



POPULATION-BASED OUTCOMES OF INTACT CANAL WALL MASTOIDECTOMY FOR CHRONIC SUPPURATIVE OTITIS MEDIA WITH INTACT OSSICULAR CHAIN: FUNCTIONAL AND AUDIOLOGICAL DETERMINANTS IN RELATION TO DEMOGRAPHIC AND SOCIOECONOMIC VARIABLES

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Abstract:

Background: suppurative otitis media (CSOM), including tubotympanic disease and limited cholesteatoma confined to the antrum and aditus with an intact ossicular chain, remains a major cause of preventable hearing impairment, particularly in socioeconomically disadvantaged populations. Intact canal wall (ICW) procedures aim to eradicate disease while preserving middle ear anatomy and functional hearing. Intact canal wall (ICW) mastoidectomy with tympanoplasty is widely performed for CSOM with intact ossicular chain aimed at disease eradication and hearing preservation. This study evaluates demographic (age, gender), socioeconomic (education, economic status), clinical (time to surgical intervention, hospital stay), audiological (PTA, ABG, impedance), complications, interaural attenuation, and functional subjective acceptance of residual hearing. **Methods:** A population-based cohort of CSOM patients undergoing ICW surgery between October 2023 and September 2025 was analyzed. Variables collected included socio-demographics, duration from symptom onset to surgery, pre- and postoperative PTA, ABG, impedance audiometry, complications, interaural attenuation, and subjective hearing acceptance. Statistical analyses explored associations of outcomes with demographic and socioeconomic factors.

Results: Of the 87 patients included, significant improvements were noted in mean PTA thresholds and ABG (pre vs post, $p < 0.05$). Impedance findings improved postoperatively in 76/87 patients [87.35%]. Early surgical intervention and higher education status were associated with better functional outcomes ($p < 0.01$). Complication rates were low. Subjective acceptance correlated with objective audiological gains.

Conclusion: This population-based study confirms that intact canal wall (ICW) mastoidectomy with tympanoplasty is a safe and effective surgical option for selected cases of chronic suppurative otitis media with an intact ossicular chain. Significant postoperative audiological improvement was

demonstrated, with mean pure tone average improving from 38.45 ± 3.15 dB to 22.65 ± 2.30 dB and air–bone gap reducing from 26.45 ± 3.50 dB to 10.18 ± 1.15 dB ($p < 0.05$). Improved middle ear compliance was observed in 87.35% of patients, while interaural attenuation improved in 65.52%.

KEY WORDS: CSOM, Compliance, PTA, Mastoidectomy and Hearing loss

INTRODUCTION

Chronic suppurative otitis media (CSOM) continues to represent a substantial public health burden in both developing and developed healthcare systems, contributing significantly to preventable hearing loss and reduced quality of life. Despite advances in medical therapy and surgical techniques, CSOM remains prevalent due to delayed presentation, socioeconomic disparities, limited access to specialist care, and variations in health-seeking behavior. The disease spectrum ranges from tubotympanic disease with central perforation to cholesteatomatous involvement of the middle ear and mastoid, each presenting unique challenges in surgical management and outcome optimization.^{1–3}

The primary objectives of surgical intervention in CSOM are complete eradication of disease, prevention of recurrence, and restoration or preservation of hearing. Among available surgical strategies, intact canal wall (ICW) mastoidectomy with tympanoplasty has gained prominence for carefully selected cases. The ICW approach preserves the posterior canal wall, maintains near-normal external auditory canal anatomy, and avoids the long-term cavity problems associated with canal wall down procedures. This anatomical preservation offers potential advantages in hearing outcomes, patient comfort, and long-term quality of life.^{4–6}

In patients with tubotympanic CSOM and those with limited cholesteatoma confined to the antrum and aditus with an intact ossicular chain, ICW procedures are particularly attractive. Preservation of the ossicular chain allows direct sound transmission, and when combined with successful tympanic membrane reconstruction, can result in significant postoperative improvements in conductive hearing. Several studies from 2020 onward have demonstrated favorable audiological outcomes following ICW mastoidectomy, with significant closure of air–bone gaps and improvement in pure tone averages.^{7–9} However, outcomes vary considerably across populations, suggesting the influence of non-surgical determinants.

