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Original Research Article

Tympanoplasty With and Without Cortical Mastoidectomy for Tubotympanic Chronic Suppurative Otitis Media: A Prospective Comparative Study

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Abstract

Background: Tubotympanic chronic suppurative otitis media is a major cause of preventable conductive hearing loss in developing countries. The role of cortical mastoidectomy as an adjunct to tympanoplasty in these cases remains controversial, particularly when middle ear mucosa appears disease free.

Objective: To compare graft success and hearing outcomes between tympanoplasty alone and tympanoplasty with cortical mastoidectomy in tubotympanic chronic suppurative otitis media, and to evaluate the influence of intraoperative middle ear mucosal status on surgical results.

Methods: A prospective comparative observational study was conducted over 28 months in a tertiary otology unit. Sixty patients aged 12 to 52 years with tubotympanic chronic suppurative otitis media and central tympanic membrane perforation were randomly allocated to two groups: Group 1 underwent tympanoplasty alone (n=30) and Group 2 underwent tympanoplasty with cortical mastoidectomy (n=30). All patients had underlay temporalis fascia grafting. Preoperative and 6 week postoperative pure tone audiometry were performed at 250, 500, 1000, and 2000 Hz. Primary success was defined as intact graft, dry ear, and air bone gap closure of at least 10 dB. Outcomes were stratified by intraoperative middle ear mucosal status.

Results: Overall success was 76.67 percent in Group 1 and 90.00 percent in Group 2 ($p<0.05$). Mean hearing gain was 12.43±7.88 dB in Group 1 and 16.67±5.49 dB in Group 2 ($p=0.019$). In ears with normal mucosa, success was 95.45 percent with tympanoplasty alone and 95.00 percent with the combined procedure ($p>0.05$). In ears with pathologic mucosa, success was 25.00 percent versus 80.00 percent, respectively ($p<0.01$). Ossicular pathology was present in 45 percent, predominantly involving the long process of the incus. Residual perforation occurred in 6.67 percent and 3.33 percent of Groups 1 and 2, respectively. No major complications were encountered.

Conclusion: Cortical mastoidectomy provides clear additional benefit when combined with tympanoplasty in tubotympanic chronic suppurative otitis media with diseased middle ear mucosa, improving both graft success and hearing gain. In ears with normal mucosa, tympanoplasty alone achieves excellent results comparable to the combined procedure, and routine mastoidectomy is not required. A selective, intraoperative pathology based approach is recommended.

Keywords: Tympanoplasty, Mastoidectomy, Chronic Suppurative Otitis Media, Ossicular Pathology, Middle Ear Surgery.

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Introduction

Chronic suppurative otitis media continues to be a significant public health problem and a leading cause of remediable hearing loss, particularly in regions with limited access to early otologic care.

[1-4] The tubotympanic type, characterized by central tympanic membrane perforation and absence of cholesteatoma, constitutes the majority of cases. Although considered relatively safe compared with atticoantral disease, tubotympanic chronic suppurative otitis media causes persistent discharge, social embarrassment, and progressive conductive hearing loss. [1-4]

Tympanoplasty has been the standard surgical procedure for tubotympanic chronic suppurative otitis media for several decades, with reported graft success rates of 80% to 95% and average hearing gains of 10 to 20 dB.[5–8] The need for additional cortical mastoidectomy in these patients remains debated.[8–14] Proponents argue that mastoidectomy removes a chronic inflammatory reservoir, improves aeration of the middle ear-mastoid system, and reduces recurrent infection and graft failure, whereas opponents contend that meticulous tympanoplasty alone is sufficient in uncomplicated disease. [9-14]

One possible explanation for these differing views is that not all ears with tubotympanic disease are biologically equivalent. In particular, the intraoperative appearance of the middle ear mucosa may identify subgroups that respond differently to mastoidectomy. Ears with normal mucosa may behave differently from those demonstrating granulation tissue or polypoidal changes. [15-17] The present study was designed to compare tympanoplasty alone with tympanoplasty with cortical mastoidectomy in tubotympanic chronic suppurative otitis media, with specific emphasis on the modifying effect of intraoperative mucosal status on surgical success and hearing outcomes.

