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Mastoid Cavity Obliteration Versus Open Cavity in Canal Wall Down Mastoidectomy: A Prospective Comparative Study.

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ABSTRACT

Canal wall down (CWD) mastoidectomy effectively eradicates atticoantral chronic suppurative otitis media (CSOM) but yields an open cavity prone to chronic otorrhea and lifelong morbidity. This study evaluates the clinical efficacy of concurrent mastoid obliteration using autologous materials to mitigate cavity-associated complications. A prospective, randomized, parallel-group clinical study was conducted on 50 patients requiring CWD mastoidectomy for unsafe CSOM. The cohort was equally partitioned into Group A (concurrent obliteration utilizing autologous bone pâté and cartilage; n = 25) and Group B (standard open mastoid cavity; n = 25). Postoperative otalgia, otorrhea, giddiness, waxy debris, and cavity epithelialization timelines were longitudinally evaluated over a 90-day tracking period. Baseline demographics, laterality, and preoperative hearing loss were statistically homogenous across both arms. While early postoperative pain and giddiness resolved comparably, otorrhea resolution diverged significantly. By postoperative Day 21, active discharge persisted in 100% of open cavities compared to 72% of obliterated cavities (p = 0.0096). The average duration required to achieve complete, definitive cavity epithelialization was dramatically accelerated in the obliteration cohort (6 weeks) compared to the conventional open cavity cohort (13 weeks). Mastoid cavity obliteration with an autologous composite of bone pâté and cartilage yields vastly superior healing dynamics following CWD mastoidectomy. By significantly accelerating complete epithelialization and early otorrhea resolution, this reconstructive technique successfully restores a dry, self-cleaning anatomical contour and minimizes the long-term clinical care burden.

Keywords: Chronic suppurative otitis media, Canal wall down mastoidectomy, Mastoid obliteration, Autologous bone pâté, Epithelialization, Cholesteatoma.

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INTRODUCTION

Chronic suppurative otitis media (CSOM), particularly the chronically discharging ear, remains one of the most prevalent clinical challenges encountered by otorhinolaryngologists in developing nations. Current estimates suggest that approximately 6% of the Indian population is affected by chronic ear pathologies [1]. The persistence of infection, combined with the osteolytic behaviour of cholesteatoma and granulation tissue, drives the primary pathological complications associated with this disease. Because there is no simple conservative method to eradicate these destructive processes, timely and definitive surgical intervention by an otologist is essential to prevent significant morbidity [2]. Historically, intact canal wall (ICW) mastoidectomy has been favoured due to the functional advantages of preserving the posterior canal wall. These benefits include the elimination of routine mastoid bowl cleaning, protection against water intolerance and calorically induced vertigo, and the preservation of normal anatomy for easier hearing aid fitting [2]. Conversely, patients left with a traditional open mastoid cavity frequently endure a substantial post-operative burden, characterized by recurrent otorrhea, water intolerance, the necessity for frequent microscopic debridement, susceptibility to caloric and barometric vertigo, and profound difficulties with conventional hearing aids [2].

For cases of CSOM involving atticoantral or posterosuperior marginal pathology, definitive surgical management is mandatory, typically involving either a canal wall down (CWD) or an ICW approach [3]. While the ICW technique successfully avoids cavity-associated morbidities, it often compromises surgical exposure, leading to higher rates of residual or recurrent disease [3]. The overarching goals of surgical intervention in chronic otitis media are the complete eradication of pathology, the restoration of hearing, and the preservation of normal anatomical contours. Prior to the mid-twentieth century, achieving disease clearance almost exclusively required the removal of the posterior external auditory canal wall, resulting in a radical or modified radical cavity [4]. Today, while many surgeons default to ICW mastoidectomy with tympanoplasty, the CWD approach remains indispensable for managing extensive or anatomically difficult disease. CWD mastoidectomy guarantees superior disease eradication, but historically, this success has come at the expense of chronic cavity issues and significant conductive hearing loss. To bridge this gap, mastoid cavity obliteration has been increasingly integrated into CWD procedures. Obliteration serves to minimize the surface area of nitrogen-absorbing mucosa—thereby reducing the likelihood of tympanic membrane retraction in cases of Eustachian tube dysfunction—while simultaneously eliminating the anatomical dead space where squamous epithelium and infections typically pool [4]. Ultimately, this reconstructive step yields a contracted, physiologically self-cleaning cavity that is easily maintained.