Audiological evaluation remains central to outcome assessment following otologic surgery. Pure tone audiometry (PTA) and air–bone gap (ABG) measurement are universally accepted objective measures of hearing improvement. Impedance audiometry provides complementary information regarding middle ear compliance and tympanic membrane mobility, offering insight into graft integrity and middle ear mechanics. More recently, attention has also been directed toward interaural attenuation and binaural hearing balance, which influence spatial hearing and speech perception in noise.^{10–12}

Beyond objective audiological measures, functional and subjective acceptance of residual hearing has emerged as an equally important endpoint. Patients' perception of hearing benefit, ease of communication, and satisfaction with surgical outcomes may not always correlate directly with audiometric gains. Incorporating patient-reported outcome measures allows a more comprehensive assessment of surgical success and aligns with contemporary patient-centered care paradigms.^{13, 14}

Socioeconomic and demographic variables play a critical role in CSOM outcomes. Educational status influences disease awareness, compliance with treatment, and timing of presentation, while economic status affects access to specialist services and affordability of surgical care. Multiple population-based studies have demonstrated delayed presentation and worse baseline hearing thresholds among patients from lower socioeconomic strata.^{15–17} The duration between symptom onset and surgical intervention has been identified as a modifiable risk factor, with prolonged disease associated with ossicular erosion, mucosal changes, and poorer postoperative hearing results.¹⁸

Hospital stay and perioperative morbidity are additional parameters reflecting healthcare efficiency and surgical safety. Shorter hospital stays without increased complication rates are particularly

relevant in resource-constrained settings. Complication profiling—including graft failure, infection, vertigo, and sensorineural hearing deterioration—is essential to establish the safety profile of ICW techniques in real-world populations.^{19, 20}

Despite extensive literature on surgical techniques and audiological outcomes, there remains a paucity of population-based studies integrating **demographic, socioeconomic, audiological, functional, and subjective variables** into a single outcome framework for ICW surgery in CSOM. Most available studies are institution-based, focus narrowly on audiometric results, or exclude patient-reported outcomes. Furthermore, limited data exist on interaural attenuation and functional acceptance of residual hearing following ICW procedures.

The present population-based study was therefore designed to comprehensively evaluate final outcomes of ICW mastoidectomy with tympanoplasty in patients with tubotympanic CSOM and minimal cholesteatoma limited to the antrum and aditus with intact ossicular chains. By examining age, gender, educational status, economic status, time to surgical intervention, hospital stay, audiological outcomes (PTA, ABG, impedance), complications, interaural attenuation, and subjective hearing acceptance, this study aims to provide an integrated understanding of surgical success and its determinants in a real-world population.

Chronic suppurative otitis media (CSOM) is a persistent inflammatory condition of the middle ear characterized by tympanic membrane perforation, otorrhea, and varying degrees of conductive hearing loss. Surgical management aims to eradicate disease and preserve or restore auditory function. Among surgical approaches, intact canal wall (ICW) mastoidectomy with tympanoplasty is increasingly favored for selected cases with intact ossicular chain, offering anatomical preservation and potentially better hearing outcomes compared to traditional canal wall down techniques. ICW procedures seek to maintain middle ear architecture while providing access to disease loci. ([Springer](#)) Postoperative functional outcomes are typically assessed by audiological measures such as pure tone audiometry (PTA) and air–bone gap (ABG). Improving ABG and overall hearing thresholds remain primary indicators of surgical success. Additionally, impedance audiometry can elucidate middle ear compliance changes postoperatively. Socioeconomic determinants such as educational level, economic status, and timing to surgical intervention may influence access to care and outcomes, yet few large population-based studies have explored these relationships. Identifying modifiable predictors may guide tailored interventions and health policy. ([PubMed](#))

This study aims to evaluate outcomes of ICW mastoidectomy for CSOM (tubotympanic and limited cholesteatoma involving antrum and aditus with intact ossicular chain) in a population-based cohort, emphasizing audiological outcomes, complications, and the influence of demographic and socioeconomic variables on final functional hearing and subjective acceptance.

METHODS

Study Design and Population

A retrospective population-based observational study was conducted at a Tertiary care Hospital of Telangana between October 2023 and September 2025. **Inclusion criteria:** Patients above 18 years and adolescents were included. Patients diagnosed with CSOM (tubotympanic or limited cholesteatoma confined to mastoid antrum and aditus) were included. Patients with intact ossicular chain confirmed intraoperatively were included. Patients who underwent ICW mastoidectomy with tympanoplasty were included. **Exclusion criteria** Patients with extensive cholesteatoma requiring canal wall down surgery were excluded. Patients with previous revision mastoidectomy were excluded.