Materials and Methods

Study Design and Setting: This prospective comparative observational study was conducted at the Department of Otorhinolaryngology and Head & Neck Surgery, Datta Meghe Medical College, Shalinitai Meghe Hospital & Research Centre, Nagpur, Maharashtra, India, over a 28 months period from July 2023 to November 2025. The institutional ethics committee approved the study protocol and written informed consent was obtained from all participants.

Patient Selection: Sixty consecutive patients with tubotympanic chronic suppurative otitis media and central tympanic membrane perforation who were planned for surgery were enrolled. Patients were randomly allocated into two equal groups using simple randomization:

- Group 1: tympanoplasty alone (n=30)
- Group 2: tympanoplasty with cortical mastoidectomy (n=30)

Inclusion Criteria

- Age 12 to 52 years
- Diagnosis of tubotympanic chronic suppurative otitis media with central perforation
- Dry ear for at least 6 weeks following appropriate medical treatment
- Conductive hearing loss documented on pure tone audiometry
- Willingness and ability to complete at least 90 days of follow up

Exclusion Criteria

- Primary sensorineural hearing loss
- Previous ear surgery on the affected side
- Active infection of nose, paranasal sinuses, or nasopharynx
- Atticoantral disease or suspected cholesteatoma
- Otogenic intracranial or extracranial complications
- Uncontrolled systemic illness

Preoperative Evaluation: A detailed history was obtained regarding duration, nature, and intermittency of discharge; subjective hearing loss; tinnitus; otalgia; and relation to upper respiratory infection. Otoscopic examination assessed perforation size and location. Perforations were categorized as small (less than 25 percent of tympanic membrane area), medium (25 to 50 percent), or large (50 to 75 percent).

Tuning fork tests (Rinne and Weber) were carried out using a 512 Hz fork. Pure tone audiometry was performed by a qualified audiologist according to international standards at 250, 500, 1000, and 2000 Hz in both air and bone conduction. Hearing loss was classified as mild, moderate, or severe using World Health Organization criteria. High resolution computed tomography of the temporal bone evaluated mastoid pneumatization, middle ear and mastoid opacification, and obvious ossicular disruption.

Surgical Technique: All procedures were performed under general anesthesia by the senior author or under direct supervision. A postauricular (William Wilde) incision was used in every case. After creation of the flap, the tympanomeatal flap was elevated, and the middle ear and epitympanum were inspected systematically. Middle ear mucosa was categorized as normal (thin, pale, glistening) or pathologic (granulation tissue, polypoidal mucosa, or obvious tympanosclerosis). Ossicular status was classified according to the Austin–Kartush system and the chain was palpated to assess mobility. In Group 2, cortical mastoidectomy was performed using a canal wall up technique. The mastoid cortex was drilled to expose the antrum and accessible air cells, which were exenterated along with any visible diseased mucosa. The facial recess

and sinus tympani were inspected where feasible, taking care to preserve the bony canal wall.

In both groups, diseased middle ear mucosa and granulation tissue were removed. Ossiculoplasty was undertaken when indicated, using remaining ossicles, sculpted remnants, or cartilage interposition grafts. Temporalis fascia was harvested and placed as an underlay graft medial to the tympanic membrane remnant and in contact with the ossicular chain. Gelfoam was placed in the middle ear and external canal to support the graft.

Postoperative care and follow up: All patients received systemic antibiotics for 7 days and standard postoperative instructions including avoidance of water entry, nose blowing, and heavy lifting. Follow up visits were scheduled at approximately 1, 2, 4, 6, and 12 weeks after surgery. At each visit, the ear was examined with otoscopy or microscopy to assess graft integrity and presence of discharge.

Pure tone audiometry was repeated at around 6 weeks. Patients with less than 90 days of follow up or incomplete audiometric data were excluded, but no such exclusions were required in this series.

Outcome measures and analysis

Primary success was defined as:

1. Intact graft without residual perforation
2. Dry ear at final follow up
3. Air bone gap closure of at least 10 dB compared with baseline

Secondary outcomes included final air bone gap, hearing gain at individual frequencies, distribution of hearing categories, and complications. Outcomes were also analyzed according to intraoperative middle ear mucosal status.

