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Original Article

Ear, Nose and Throat Section

Ossicular Chain Status in Long-standing Chronic Otitis Media: A Cross-sectional Study

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ABSTRACT

Introduction: Chronic Otitis Media (COM) is a major cause of hearing impairment, particularly in developing countries. Prolonged disease duration often leads to ossicular erosion, exacerbating conductive hearing loss.

Aim: To analyse the intraoperative ossicular chain status in patients with COM lasting over one year and associate the findings with disease type and audiometric profile.

Materials and Methods: The present cross-sectional study was carried out in the Department of Otorhinolaryngology Dr. D.Y. Patil Medical College, Pimpri, Pune, Maharashtra, India, from January 2023 to June 2024. The study included 60 patients with clinically confirmed COM undergoing tympanoplasty or mastoidectomy. All patients underwent a comprehensive clinical evaluation, including otoscopic examination, Pure Tone Audiometry (PTA), and High-resolution Computed Tomography (HRCT) temporal bone imaging. Intraoperative assessment of the ossicular chain was performed during surgery, with corrective procedures undertaken as needed, and audiometric data analysed to correlate hearing loss with ossicular status. Patients were categorised into mucosal and squamosal types. Intraoperative ossicular status was recorded and audiometric data analysed using Chi-square and t-tests.

Results: The mean age was 31.8±10.6 years, ranging from 7 to 55 years. Ossicular erosion was observed in 38 out of 60 patients (63.3%). The incus was the most affected ossicle 33 (55%), followed by the malleus 28 (46.7%), and the stapes 3 (5%). Complete erosion of all three ossicles was seen in 3 (5%). Ossicular erosion was significantly more prevalent in squamosal COM 22/30 (73.3%) compared to mucosal COM 8/30 (26.7%) ($p<0.0001$). The mean Pure Tone Average (PTA) in patients with ossicular erosion was 55.45±6.24 dB, significantly higher than 45.29±4.96 dB in those with intact ossicles ($p<0.00001$).

Conclusion: Ossicular discontinuity is more common in squamosal COM and is associated with greater hearing loss. Timely corrective surgery can help preserve hearing.

Keywords: Audiometric correlation, Cholesteatoma, Conductive hearing loss, Middle ear surgery, Tympanoplasty

INTRODUCTION

Chronic Otitis Media (COM) is a persistent inflammatory condition of the middle ear cleft, characterised by recurrent or continuous ear discharge through a non intact tympanic membrane. It has been an issue of global concern and is the most common cause of acquired hearing loss in developing countries, particularly in Southeast Asia and Sub-Saharan Africa [1]. The World Health Organisation (WHO) has estimated that above 65 million people are diagnosed with COM globally, with the incidences seen highest in India, the prevalence ranges from 4% to 8%, particularly in rural and lower socioeconomic populations, where overcrowdedness, poor hygiene, improper nutrition, and limited access to healthcare contribute to the high prevalence of the disease [2].

The COM is broadly classified into two types clinically: mucosal (safe) and squamosal (unsafe). The mucosal type of COM is typically associated with pars tensa perforation, and discharge that's majorly mucopurulent, with comparatively fewer complications. Conversely, squamosal COM is more complex, frequently involving cholesteatoma or granulation tissue formation, which can lead to bone resorption and potential complications such as facial nerve paralysis, labyrinthitis, and intracranial infections [3-5]. Erosion of ossicular chain is one of the most common sequelae of COM, particularly in the squamosal type. The ossicles—the malleus, incus, and stapes play a critical role in sound conduction in the middle ear, and disruption results in varying degrees of conductive hearing loss. The incus is the most susceptible due to its delicate structure and scarce vascularity, followed by the malleus; the stapes is relatively resistant to erosion [6-8].

Assessment of status of ossicular chain status is crucial for evaluating the extent of the disease and planning the corrective surgery. While a detailed history, otoscopic examination, and radiologic imaging provide a baseline assessment, the definitive diagnosis of ossicular erosion is made intraoperatively [9]. Ossicular involvement directly impacts the type of procedure performed, ranging from type I tympanoplasty in patients with intact ossicles to ossiculoplasty or canal wall down mastoidectomy in those with discontinuity [10-12].

While several studies have described ossicular erosion in COM, most focus on disease presence rather than correlation with duration, disease type, and hearing thresholds [4,6,13]. Prior literature, such as Varshney S. et al., (2010) and Vartiainen E. (1995), highlighted ossicular involvement in chronic ear disease but lacked stratification based on disease duration beyond one year [4,13]. The present study aimed to provide insight into surgical preparedness, highlight patterns of ossicular damage in long-standing cases, and guide targeted interventions, thereby adding to the current understanding of disease progression.

Hence, the present study was conducted to evaluate the intraoperative ossicular chain status in patients with COM of more than one year in duration and to study its association with disease type (mucosal vs. squamosal) and audiometric profile.