A wide array of both autologous and synthetic materials has been proposed for mastoid obliteration, including free fascial grafts, adipose tissue, cartilage, bone chips, bone pâté, hydroxyapatite, and various periosteal-muscular flaps. In the present study, mastoid cavity obliteration was performed utilizing a combination of autologous bone pâté and cartilage [5]. Therefore, this study is designed to evaluate and compare the postoperative outcomes of standard CWD mastoidectomy versus CWD mastoidectomy with concurrent cavity obliteration in patients afflicted with atticoantral or posterosuperior marginal CSOM pathology.

MATERIAL AND METHODS

Study Design and Ethical Considerations

This study was a single-center, longitudinal, prospective, parallel-group, randomized clinical investigation conducted within the Department of Otorhinolaryngology. The study protocol was designed and executed in strict accordance with the ethical standards prescribed by the Institutional Ethics Committee and complied fully with the tenets of the 1964 Declaration of Helsinki and its subsequent amendments. Prior to enrolment, comprehensive written informed consent was obtained from all individual participants or their legal guardians.

Patient Selection and Sample Size

The study population comprised patients presenting to the Otolaryngology Outpatient Department (OPD) who required surgical management for chronic ear disease. A total sample size of 50

patients was enrolled based on explicit eligibility criteria and monitored through a structured post-operative follow-up period.

The study population was partitioned into two distinct treatment arms:

- **Group A (Obliteration Group; n = 25):** Patients who underwent a canal wall down (CWD) / modified radical mastoidectomy followed by concurrent mastoid cavity obliteration utilizing autologous bone pâté and cartilage.
- **Group B (Open Cavity Group; n = 25):** Patients who underwent a conventional CWD / modified radical mastoidectomy resulting in a standard open mastoid bowl without reconstructive obliteration.

Relevant clinical history, demographic details, radiological findings, and surgical outcomes were systematically cataloged for each patient using a standardized, pre-designed clinical proforma.

Eligibility Criteria

Inclusion Criteria:

- Patients clinically and radiologically diagnosed with unsafe (atticoantral or posterosuperior marginal) chronic suppurative otitis media (CSOM).
- Patients with explicit indications for a canal wall down / modified radical mastoidectomy.
- Patients of all age groups and both sexes.

Exclusion Criteria:

- Patients presenting with safe (tubotympanic) CSOM.
- Patients demonstrating evidence of coexisting temporal bone or head and neck malignancies.
- Patients or guardians who declined to provide informed consent for participation in the study.

Timeline and Statistical Analysis

The clinical trial spanned a formal investigation period from August 2022 to February 2024, utilizing a longitudinal follow-up framework to evaluate surgical and healing outcomes over time. Statistical analysis of the gathered comparative data was executed using specialized software, with Fisher's Exact Test applied as the primary inferential tool to assess significance in categorical variables between Group A and Group B.

RESULTS

A total sample size of 50 patients diagnosed with atticoantral type chronic suppurative otitis media (CSOM) successfully completed the study protocol. The cohort was evenly partitioned into two distinct surgical treatment arms: Group A (n = 25), comprising patients who underwent a canal wall down / modified radical mastoidectomy (MRM) with concurrent mastoid cavity obliteration utilizing autologous bone pâté and cartilage, and Group B (n = 25), comprising patients who underwent standard MRM resulting in a conventional open mastoid cavity.