Continuous variables are presented as mean±standard deviation, and categorical variables as number and percentage. Inter group comparisons used independent sample t tests for continuous data and chi square or Fisher exact tests for categorical data. A p value less than 0.05 was considered statistically significant.

Results

Demographic and clinical characteristics: All 60 enrolled patients completed follow up. The mean age was 27.75±12.1 years (range 12 to 52 years). The majority (68.33 percent) were between 12 and 29 years, with a peak in the third decade. There were 36 females (60 percent) and 24 males (40 percent). Age, sex distribution, and disease duration did not differ significantly between the two groups. [Table 1].

All patients presented with otorrhea; the mean duration was 6.5±4.1 years. Subjective hearing loss was reported by 35 patients (58.33 percent), although audiometry demonstrated conductive hearing loss in all 60 patients. Associated upper respiratory infection was reported by 25 patients (41.67 percent). Otalgia occurred in 8 patients (13.33 percent) and tinnitus in 5 (8.33 percent). [Table 2].

Radiologic and tympanic membrane findings: Imaging showed normal mastoid pneumatization in 44 patients (73.33 percent) and sclerotic or hypocellular mastoids in 16 (26.67 percent). There was incomplete concordance between radiologic pneumatization and intraoperative mucosal pathology, highlighting the limitation of imaging in predicting middle ear status. [Table 3].

Medium sized central perforations were the most frequent pattern (40 patients, 66.67 percent), followed by large perforations in 12 (20.00 percent) and small perforations in 8 (13.33 percent). Perforation size and location were similar in both groups. [Table 4].

Ossicular status and middle ear mucosa: The ossicular chain was intact in 33 patients (55.00 percent). Ossicular disruption or erosion was seen in 27 patients (45.00 percent), most often involving the long process of the incus (23 patients, 38.33 percent). Malleus erosion was less frequent, and no case showed stapes suprastructure erosion. [Table 5 and Figure 1].

Intraoperatively, middle ear mucosa was normal in 42 patients (70.00 percent) and pathologic in 18 (30.00 percent). Pathologic findings included granulation tissue in 6 patients (10.00 percent) and polypoidal mucosa in 12 (20.00 percent). Distribution of mucosal status was similar between the two groups. [Table 6].

Overall surgical outcomes: The overall primary success rate was 76.67 percent (23 of 30) in the tympanoplasty only group and 90.00 percent (27 of 30) in the combined group ($p<0.05$). Complete graft uptake occurred in 28 patients (93.33 percent) in Group 1 and 29 patients (96.67 percent) in Group 2. Residual perforation occurred in 2 (6.67 percent) and 1 (3.33 percent) patients, respectively. Persistent discharge beyond the early postoperative period was more frequent in Group 1 but did not reach statistical significance. No major complications, including facial nerve injury, canal stenosis, or sensorineural hearing loss, were observed. [Table 8].

Outcomes stratified by middle ear mucosa: In ears with normal mucosa, tympanoplasty alone and the combined procedure achieved almost identical success. Group 1 had 21 successes among 22 patients (95.45 percent) and Group 2 had 19 successes among 20 patients (95.00 percent; $p>0.05$). In ears with pathologic mucosa, success in

Group 1 was only 25.00 percent (2 of 8 patients), whereas Group 2 achieved 80.00 percent success (8 of 10 patients), a difference of 55 percentage points ($p<0.01$). [Table 7 and Figure 2].

Hearing outcomes: Preoperatively, most patients had moderate conductive hearing loss. Mean air conduction thresholds were 40.66±10.62 dB in Group 1 and 39.53±10.04 dB in Group 2 ($p>0.05$).[Table 9]. At 6 weeks, both groups showed improvement, but the combined group had superior hearing outcomes. Mean hearing gain was 12.43±7.88 dB in Group 1 and 16.67±5.49 dB in Group 2 ($p=0.019$). A greater proportion of patients in Group 2 achieved air bone gap less than 20 dB and more than 10 dB improvement. [Tables 10 to 12].

Frequency specific analysis demonstrated larger gains in Group 2 at all test frequencies, with the most marked difference at 2000 Hz (19 dB versus 14 dB). See Table 11 and Figure 3.

