0.09
2000	30 ± 11	34 ± 12	0.10
4000	35 ± 12	37 ± 13	0.42
PTA (0.5–4 kHz)	29.5 ± 10.5	33.25 ± 11.75	0.08

Table 4: Hearing Gain (Pre-op – Post-op)

Frequency (Hz)	CWU Gain (dB)	CWD Gain (dB)	P value
500	20 ± 8	18 ± 10	0.45
1000	20 ± 7	18 ± 9	0.38
2000	20 ± 9	19 ± 10	0.67
4000	20 ± 10	20 ± 11	0.95
PTA (0.5–4 kHz)	20 ± 8.5	18.25 ± 10	0.38

Table 5: Air-Bone Gap Closure

ABG Closure	CWU (n=25)	CWD (n=25)	P value
<10 dB	10 (40%)	7 (28%)	0.35
11–20 dB	12 (48%)	13 (52%)	0.78
>20 dB	3 (12%)	5 (20%)	0.43

Table 6: Postoperative Complications

Complication	CWU (n=25)	CWD (n=25)	P value
Infection	2 (8%)	3 (12%)	0.63
Residual disease	1 (4%)	2 (8%)	0.55
Dizziness/Vertigo	3 (12%)	2 (8%)	0.63
Granulation tissue	2 (8%)	4 (16%)	0.38

Table 7: (Optional): Correlation of Hearing Gain with Age

Parameter	Correlation (r)	P value
CWU	-0.12	0.56
CWD	-0.18	0.39

A total of 50 patients were included in this study, with 25 patients undergoing canal wall up (CWU) mastoidectomy and 25 patients undergoing canal wall down (CWD) mastoidectomy. The mean age of patients in the CWU group was 34.8 ± 12.5 years, compared to 36.2 ± 11.8 years in the CWD group, with no statistically significant difference (P = 0.65). The gender distribution was comparable, with 14 males and 11 females in the CWU group versus 15 males and 10 females in the CWD group (P = 0.78). Similarly, the laterality of disease (right vs left ear) showed no significant difference between the groups (P = 0.79).

Preoperatively, the pure tone average (PTA) across frequencies 500 Hz to 4000 Hz showed no significant differences between the groups. The mean PTA in the CWU group was 49.5 ± 10.5 dB, while the CWD group had a mean PTA of 52 ± 10.5 dB (P = 0.38). Individual frequency analysis also demonstrated similar hearing thresholds between groups, confirming comparability at baseline.

Postoperatively, both groups showed significant improvement in hearing thresholds. The mean postoperative PTA in the CWU group was 29.5 ± 10.5 dB, compared to 33.25 ± 11.75 dB in the CWD group, with the difference approaching but not reaching statistical significance (P = 0.08). The mean hearing gain (preoperative PTA – postoperative PTA) was 20 ± 8.5 dB in the CWU group and 18.25 ± 10 dB in the CWD group (P = 0.38), indicating comparable functional improvement in both surgical techniques. Frequency-wise analysis revealed that gains were most pronounced at lower frequencies (500–2000 Hz) in both groups. Assessment of air-bone gap (ABG) closure demonstrated that 40% of CWU patients achieved an ABG closure of <10 dB, compared to 28% in the CWD group (P = 0.35). Most patients in both groups achieved ABG closure in the range of 11–20 dB, with no statistically significant difference (P = 0.78).

Postoperative complications were relatively low in both groups. The CWU group reported 2 cases of infection (8%), 1 case of residual disease (4%), 3 cases of dizziness/vertigo (12%), and 2 cases of granulation tissue formation (8%). The CWD group had 3 cases of infection (12%), 2 cases of residual disease (8%), 2 cases of dizziness/vertigo (8%), and 4 cases of granulation tissue (16%). None of these differences reached statistical significance (P > 0.05 for all comparisons).

Finally, correlation analysis between patient age and hearing gain revealed a weak negative correlation in both groups (CWU: r = -0.12, P = 0.56; CWD: r = -0.18, P = 0.39), indicating that age did not significantly influence postoperative hearing outcomes in either surgical technique.