Patient Demographics and Baseline Characteristics

Age Distribution

The study population spanned a broad age distribution, with the 20–30 years age bracket constituting the largest overall segment at 38% (n = 19); 36% in Group A and 40% in Group B). This was sequentially followed by the 10–20 years demographic at 22% (n = 11). Statistical verification demonstrated that the age variance between the two treatment cohorts was entirely homogenous and non-significant (p = 1.000).

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Table 1: Age Distribution

Age Group (Years)	Group A (n=25)	Group B (n=25)	Total (n=50)
0–10	1 (4%)	2 (8%)	3 (6%)
10–20	6 (24%)	5 (20%)	11 (22%)
20–30	9 (36%)	10 (40%)	19 (38%)
30–40	5 (20%)	4 (16%)	9 (18%)
40–50	2 (8%)	3 (12%)	5 (10%)
>50	2 (8%)	1 (4%)	3 (6%)

Gender Distribution

A clear male preponderance was observed across the global study population, with 36 male patients (72%) and 14 female patients (28%), establishing a male-to-female ratio of 2.57:1. Both surgical cohorts featured an identical gender distribution of 18 males (72%) and 7 females (28%), indicating zero baseline variance between the arms (p = 1.000).

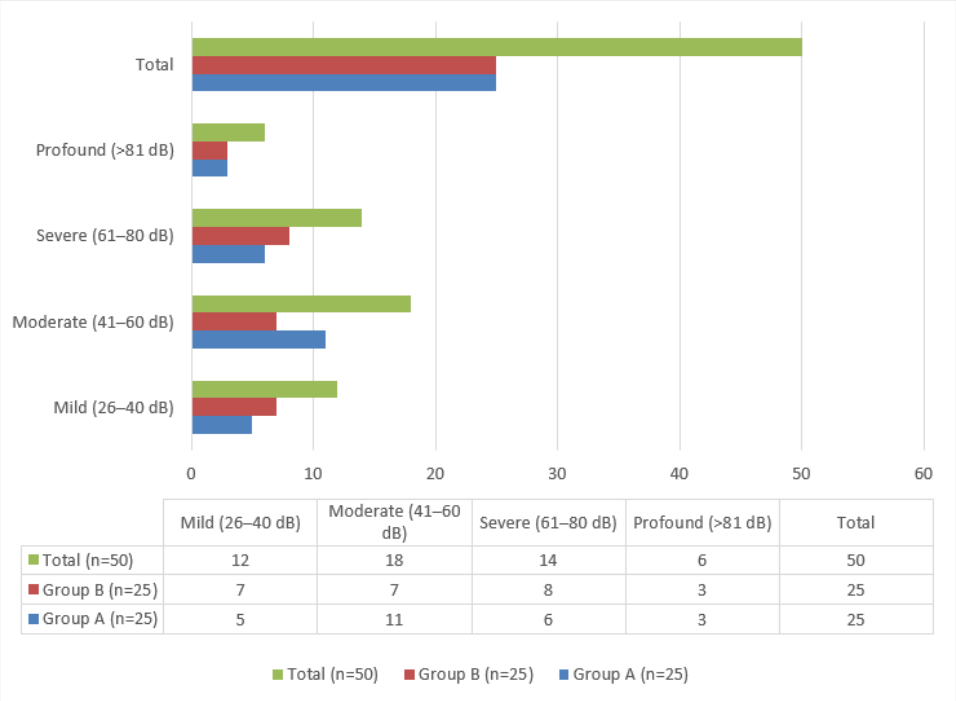
Laterality

The surgical site laterality was evenly counterbalanced across the entire study sample. In Group A, the right ear was operated on in 13 cases (52%) and the left ear in 12 cases (48%). In Group B, the distribution was nearly inverse, with 12 right ears (48%) and 13 left ears (52%). This baseline anatomical distribution was statistically negligible (p = 1.000).