The contralateral ear was normal in 70.00 percent of patients. Remaining patients had retraction, small perforation, or tympanosclerosis, with similar distribution between groups. [Table 13].

Table 1: Demographic and clinical characteristics of the study population

Parameter	Tympanoplasty only (n=30)	With mastoidectomy (n=30)	Total (n=60)	P value
Age (years), mean±SD	27.2±12.4	28.3±11.8	27.75±12.1	>0.05
Age range (years)	12–52	13–50	12–52	—
12–19 years, n (%)	6 (20.0)	6 (20.0)	12 (20.0)	—
20–29 years, n (%)	9 (30.0)	10 (33.3)	19 (31.7)	—
30–39 years, n (%)	7 (23.3)	7 (23.3)	14 (23.3)	—
40–49 years, n (%)	5 (16.7)	5 (16.7)	10 (16.7)	—
50–52 years, n (%)	3 (10.0)	2 (6.7)	5 (8.3)	—
Female, n (%)	18 (60.0)	18 (60.0)	36 (60.0)	>0.05
Male, n (%)	12 (40.0)	12 (40.0)	24 (40.0)	—
Disease duration (years), mean±SD	6.2±4.3	6.8±3.9	6.5±4.1	>0.05

Table 2: Clinical presentation and associated symptoms

Symptom	Number	Percentage
Ear discharge (all patients)	60	100.00
Subjective hearing loss	35	58.33
Associated upper respiratory infection	25	41.67
Combined discharge and hearing loss	20	33.33
Otalgia	8	13.33
Tinnitus	5	8.33
Postauricular tenderness	3	5.00

Table 3: Radiologic assessment of mastoid pneumatization

Classification	Number	Percentage	Correlation with intraoperative findings
Normal pneumatization	44	73.33	80% had normal middle ear mucosa
Sclerotic / hypocellular	16	26.67	87.5% had middle ear pathology
Total	60	100.00	—

Table 4: Tympanic membrane perforation characteristics

Characteristic	Number	Percentage	Tympanoplasty only (n)	With mastoidectomy (n)
Size of perforation				
Small (<25% of tympanic membrane)	8	13.33	4	4
Medium (25–50% of tympanic membrane)	40	66.67	20	20
Large (50–75% of tympanic membrane)	12	20.00	6	6
Location of perforation				
Anteroinferior	28	46.67	14	14
Anterosuperior	18	30.00	9	9
Posteroinferior	8	13.33	4	4
Posterosuperior	6	10.00	3	3

Table 5: Ossicular status according to Austin–Kartush classification

Classification	Tympanoplasty only (n=30)	With mastoidectomy (n=30)	Total (n=60)	Percentage
M+I+S+ (all ossicles present)	18	15	33	55.00
M+I−S+ (incus absent/eroded)	8	7	15	25.00
M−I+S+ (malleus absent/eroded)	1	3	4	6.67
M−I−S+ (malleus and incus absent)	3	5	8	13.33
Total	30	30	60	100.00

Table 6: Intraoperative middle ear mucosal findings

Pathological finding	Tympanoplasty only (n=30)	With mastoidectomy (n=30)	Total (n=60)	Percentage
Normal mucosa	22	20	42	70.00
Granulation tissue	2	4	6	10.00
Polypoidal mucosa	6	6	12	20.00
Total	30	30	60	100.00

Table 7: Surgical success rates stratified by middle ear mucosal status

Middle ear status	Group 1 (tympanoplasty only) n / N	Success rate (%)	Group 2 (with mastoidectomy) n / N	Success rate (%)	Absolute difference (%)	P value
Normal mucosa	21 / 22	95.45	19 / 20	95.00	0.45	>0.05
Granulation tissue	1 / 2	50.00	4 / 4	100.00	50.00	<0.05
Polypoidal mucosa	1 / 6	16.67	4 / 6	66.67	50.00	<0.05
Overall	23 / 30	76.67	27 / 30	90.00	13.33	<0.05