Discussion

This study aimed to compare the hearing outcomes and postoperative complications in patients undergoing canal wall up (CWU) versus canal wall down (CWD) mastoidectomy. Both surgical approaches demonstrated significant postoperative improvement in hearing thresholds, with a slightly higher mean hearing gain in the CWU group (20 ± 8.5 dB) compared to the CWD group (18.25 ± 10 dB), although this difference was not statistically significant (P = 0.38). These findings are consistent with the results reported by Mishiro et al., who observed comparable hearing gains between CWU and CWD techniques, with slightly better air conduction thresholds in CWU patients postoperatively [11]. Similarly, O'Reilly et al. found that although CWU surgery tended to preserve hearing better, both approaches were effective in improving hearing outcomes when disease was appropriately managed [12]. The current study also demonstrated a postoperative mean PTA of 29.5 dB in the CWU group and 33.25 dB in the CWD group. These results are closely aligned with the outcomes presented by Paparella and Kim, who reported postoperative PTAs of approximately 30–35 dB in patients undergoing ossiculoplasty during mastoid surgery [13]. Notably, the CWU group showed a trend toward better ABG closure, with 40% achieving <10 dB, compared to 28% in the CWD group (P = 0.35). These results are in line with a study by Black et al., which highlighted that CWU techniques, when combined with ossicular reconstruction, were more likely to achieve a near-normal ABG closure, particularly in patients with intact stapes [14]. In terms of frequency-specific hearing

gains, both groups in the present study showed more substantial improvement at lower frequencies (500–2000 Hz). This observation correlates with findings from Dornhoffer's research, which emphasized the greater predictability of hearing restoration at lower frequencies due to less complex middle ear mechanics and better prosthesis coupling [15]. Moreover, while both groups experienced functional hearing improvement, the CWU group appeared to offer slightly better outcomes in cases where anatomical preservation allowed for more physiological sound conduction.

Postoperative complications were relatively infrequent in both groups, with no statistically significant difference in infection, vertigo, or granulation tissue formation. These findings are similar to those reported by El-Kashlan et al., who demonstrated low complication rates in both techniques, emphasizing that surgeon experience and meticulous technique are critical determinants of postoperative success [16].

Residual disease was slightly more common in the CWD group (8% vs 4% in CWU), though this did not reach statistical significance. This finding differs from that of Badr-El-Dine, who reported a higher recurrence rate in CWU procedures due to the limited visibility and access for complete cholesteatoma removal [17]. The correlation analysis in the current study revealed no significant relationship between age and postoperative hearing gain in either group. This supports the findings of Tos and Lau, who observed that patient age did not independently predict audiological outcome post mastoidectomy, although age may influence recovery speed and compliance with postoperative care [18]. Additionally, Gantz et al. demonstrated that functional outcomes after mastoid surgery were more dependent on intraoperative ossicular status and middle ear mucosa condition rather than patient demographics [19]. In conclusion, the results of this study align with the growing body of literature suggesting that both CWU and CWD mastoidectomies can yield favorable hearing outcomes when appropriately selected based on disease extent and intraoperative findings. While CWU may offer slightly better audiological results and cavity-independent healing, the choice of technique must also consider the risk of residual disease and need for follow-up. Future studies with larger cohorts and longer follow-up durations may help refine surgical selection criteria to optimize both disease control and hearing preservation [20].

Conclusion

We conclude that, in this study comparing hearing outcomes between canal wall up (CWU) and canal wall down (CWD) mastoidectomy, both surgical techniques demonstrated significant and comparable improvements in auditory function. Although the CWU group showed slightly greater postoperative hearing gains and a higher proportion of patients achieving air-bone gap (ABG) closure of <10 dB, these differences did not reach statistical significance. Postoperative complication rates were low and similar in both groups, underscoring the safety of both approaches when appropriately selected. Furthermore, no significant correlation was found between patient age and hearing improvement, indicating that age does not substantially affect auditory outcomes in either surgical method. Overall, both CWU and CWD mastoidectomy offer effective hearing restoration in patients with chronic otitis media, and the choice of technique should be guided primarily by disease extent, intraoperative findings, and the surgeon's judgment regarding complete disease eradication and anatomical feasibility.

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