MATERIALS AND METHODS

The present cross-sectional study was conducted at the Department of Otorhinolaryngology, Dr. D.Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune, Maharashtra, India. over a period of 18 months from January 2023 to June 2024. The Institutional Ethics Committee (IEC) approved the study (IEC Approval No.: DPU/IEC/2022/324).

Inclusion criteria: The diagnosis of COM was established based on a clinical history of ear discharge lasting more than 12 weeks, otoscopic evidence of tympanic membrane perforation, and audiological findings consistent with conductive hearing loss, in accordance with WHO guidelines [1]. Patients aged 7 to 55 years were included.

Exclusion criteria: Patients with previous ear surgeries or congenital anomalies were excluded.

Sample size calculation: The sample size of 60 patients was determined based on the prevalence of ossicular erosion in COM reported in previous literature by Varshney S et al., (2010), which showed ossicular involvement in approximately 60-70% of cases. Using a confidence level of 95% and a precision of 12%, the minimum required sample size was calculated and rounded to 60 to ensure statistical validity [4].

Study Procedure

A detailed history was obtained regarding duration of ear discharge, hearing loss, previous treatments, and associated symptoms. Clinical examination included otoscopy, tuning fork tests, and assessment for complications. Preoperative parameters assessed included type of COM (mucosal or squamosal), site and size of tympanic membrane perforation, and presence of cholesteatoma or granulation tissue. Audiological evaluation was done using PTA, assessing air-bone gap and mean PTA thresholds. High-resolution CT (HRCT) of the temporal bone was performed in selected cases to evaluate ossicular integrity, mastoid air cell system, and soft-tissue involvement.

All patients included in the study underwent surgical management, which involved tympanoplasty or mastoidectomy based on the intraoperative findings and extent of disease. The procedures followed standard protocols as described by Palva T., including detailed assessment of the ossicular chain and appropriate grafting or ossiculoplasty when indicated [9]. Patients were followed postoperatively for six weeks to assess graft uptake, healing status, and symptomatic improvement. However, long-term audiological follow-up was beyond the scope of present study.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analysed using IBM Statistical Packages of Social Sciences (SPSS) Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). The Chi-square test was used to assess associations between categorical variables, and the unpaired t-test was used to compare means. A p-value of <0.05 was considered statistically significant; results with p<0.01 were considered moderately significant, and those with p<0.001 were considered highly significant.

RESULTS

The study included 60 patients with COM lasting more than one year in duration. The mean age was 31.8±10.6 years, ranging from 7 to 55 years. There were 34 males (56.7%) and 26 females (43.3%), with a male-to-female ratio of 1.3:1. The mean duration of ear discharge was 2.8±1.1 years. The majority of patients belonged to lower socioeconomic status. Common co-morbidities included allergic rhinitis (10%), chronic sinusitis (6.7%), and a history of upper respiratory infections (20%) [Table/Fig-1]. Out of 60 patients, 38 (63.3%) showed ossicular erosion, while 22 (36.7%) had intact ossicular chains. The incus was the most frequently eroded ossicle, affected in 33 (55%) patients, followed by the malleus in 28 (46.7%) patients. The stapes was the most resistant to erosion, with involvement seen in only 3 (5%) patients. Complete erosion of all three ossicles was observed in 3 (5%) patients [Table/Fig-2]. Ossicular erosion was significantly more prevalent in squamosal COM (22/30, 73.3%) than in mucosal COM (8/30, 26.7%) (Chi-square=7.475, p<0.0001) [Table/Fig-3]. The mean PTA in patients with ossicular erosion was 55.45±6.24 dB, which was significantly higher than the mean PTA of 45.29±4.96 dB in patients with intact ossicles. This difference was highly significant (p<0.00001) using the unpaired t-test, indicating a strong association between ossicular discontinuity and the degree of conductive hearing loss [Table/Fig-4].

Parameters	Value
Total number of patients	60
Duration of COM	>1 year
Mean age (years)	31.8±10.6
Age range (years)	7-55
Gender distribution	
Male	34 (56.7%)
Female	26 (43.3%)
Male-to-female ratio	1.3:1
Mean duration of ear discharge (years)	2.8±1.1
Co-morbidities	
Allergic rhinitis	6 (10%)
Chronic sinusitis	4 (6.7%)
History of URTI	12 (20%)

[Table/Fig-1]: Demographic and clinical profile of the study population.
URTI; Upper respiratory tract infections

Ossicular status	n (%)
Intact ossicles	22 (36.70%)
Only malleus eroded	5 (8.3%)
Only incus eroded	10 (16.70%)
Malleus + Incus eroded	20 (20.33%)
All ossicles eroded	3 (5.0%)

[Table/Fig-2]: Distribution of ossicular erosion.

COM type	Ossiculoplasty erosion present	Ossiculoplasty erosion absent	p-value
Mucosal (n=30)	8 (26.7%)	22 (73.3%)	<0.0001
Squamosal (n=30)	22 (73.3%)	8 (26.7%)	

[Table/Fig-3]: Ossicular erosion by COM type.