Table 8: Graft uptake, residual perforation, and postoperative complications

Outcome	Tympanoplasty only (n=30)	Percentage	With mastoidectomy (n=30)	Percentage	P value
Graft and ear status					
Complete graft uptake	28	93.33	29	96.67	>0.05
Residual perforation	2	6.67	1	3.33	>0.05
Dry ear at final follow up	27	90.00	29	96.67	>0.05
Postoperative complications					
Prolonged discharge (>1 week)	3	10.00	1	3.33	>0.05
Infection	0	0.00	0	0.00	—
Canal stenosis	0	0.00	0	0.00	—
Facial nerve injury	0	0.00	0	0.00	—
Sensorineural hearing loss	0	0.00	0	0.00	—
Functional outcomes					
Hearing improvement	26	86.67	28	93.33	>0.05
Hearing decline	2	6.67	1	3.33	>0.05

Table 9: Preoperative hearing loss classification (WHO 2008)

Hearing loss category	Threshold range (dB)	Number	Percentage	Group 1 (n)	Group 2 (n)
Mild	16–30	9	15.00	5	4
Moderate	31–45	36	60.00	18	18
Severe	46–60	15	25.00	7	8
Total	—	60	100.00	30	30
Mean AC threshold±SD	—	—	—	40.66±10.62	39.53±10.04

Table 10: Postoperative hearing loss classification (WHO 2008)

Hearing loss category	Threshold range (dB)	Group 1 (n=30)	Percentage	Group 2 (n=30)	Percentage
Mild	16–30	20	66.67	27	90.00
Moderate	31–45	9	30.00	3	10.00
Severe	46–60	1	3.33	0	0.00
Total	—	30	100.00	30	100.00

Table 11: Air conduction thresholds and mean improvement at key frequencies

Frequency (Hz)	Group 1 preop (dB)	Group 1 postop (dB)	Group 1 improvement (dB)	Group 2 preop (dB)	Group 2 postop (dB)	Group 2 improvement (dB)	Difference (dB)
250	48	36	12	46	32	14	2
500	42	30	12	41	24	17	5
1000	38	26	12	37	20	17	5
2000	34	20	14	34	15	19	5
Three tone average (500, 1000, 2000)	38	25.33	12.67	37.33	19.67	17.67	5
Four tone average (250, 500, 1000, 2000)	40.66	28.06	12.43	39.53	22.43	16.67	4.24

Table 12: Hearing improvement and statistical significance

Parameter	Group 1 (tympanoplasty only)	Group 2 (with mastoidectomy)	Absolute difference	P value
Mean preoperative AC threshold (dB)	40.66±10.62	39.53±10.04	1.13	>0.05
Mean postoperative AC threshold (dB)	28.06±8.78	22.43±5.72	5.63	0.019
Mean hearing improvement (dB)	12.43±7.88	16.67±5.49	4.24	0.019
Patients with >10 dB gain, n (%)	22 (73.33)	28 (93.33)	6 (20.00)	<0.05
Patients with ABG <20 dB, n (%)	16 (53.33)	22 (73.33)	6 (20.00)	<0.05
Patients with ABG <30 dB, n (%)	26 (86.67)	29 (96.67)	3 (10.00)	>0.05
Mean three tone average improvement (dB)	12.67±8.02	17.67±5.67	5.00	<0.05

Table 13: Contralateral ear status

Status	Number	Percentage	Group 1 (n)	Group 2 (n)
Normal	42	70.00	21	21
Retracted tympanic membrane	7	11.67	3	4
Small perforation	5	8.33	3	2
Tympanosclerosis	6	10.00	3	3
Total	60	100.00	30	30