Preoperative Hearing Loss

Baseline audiological evaluation demonstrated that moderate conductive hearing loss (41–60 dB) was the most frequent presentation, accounting for 36% (n = 18) of the entire cohort (44% in Group A vs. 28% in Group B). Severe hearing loss (61–80 dB) was present in 28% (n = 14), mild loss (26–40 dB) in 24% (n = 12), and profound hearing loss (>81 dB) in 12% (n = 6) of patients. Comparative distribution analysis confirmed that baseline hearing thresholds were well-matched between Group A and Group B without any significant difference (p = 0.6926).

Figure 1: Comparison of baseline preoperative hearing loss severity between Group A (Obliteration) and Group B (Open Cavity) (p = 0.6926).



	Mild (26–40 dB)	Moderate (41–60 dB)	Severe (61–80 dB)	Profound (>81 dB)	Total
Total (n=50)	12	18	14	6	50
Group B (n=25)	7	7	8	3	25
Group A (n=25)	5	11	6	3	25

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Table 2: Baseline distribution of preoperative hearing loss severity

Hearing Loss Severity	Group A (n=25)	Group B (n=25)	Total (n=50)
Mild (26–40 dB)	5 (20%)	7 (28%)	12 (24%)
Moderate (41–60 dB)	11 (44%)	7 (28%)	18 (36%)
Severe (61–80 dB)	6 (24%)	8 (32%)	14 (28%)
Profound (>81 dB)	3 (12%)	3 (12%)	6 (12%)
Total	**25 (100%)**	**25 (100%)**	**50 (100%)**

Note: Baseline inter-group variance is statistically non-significant (Fisher's Exact Test: p = 0.6926)

Clinical Parameters and Post-Operative Follow-Up

Postoperative Pain

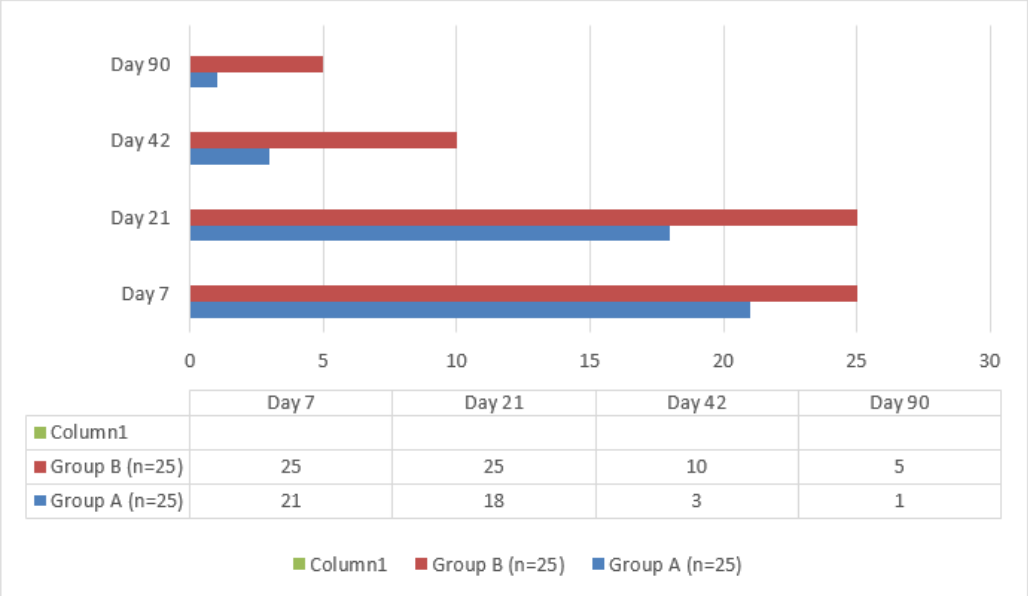
Postoperative otalgia resolved progressively and uniformly across both tracking arms. At the initial post-operative assessment on Day 7, pain complaints were reported by 48% (n = 12) of Group A patients and 40% (n = 10) of Group B patients (p = 0.7761). By Day 21, the incidence had decreased to 24% and 20% respectively (p = 1.000). On Day 42, minimal residual pain was reported by only 4% (n = 1) in Group A and 8% (n = 2) in Group B (p = 1.000). At the final Day 90 clinical endpoint, otalgia was completely resolved in the obliterated group (0%), while a single patient (4%) in the open cavity arm reported mild persistent pain (p = 1.000). There was no statistically significant difference in pain profiles at any observation interval.