Data Collection

Demographics (age, gender) and socioeconomic data (education level, economic status) were recorded. Clinical variables included time from symptom onset to surgery and length of hospital stay.

Pre- and postoperative audiological data were collected: PTA (0.5–4 kHz), ABG, and impedance audiometry. Interaural attenuation and subjective hearing acceptance were assessed via validated questionnaires. Complications (intraoperative, postoperative) were documented.

Surgical Technique and Follow-Up

All surgeries involved ICW mastoidectomy and tympanoplasty using microscopic/endoscopic techniques. Patients were followed for [minimum period] with audiological evaluation at **3 and 6 months** postoperatively.

Statistical Analysis

Continuous data were expressed as mean $\pm$ SD and compared using paired t-tests. Categorical variables were analyzed using chi-square tests. Multivariate regression evaluated predictors of audiological and functional outcomes with significance set at $p < 0.05$.

RESULTS

Demographics and Clinical Characteristics

A total of 87 patients with mean age 27.48 ± 2.10 years were included with 54/87 (62.06% males and 38% female patients). Median time to surgical intervention was 14 months. Median hospital stay was 11.78 ± 2.34 days. Higher education and economic status were positively associated with shorter time to surgery ($p < 0.05$), (**Table 1**)

Table 1: Demographic and Clinical Profile of Study Participants (n = 87)

Variable	Category	Number (n)	Percentage (%)
Age (years)	0 – 10	4	4.60
	11 – 20	18	20.69
	21 – 30	34	39.08
	31 – 40	21	24.14
	41 – 50	10	11.49
Mean age (years)	—	27.48 ± 2.10	—
Gender	Male	54	62.06
	Female	33	37.94
Time to surgery	Median (months)	14	—
Hospital stay	Mean (days)	11.78 ± 2.34	—
Socio-economic factors	Higher education & income	—	Shorter time to surgery ($p < 0.05$)

Table 2: Association of Socio-Economic Variables with Time to Surgical Intervention (n = 87)

Socio-economic Variable	Category	Number (n)	Median Time to Surgery (months)	p value
Educational status	Up to secondary school	41	18	< 0.5
	Higher secondary & above	46	11	< 0.05
Economic status	Lower / Lower-middle	39	19	
	Upper-middle / Upper	48	10	< 0.05

(Time to surgery expressed as **median months**, Statistical analysis performed using appropriate non-parametric tests, $p < 0.05$ considered statistically significant and Higher educational and economic status demonstrated a **significant association with shorter time to surgical intervention**)**Audiological Outcomes**

Mean PTA improved from 38.45 ± 3.15 dB preoperatively to 22.65 ± 2.30 dB postoperatively ($p < 0.05$). Mean ABG decreased significantly from 26.45 ± 3.50 dB to 10.18 ± 1.15 dB; $p < 0.01$). Impedance Audiometry showed improved middle ear compliance in 87.35% of patients postoperatively. (**Table 2 and 3**)

Table 3: Pre- and Postoperative Audiological Outcomes Following ICW Procedure

Audiological Parameter	Preoperative Value (Mean $\pm$ SD)	Postoperative Value (Mean $\pm$ SD)	Statistical Significance
Pure Tone Average (PTA) (dB)	38.45 ± 3.15	22.65 ± 2.30	$p < 0.05$
Air–Bone Gap (ABG) (dB)	26.45 ± 3.50	10.18 ± 1.15	$p < 0.01$
Impedance Audiometry (Middle ear compliance)	Reduced compliance	Improved compliance in 87.35% patients	—

Complications

Overall complication rate was low 2/87 patients (02.29%), primarily minor wound or mild transient vertigo. No significant sensorineural loss was observed.

Interaural Attenuation and Subjective Acceptance

Postoperative interaural attenuation improved in 65% of cases. Higher subjective acceptance scores correlated with greater ABG reduction ($r = 8.36$, $p < 0.01$), (**Table 4**).

Table 4: Postoperative Interaural Attenuation and Subjective Acceptance Outcomes (n = 87)

Variable	Outcome Category	Number (n)	Percentage (%)	Statistical Measure
Interaural attenuation	Improved	57	65.52	—
	Not improved	30	34.48	—
Subjective acceptance score	Higher score	—	—	Correlated with ABG reduction
Correlation analysis	—	—	—	$r = 0.836$, $p < 0.01$

Multivariate Analysis

Earlier surgical intervention and higher educational level independently predicted superior audiological outcomes ($p < 0.01$), (**Table 5**).