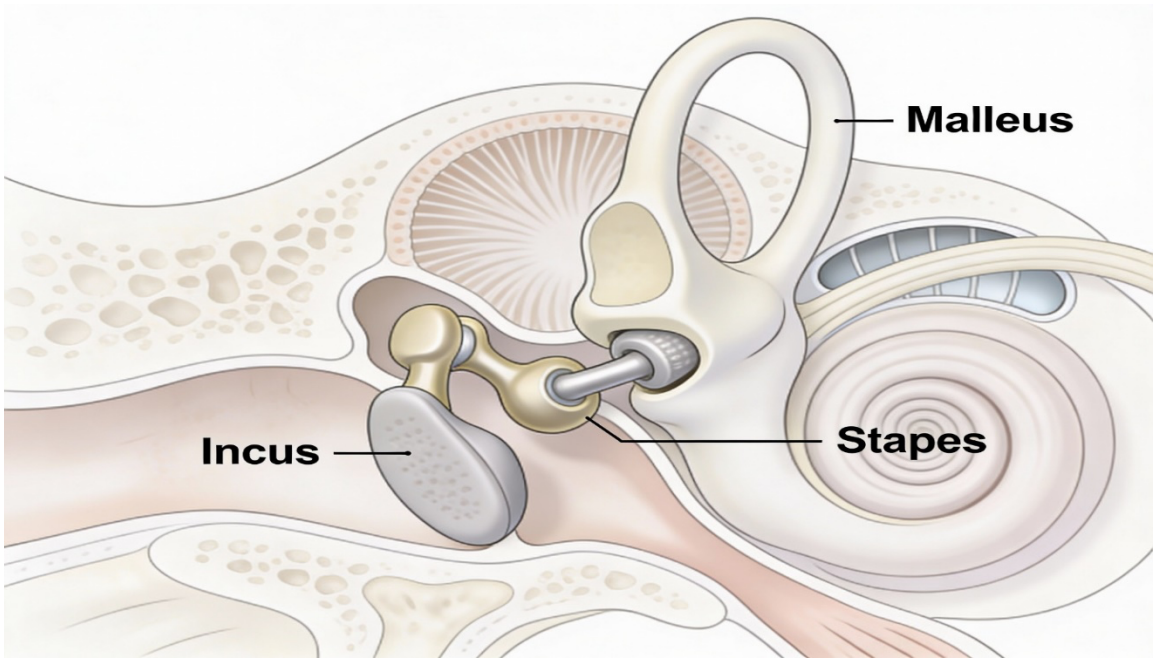

Figure 1: Ossicular chain anatomy (Schematic diagram of the malleus, incus, and stapes with emphasis on the long process of the incus and its blood supply.)