Postoperative Discharge

The incidence of persistent post-operative ear discharge (otorrhea) revealed a critical clinical divergence between the two interventions. On post-operative Day 7, otorrhea was observed in 84% (n = 21) of Group A patients and 100% (n = 25) of Group B patients, showing no early significant difference (p = 0.1099).

However, by post-operative Day 21, a statistically highly significant therapeutic advantage emerged favouring the mastoid obliteration technique. Specifically, the incidence of active discharge dropped down to 72% (n = 18) within the obliterated cohort (Group A), whereas 100% (n = 25) of the conventional open cavity cohort (Group B) continued to present with active otorrhea (p = 0.0096).

Figure 2: Longitudinal trends in post-operative ear discharge (Otorrhea) showing highly significant differences on Day 21 (p = 0.0096) and borderline significance on Day 42 (p = 0.0507)



By Day 42, this trend maintained borderline statistical significance (p = 0.0507) , with otorrhea dropping sharply to 12% (n = 3) in Group A compared to 40% (n = 10) in Group B. At the terminal 90-day review, active discharge was recorded in only a nominal 4% (n = 1) of obliterated cavities, compared to 20% (n = 5) of open mastoid bowls (p = 0.1895).

Postoperative Giddiness

Transient vertiginous symptoms or post-operative giddiness were more frequently noted early on within the open cavity arm. On post-operative Day 7, giddiness was documented in 20% (n = 5) of Group B patients compared to only 8% (n = 2) of Group A patients, though the small absolute case counts kept this finding below the threshold of formal statistical significance (p = 0.4174). Symptoms declined rapidly by Day 21 (Group A: 4% vs. Group B: 8%; p = 1.000) and were practically non-existent by Day 42, where only a single patient (4%) in Group B reported persistent equilibrium issues (p = 1.000). By Day 90, no patient in either arm experienced giddiness (p = 1.000).

Accumulation of Wax Debris

The presentation of accumulated waxy debris was objectively checked at the final 90-day post-operative consultation window. Group B (open cavity) demonstrated a distinct tendency toward debris collection, with 16% (n = 4) of cases requiring cleaning, compared to a solitary case (4%) in the obliterated group (Group A). This numerical divergence was found to be statistically non-significant within the current study volume (p = 0.3487).

Healing and Epithelialization Outcomes

The physiological healing duration required to secure a fully stable, dry ear differed substantially between the groups. The average timeline to achieve complete, definitive epithelialization of the mastoid bowl was dramatically accelerated in Group A, requiring an average of **6 weeks**. In contrast, the conventional open cavity group (Group B) exhibited a significantly protracted healing curve, demanding an average of **13 weeks** to accomplish full cavity epithelialization.

Table 3: Longitudinal master tracking matrix of post-operative clinical parameters

Follow-Up Interval	Clinical Evaluation Parameter	Group A (n=25)N (%)	Group B (n=25)N (%)	Fisher's Exactp-value	Statistical Significance
Post-Op Day 7	Pain	12 (48%)	10 (40%)	p = 0.7761	No
	Discharge	21 (84%)	25 (100%)	p = 0.1099	No
	Giddiness	2 (8%)	5 (20%)	p = 0.4174	No
Post-Op Day 21	Pain	6 (24%)	5 (20%)	p = 1.0000	No
	Discharge	18 (72%)	25 (100%)	p = 0.0096	**Yes (Highly Significant)**
	Giddiness	1 (4%)	2 (8%)	p = 1.0000	No
Post-Op Day 42	Pain	1 (4%)	2 (8%)	p = 1.0000	No
	Discharge	3 (12%)	10 (40%)	p = 0.0507	Borderline non-significant
	Giddiness	0 (0%)	1 (4%)	p = 1.0000	No
Post-Op Day 90	Pain	0 (0%)	1 (4%)	p = 1.0000	No
	Discharge	1 (4%)	5 (20%)	p = 0.1895	No
	Giddiness	0 (0%)	0 (0%)	p = 1.0000	No
	Wax Debris	1 (4%)	4 (16%)	p = 0.3487	No