Table 5: Multivariate Analysis of Predictors of Audiological Outcome

Predictor Variable	Outcome Measure	Effect	Statistical Significance
Time to surgery	Audiological improvement	Earlier intervention associated with superior outcome	$p < 0.01$
Educational level	Audiological improvement	Higher education independently predictive	$p < 0.01$

DISCUSSION

The findings of this population-based study demonstrate that intact canal wall mastoidectomy with tympanoplasty yields favorable anatomical, audiological, and functional outcomes in selected patients with CSOM and intact ossicular chains. Significant postoperative improvement in PTA thresholds and air–bone gap closure observed in this cohort aligns with contemporary literature, reinforcing the efficacy of ICW techniques when applied with appropriate case selection.^{7, 9}

The magnitude of ABG reduction observed postoperatively reflects restoration of conductive hearing mechanisms through disease clearance and tympanic membrane reconstruction. Preservation of the ossicular chain plays a pivotal role in achieving these outcomes. Previous studies have consistently shown superior hearing results in patients with intact ossicular continuity compared to those requiring ossiculoplasty, underscoring the importance of early surgical intervention before ossicular damage occurs.^{18, 21}

Impedance audiometry findings in the postoperative period demonstrated improved middle ear compliance in the majority of patients, indicating satisfactory graft uptake and middle ear aeration. These results are comparable to reports by Sarolli et al. and others, who emphasized the value of impedance measures as an adjunct to pure tone audiometry in assessing functional success.^{1, 10}

An important observation in this study was the influence of socioeconomic and educational status on timing of presentation and outcomes. Patients from higher educational and economic strata presented earlier and achieved superior postoperative hearing gains. This finding echoes population-based analyses demonstrating that delayed presentation among disadvantaged groups results in worse baseline hearing thresholds and limited postoperative improvement.^{15, 17} These disparities highlight the need for targeted public health interventions, community education, and improved referral pathways to reduce disease chronicity.

Hospital stay was generally short and complication rates were low, confirming the safety profile of ICW mastoidectomy. The absence of major complications such as persistent vertigo or sensorineural hearing loss supports the continued use of ICW techniques in appropriate candidates. Comparable complication rates have been reported in recent multicenter studies, reinforcing the reliability of this approach.^{19, 20}

Interaural attenuation and binaural hearing balance represent under-explored but clinically relevant outcomes. Improvement in interaural attenuation observed in this study suggests enhanced binaural integration following surgery. Restoration of symmetrical hearing contributes to better speech perception in noise and spatial localization, factors closely tied to patient satisfaction.^{11, 12}

Subjective acceptance of residual hearing showed a strong correlation with objective audiological improvement, particularly ABG closure. However, some patients reported high satisfaction despite modest audiometric gains, emphasizing the complex relationship between measured hearing thresholds and perceived benefit. This finding supports incorporation of patient-reported outcome measures into routine otologic outcome assessment.^{13, 14}

The population-based nature of this study strengthens its external validity and applicability to real-world clinical practice. By integrating multiple outcome domains demographic, socioeconomic, audiological, functional, and subjective this study provides a holistic view of surgical success beyond traditional audiometric endpoints.

CONCLUSIONS:

This population-based study confirms that intact canal wall (ICW) mastoidectomy with tympanoplasty is a safe and effective surgical option for selected cases of chronic suppurative otitis media with an intact ossicular chain. Significant postoperative audiological improvement was demonstrated, with mean pure tone average improving from 38.45 ± 3.15 dB to 22.65 ± 2.30 dB and air–bone gap reducing from 26.45 ± 3.50 dB to 10.18 ± 1.15 dB ($p < 0.05$). Improved middle ear compliance was observed in **87.35%** of patients, while interaural attenuation improved in **65.52%**, contributing to enhanced functional hearing. Early surgical intervention and higher educational status independently predicted superior outcomes ($p < 0.01$). The low complication rate (**2.29%**) further supports ICW mastoidectomy as an effective, patient-centered approach emphasizing timely care and socio-economic awareness for optimal hearing restoration.

Limitations include the observational design and reliance on follow-up compliance, which may introduce attrition bias. Long-term follow-up is essential to evaluate disease recurrence, particularly in cholesteatoma cases treated with ICW techniques. Future prospective studies with standardized subjective outcome instruments and longer surveillance are warranted.

Overall, the findings support ICW mastoidectomy as an effective and patient-centered surgical approach for selected CSOM cases, with outcomes influenced not only by surgical technique but also by social determinants of health.

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