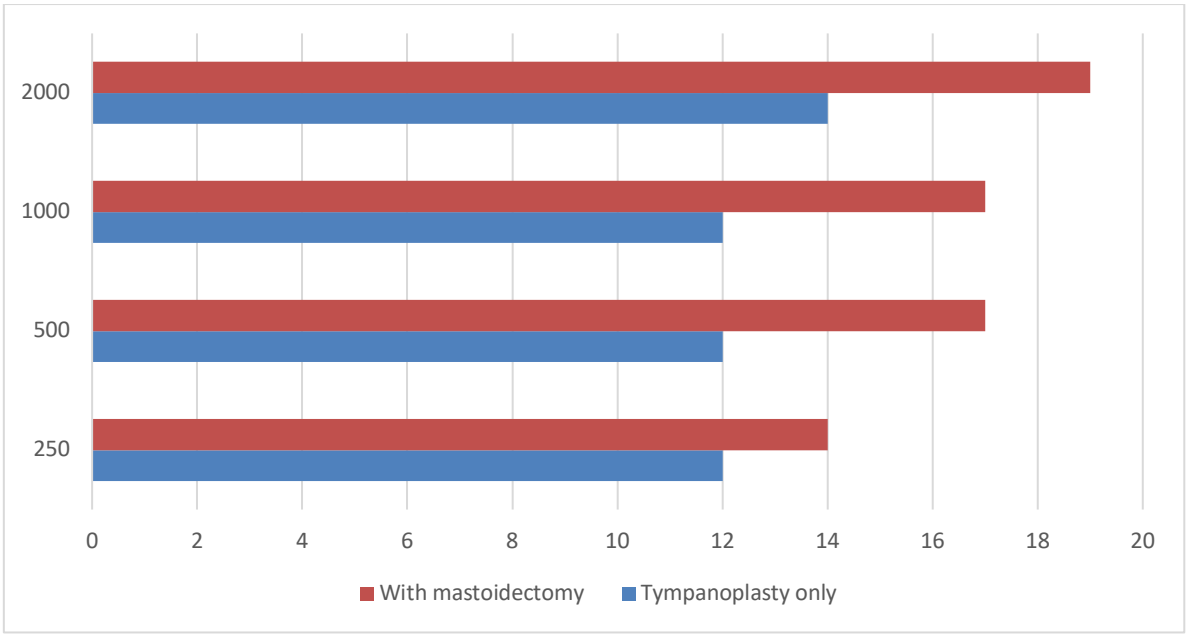

Figure 2: Surgical success rates by middle ear mucosal status

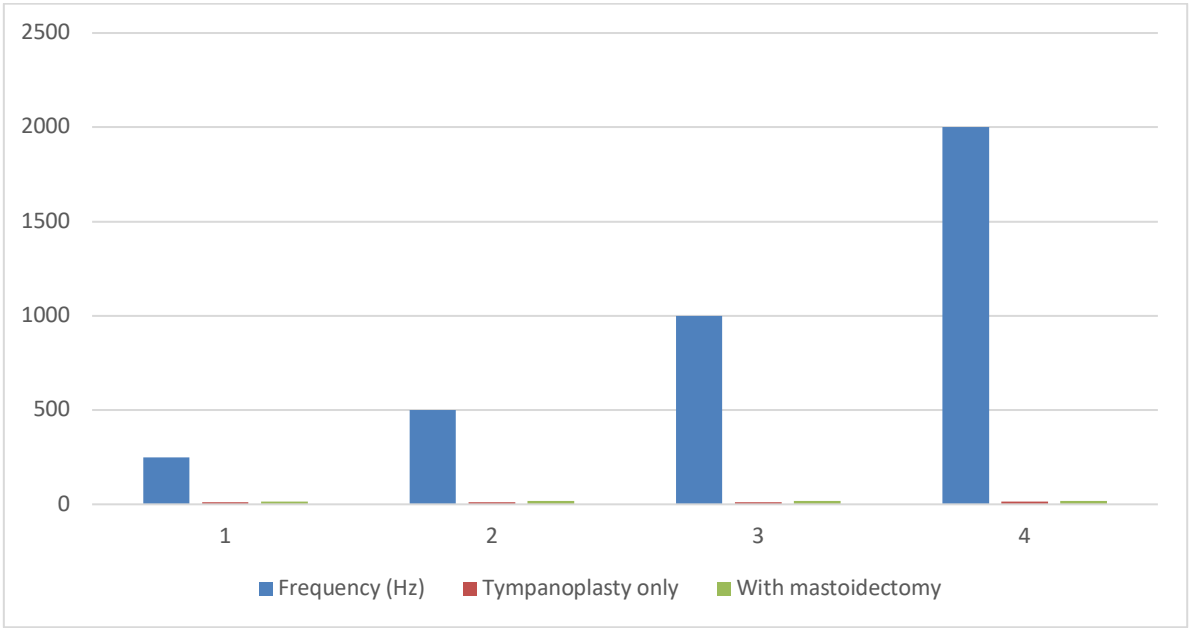

Figure 3: Hearing improvement at 250, 500, 1000, and 2000 Hz

Discussion

This prospective comparative study demonstrates that cortical mastoidectomy provides significant additional benefit when combined with tympanoplasty in patients with tubotympanic chronic suppurative otitis media having pathologic middle ear mucosa, whereas little additional benefit is observed in ears with healthy mucosa. These findings support a selective surgical strategy based on intraoperative middle ear status rather than routine mastoidectomy for all patients. [9-14] The demographic profile observed in the present study is comparable with previously published reports. The majority of patients belonged to the second and third decades of life, reflecting the continued burden of chronic ear disease among young adults in developing countries. [3,4,18-20] Similar trends have been documented in epidemiological studies of chronic suppurative otitis media worldwide. [1-4,20]

Ossicular chain pathology was identified in 45% of cases, with erosion of the long process of the incus representing the most common abnormality. This finding is consistent with studies by Austin, Kartush, Ashfaq and others, who reported that the long process of the incus is particularly vulnerable because of its delicate blood supply and prolonged exposure to local inflammatory mediators. [21-25] Preservation of the stapes suprastructure in all patients is also consistent with previous

descriptions of tubotympanic disease and contrasts with the more aggressive ossicular destruction seen in cholesteatoma. [22,25] The principal finding of this study is the significant influence of middle ear mucosal status on surgical outcome. In patients with normal middle ear mucosa, successful outcomes were achieved in approximately 95% of cases regardless of whether cortical mastoidectomy was performed. These findings suggest that in ears with inactive mucosal disease, tympanoplasty alone is sufficient to achieve favorable anatomical and functional outcomes. Similar conclusions were reported by Mishiro et al. and McGrew et al., who found no clear advantage of routine mastoidectomy in uncomplicated tubotympanic chronic suppurative otitis media. [8,9]