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Image 1: Canal wall down mastoidectomy cavity

DISCUSSION

The primary objective of surgical intervention in atticoantral chronic suppurative otitis media (CSOM) is the absolute eradication of cholesteatoma and granulation tissue to ensure patient safety. While canal wall down (CWD) mastoidectomy offers unrivaled surgical exposure to minimize residual disease, it creates a large, non-physiological mastoid bowl. This open cavity frequently results in lifelong morbidity, including persistent otorrhea, water intolerance, and regular debridement requirements. Reconstructive mastoid cavity obliteration using autologous materials—such as the bone pâté and cartilage matrix utilized in this series—aims to eliminate this anatomical dead space, thereby accelerating healing and restoring a stable self-cleaning mechanism.

Demographic Homogeneity and Epidemiological Trends

To ensure a valid comparison between the two surgical techniques, baseline demographics must be thoroughly balanced. In our investigation, the 20–30 years age bracket constituted the largest overall segment at 38% ($p = 1.000$). This pattern directly parallels the blueprint study by Maheshwari et al. [39], where the 20–30 years cohort similarly formed the statistical majority at 30%.

When contextualized against broader otological literature, variation exists:

- Paediatric Shifts: Singh et al. [24] and Chhapola et al. [27] reported younger peak presentations, with majorities falling within the 11–20 years demographic.
- Adult Extensions: Conversely, studies like those by Ramsey et al. [21] and Shah et al. [34] captured broader adult distributions, reporting mean presentation ages of 39 and 28.34 years, respectively.

The fact that our study and Maheshwari et al. [39] predominantly featured young adults emphasizes that aggressive atticoantral disease continues to disproportionately impact the economically productive demographic in developing nations.

Regarding gender, our cohort exhibited a definitive male preponderance of **72%** (M:F ratio of 2.57:1), which closely tracks the 2.75:1 male-to-female ratio documented by Maheshwari et al. [39]. While certain comparative series by Mokbel et al. [26] and Beutner et al. [22] also noted male dominance, alternative historical cohorts by Shah et al. [34], Singh et al. [24], and Ramsey et al. [21] observed a female preponderance. This shifting distribution across the literature supports the clinical consensus that gender does not significantly influence the pathogenesis or severity of cholesteatoma. Furthermore, our finding of perfectly balanced symmetric ear laterality (**50% right, 50% left**) matches Maheshwari et al. [39] and echoes the wider literature, including Ramsey et al. [21], Beutner et al. [22], and Sun et al. [23], confirming that unsafe CSOM exhibits no lateralizing bias.

Resolution Kinetics of Postoperative Otalgia

Postoperative pain patterns in our study resolved progressively and uniformly across both surgical groups, showing no statistically significant variance at Day 7 ($p = 0.7761$) or Day 90 ($p = 1.000$).

This profile tracks consistently with Maheshwari et al. [39], who reported an identical statistical insignificance across all follow-up intervals.

However, some differences appear in older literature; Chhapola et al. [27] and Deshmukh et al. [38] observed higher early pain scores specifically within open cavity cohorts around the one-month milestone. This temporary disparity is typically attributed to the delayed mucosalization of exposed raw bone in non-obliterated cavities. Because our surgical protocol included meticulous coverage of raw surfaces and uniform post-operative care, early pain pathways were effectively blunted in both arms, demonstrating that obliteration does not add to the patient's early physical burden.