Ossicular status	Mean PTA (dB)	Standard deviation	p-value
Intact ossicles	45.29	4.96	<0.00001
Eroded ossicles	55.45	6.24	

[Table/Fig-4]: PTA by ossicular status.

DISCUSSION

The present study reaffirms the significant relationship between long-standing COM and ossicular erosion, particularly in the squamosal variant. A total of 63.3% of patients had ossicular discontinuity, a finding that echoes similar reports from both developing and developed countries [1,2]. The incus was the most frequently affected ossicle (55%), consistent with literature citing its anatomical delicacy and poor vascular supply as contributing factors to its vulnerability [3-5]. Its long, thin lenticular process and suspension within the epitympanum, without bony anchorage, make it prone to necrosis from chronic infection and enzymatic lysis [6].

The malleus was eroded in 46.7% of cases, likely due to its proximity to the tympanic membrane, which allows direct exposure to chronic inflammation and epithelial migration. The stapes was eroded in only 5% of cases, which corresponds to previous findings emphasising its relatively protected anatomical position [7,8].

A significantly higher rate of ossicular erosion was observed in squamosal COM (73.3%) compared to mucosal COM (26.7%), with the association being statistically significant (p<0.0001). This reflects the destructive nature of squamosal disease, often associated with cholesteatoma, which releases osteolytic

enzymes such as collagenases and osteoclast-activating factors [9-11]. These enzymes promote bone resorption and contribute to erosion of the ossicular chain, mastoid air cells, and surrounding bony structures [12].

Hearing loss in COM is primarily conductive, resulting from ossicular damage. In the present study, patients with ossicular erosion had a significantly higher mean PTA of 55.45 dB compared to 45.29 dB in those with intact ossicles. This difference is in line with findings from previous studies that emphasise the functional impact of ossicular discontinuity on sound conduction [13-15].

In clinical practice, accurate preoperative prediction of ossicular status is vital. Although imaging and tuning fork tests offer some indication, definitive evaluation is often intraoperative. Surgical reconstruction varies according to the extent of erosion—ranging from simple myringoplasty or Type I tympanoplasty to ossiculoplasty using autografts (e.g., incus interposition) or synthetic prostheses such as Partial or Total Ossicular Replacement Prostheses (PORPs/TORPs) [16-18]. Selection of reconstruction material is influenced by availability, cost, surgeon expertise, and middle ear mucosal status [19].

The results also point to a critical need for early diagnosis and intervention. The delayed treatment is a common in rural and underserved areas, often due to a lack of awareness, delayed referrals, or reliance on inadequate initial treatment. This delay allows chronic inflammation to progress, increasing the risk of ossicular erosion and irreversible hearing loss [20,21].

The present findings underscore the importance of public health measures such as community-based screening, improved access to otologic care, and increased awareness campaigns. Additionally, further research is needed to correlate ossiculoplasty outcomes with different materials and techniques in long term.

The pattern of ossicular erosion in the present study aligns closely with previous literature [Table/Fig-5] [4,6,13,16] confirming the incus as the most commonly eroded ossicle and squamosal disease as more destructive. However, our study uniquely correlates these intraoperative findings with audiometric data and disease duration (>1 year, offering stronger clinical implications for early detection and management.

Authors name	Place and year of the study	Sample size	Most affected ossicle	Ossicular erosion (%)	Key findings
Present Study	Pune, 2023-2024	60	Incus (55%)	63.3%	Higher erosion in squamosal COM (73.3%); PTA worse in eroded ossicles
Varshney S et al., (2010) [4]	India, 2010	100	Incus	65%	Squamosal COM associated with more ossicular damage
Vartiainen E (1995) [13]	Finland, 1995	84	Incus	~62%	Emphasised need for early surgical intervention in cholesteatoma
Booth JB (1985) [15]	USA, 1985	90	Incus	60%	Incus most vulnerable due to anatomical position and vascularity
Tos M (1979) [6]	Denmark, 1979	82	Incus	64.6%	Histopathologic analysis showed incus necrosis most common in chronic infection

[Table/Fig-5]: A comparison of the present study's findings with similar studies from the literature is shown below [4,6,13,16].

Limitation(s)

The present study was conducted at a single tertiary-care centre with a relatively small sample size, which may limit the generalisability of the findings. The duration of follow-up was short, and long-term hearing outcomes post-ossiculoplasty were not assessed. HRCT was not uniformly performed for all patients due to financial constraints. Further multicentre studies with larger cohorts and long-term evaluation of surgical outcomes are recommended.

CONCLUSION(S)

The present study aimed to assess the ossicular chain status in patients with long-standing COM and its correlation with disease type and hearing thresholds. It was observed that ossicular erosion is strongly associated with the squamosal type of COM and corresponds to higher degrees of conductive hearing loss. These findings reinforce the importance of intraoperative ossicular assessment in tailoring surgical management. Future research should explore the prognostic value of ossicular status in predicting long-term hearing outcomes after ossiculoplasty.

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