In contrast, the presence of granulation tissue or polypoidal mucosa markedly altered outcomes. Patients undergoing tympanoplasty alone had a substantially lower success rate compared with those receiving combined tympanoplasty and cortical mastoidectomy. This observation suggests that mastoidectomy may offer additional benefit in ears with persistent mucosal disease by eliminating diseased mastoid air cells and reducing inflammatory burden. Similar findings have been reported by Balyan et al., Krishnan et al., Nagle et al., Bhat et al., and Albu et al., who demonstrated improved graft uptake and disease control when mastoidectomy was selectively performed in unhealthy ears. [10-14,30]

Several physiologic mechanisms may explain these findings. The mastoid air-cell system contributes to pressure regulation, gas exchange, and maintenance of middle-ear homeostasis. Diseased mastoid mucosa may function as a reservoir of inflammation and bacterial colonization, thereby compromising graft healing. Removal of this pathological tissue may improve aeration, facilitate Eustachian tube function, and create a more favorable environment for graft incorporation. These mechanisms are supported by the work of Holmquist and Bergstrom, Sade, Palva and Virtanen, Takahashi and Honjo, and Magnuson. [15,16,26-29]

Audiological outcomes in the present study also favored the combined procedure. Patients undergoing tympanoplasty with cortical mastoidectomy demonstrated greater mean hearing improvement and a higher likelihood of achieving a postoperative air-bone gap of less than 20 dB. Similar audiological benefits have been reported in other comparative investigations evaluating mastoidectomy in selected patients with chronic suppurative otitis media. [9-14,30,31]

The strengths of this study include its prospective design, balanced treatment groups, standardized surgical technique, and objective audiometric evaluation. Furthermore, stratification according to intraoperative mucosal pathology helped clarify an important biologic variable that may explain conflicting results reported in previous studies. Nevertheless, limitations include the single-center design, modest sample size, and relatively short follow-up duration. Future multicenter studies with larger patient populations and longer follow-up periods are needed to confirm the long-term benefits of selective mastoidectomy.

Overall, the findings of the present study suggest that routine cortical mastoidectomy is unnecessary in patients with dry tubotympanic chronic suppurative otitis media and healthy middle ear mucosa. However, when significant mucosal pathology is encountered intraoperatively, cortical mastoidectomy substantially improves both graft success and hearing outcomes. A selective pathology-guided surgical approach therefore appears to provide the most rational and cost-effective management strategy. [9-14,30,31]

Conclusion

In patients with tubotympanic chronic suppurative otitis media, tympanoplasty alone provides excellent anatomical and functional outcomes when the middle ear mucosa is healthy, achieving success rates comparable to those of tympanoplasty combined with cortical mastoidectomy. In contrast, the presence of granulation tissue or polypoidal middle ear mucosa is associated with poorer outcomes following tympanoplasty alone. In such cases, the addition of cortical mastoidectomy significantly improves graft uptake and postoperative hearing results. These findings suggest that routine cortical mastoidectomy is not necessary in all cases of tubotympanic CSOM.

Rather, a selective approach based on intraoperative assessment of middle ear mucosal status appears to be the most rational surgical strategy, allowing mastoidectomy to be reserved for ears demonstrating significant mucosal disease while avoiding unnecessary additional surgical intervention in otherwise healthy ears.

Clinical Implications

The intraoperative condition of the middle ear mucosa should be considered an important determinant in surgical decision-making. Tympanoplasty alone is sufficient for ears with healthy mucosa, whereas cortical mastoidectomy should be considered in the presence of granulation tissue or polypoidal mucosal changes to optimize graft success and hearing outcomes.

Ethical Approval

The study protocol was approved by the Institutional Ethics Committee of Datta Meghe Medical College and Shalinitai Meghe Hospital &

Research Centre, Nagpur, Maharashtra, India. Written informed consent was obtained from all participants prior to enrolment.

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