Otorrhea Control and Accelerated Epithelialization Mechanics

Achieving a permanently dry, trouble-free ear remains the definitive clinical milestone in otological surgery. The most prominent finding of our study was identified on post-operative Day 21, where a highly significant therapeutic divergence emerged ($p = 0.0096$). At this interval, **100%** of our open cavity patients (Group B) continued to suffer from active otorrhea, compared to only **72%** in the obliterated arm (Group A).

This acceleration in cavity drying is strongly corroborated by Maheshwari et al. [39], who reported that their obliteration group achieved significantly superior dry-ear rates by Day 45 and Day 90 ($p = 0.025$). This clinical improvement is well-validated over longer timelines: Chhapola et al. [27] recorded a dry cavity rate of 80% in obliterated ears versus 60% in open controls at the 3-month milestone, which perfectly aligns with the 80% versus 60% healing ratio published by Deshmukh et al. [38].

The underlying physiological driver behind this data is clearly illustrated by our epithelialization timelines. The average time required to achieve complete, stable epithelialization in our obliterated group was just **6 weeks**, whereas the open cavity group required more than double that duration, averaging **13 weeks**. This matches the findings of Maheshwari et al. [39], who reported an average epithelialization window of 5 weeks for obliterated ears versus 16 weeks for open mastoid bowls.

Mechanistically, an open mastoidectomy cavity secretes continuous tissue fluid from exposed bone, creating a warm, damp environment that encourages bacterial proliferation. By lining the bony walls with an autologous composite of bone pâté and cartilage, this exudative surface area is physically isolated. This effectively seals off the dead space, drastically shortens the area requiring epithelial migration, and leads to a much faster healing cycle.

Equilibrium Protection and Self-Cleaning Dynamics

Open mastoid cavities frequently act as thermal vectors, exposing an unprotected lateral semicircular canal to ambient air and water changes, which induces caloric vertigo. On post-operative Day 7, **20%** of our open cavity patients experienced transient giddiness, compared to only **8%** of the obliteration group ($p = 0.4174$).

This distribution profile aligns with Maheshwari et al. [39], where early giddiness was noted in 33.33% of open cavities versus 13.33% of obliterated cases. As the biological barrier thickens via mucosalization, these thresholds stabilize, explaining why vertigo dropped to zero in both series by Day 90. This early protection provided by the bone pâté and cartilage matrix is a major clinical advantage for immediate postoperative quality of life.

Similarly, the structural reduction of the cavity directly optimizes the ear's natural self-cleaning capacity. At our 90-day review, waxy debris accumulated in **16%** of open cavities compared to a nominal **4%** in obliterated ears ($p = 0.3487$). This mirrors the long-term trends identified by Maheshwari et al. [39] (20% vs. 6.66%), Chhapola et al. [27] (10% in open controls), and Deshmukh et al. [38].

In a standard large mastoid bowl, the natural desquamation pathways of squamous epithelium are disrupted, causing keratin and wax to pool in deep anatomical recesses. Obliteration rounds out these sharp contours and scales down the volume of the bowl. This restores natural epithelial migration

outward, significantly lowering doctor dependence, minimizing recurrent outpatient cleaning visits, and reducing the long-term clinical burden on hospital resources.

CONCLUSION

Concurrent obliteration of the mastoid cavity following a canal wall down (CWD) mastoidectomy significantly mitigates the lifelong morbidity traditionally associated with an open mastoid bowl. By systematically reducing the exposed internal surface area, obliteration physically isolates the secretory bone. This eliminates the damp, exudative dead space that typically serves as a rich medium for bacterial proliferation and granulation tissue. Consequently, the reconstructed, smaller cavity regains its natural epithelial migratory potential, rendering it physiologically self-cleaning. Furthermore, the structural barrier provides critical thermal insulation for the lateral semicircular canal—preventing calorically induced vertigo upon exposure to cold air or water—and restores a normal anatomical contour that easily accommodates traditional hearing aids.

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