



EFFECT OF MASTOID PNEUMATIZATION ON THE SEVERITY OF CONDUCTIVE HEARING LOSS IN PATIENTS WITH LARGE CENTRAL TYMPANIC MEMBRANE PERFORATIONS: A PROSPECTIVE OBSERVATIONAL STUDY.

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ABSTRACT

Background: Mastoid pneumatization plays an important role in middle ear pressure regulation and sound transmission. Reduced mastoid air cell volume may increase conductive hearing loss in patients with tympanic membrane perforations. This study aimed to evaluate the effect of mastoid pneumatization on the severity of conductive hearing loss in patients with large central tympanic membrane perforations. **Materials and Methods:** This prospective observational analytical study was conducted in the department of otorhinolaryngology at PDU medical college and hospital, Rajkot, from January to June 2026. Fifty patients aged 18–60 years with chronic otitis media of the mucosal type, large central tympanic membrane perforations, intact ossicular chains, and pure conductive hearing loss were included. Patients with small or medium perforations, cholesteatoma, previous ear surgery, ossicular disruption, mixed or sensorineural hearing loss, or active ear discharge were excluded. Otoscopic and endoscopic examinations were performed, and hearing was assessed using pure-tone audiometry. Mastoid pneumatization was evaluated radiologically using Schüller's view and classified as well-pneumatized or sclerotic. Hearing loss was compared between the two groups using the student's t-test, with $p < 0.05$ considered statistically significant. **Results:** of the 50 patients, 32 (64%) were female and 18 (36%) were male, with a mean age of 36.92 years. Patients were divided equally into two groups: those with well-pneumatized mastoids and those with sclerotic mastoids. The mean hearing loss was 26.66 dB in patients with well-pneumatized mastoids and 37.15 dB in those with sclerotic mastoids. The difference was statistically significant ($p < 0.005$), indicating greater conductive hearing loss in patients with reduced mastoid pneumatization. **Conclusion:** Reduced mastoid pneumatization is associated with increased severity of conductive hearing loss in patients with large central tympanic membrane perforations. Radiological assessment of mastoid pneumatization may serve as an additional predictor of hearing loss, assist in patient counselling, and contribute to individualized surgical planning and prognostic assessment.

KEYWORDS : Mastoid Pneumatization, Conductive Hearing Loss, Tympanic Membrane Perforations, Chronic Otitis Media, Mastoid Sclerosis

INTRODUCTION

Conductive hearing loss occurs when there is any pathology in conducting sound waves anywhere along the route through the external ear, tympanic membrane and ossicles in the middle ear. The role of all these components of sound transmission in mechanisms of hearing is well documented.

Apart from these, mastoid air cell system is also an important contributor to hearing transmission due to its role in middle ear pressure regulation by gas exchange.

A well-pneumatized mastoid increases the effective air volume of the middle ear system, improving acoustic compliance. Whereas, a sclerotic or poorly pneumatized mastoid reduces middle ear volume and may increase conductive hearing loss for same size perforation in absence of other middle ear pathology.

The present study is designed to analyze the effect of mastoid air space volume in large tympanic membrane perforation with conductive hearing loss.

MATERIALS AND METHODS:

STUDY DESIGN: Prospective observational analytical study

Population: patients with chronic mucosal safe otitis media presenting to outpatient department of ENT, PDU medical college from January to June 2026

Inclusion Criteria

- Age 18 to 60 years
- Large central perforation
- Intact ossicular chain on clinical assessment
- Pure Conductive hearing loss

Exclusion Criteria

- Small and medium sized perforations
- Cholesteatoma
- Previous ear surgery
- Patients with ossicular disruption
- Mixed or sensorineural hearing loss
- Active ear discharge

A total of 50 patients with chronic otitis media mucosal type from outpatient department of otorhinolaryngology at PDU medical college and hospital, Rajkot were studied during the period of January 2026 to June 2026.

Patients were selected based on the inclusion and exclusion criteria. Written informed consent from those willing to enroll in the study was taken. Detailed proforma for each patient with history, otological, audiological and radiological investigations were documented.

Ear examination was carried out with Heinz otoscope in OPD and later examination under zero degree endoscope. Size, site of perforation and ossicular chain status were assessed.

Hearing assessment was done preoperatively by pure tone audiometry using advanced digital audiometer in sound proof environment of audiology room of ENT department including testing of air conduction and bone conduction in frequencies of 250Hz, 500 Hz, 1000 Hz, 2000Hz and 4000Hz.

Digital radiography was done and middle ear space volume was assessed by evaluating cellularity of mastoid xrays Schüller's view and pneumatization of mastoid graded as cellular and sclerotic. Variations in severity of conductive hearing loss in correlation of mastoid pneumatization was evaluated.

A master chart was prepared with variables of mastoid pneumatization status, and pure-tone average and air-bone gap as indicator of conductive hearing loss severity.

Student t-test was applied to find significance of study parameters between 2 groups

P value of < 0.05 was considered statistically significant.

RESULTS

In the present study, 50 patients with large central tympanic membrane perforation and conductive hearing loss were grouped into patients with sclerotic mastoid and patients with well-pneumatized mastoids.

As regards demographic profile of the study population 18 out of 50 patients were males constituting for 36% of study population and 32 out of 50 patients were females constituting 64% of the study population.

The mean age of patients in our study was 36.92 years and the mean age of males in this study was 35.055 years and the mean age of females in this study population was 37.18 years.

Table 1 : Demographic Data of Subjects in this Study Population

Variable	Sub group		Mean
Gender	Males	36%	
	Females	64%	
Age	Males	35.055 years	36.92 years
	Females	37.187 years	

All the 50 patients in our study population were sub divided into two subgroups

Group 1 : Large central perforation with well pneumatized mastoids

Group 2 : Large central perforations with sclerotic mastoids

Table 2: Comparison of Magnitude of Hearing Loss with Varying Mastoid Airspace Volume

Group	Mastoid status	Perforation size	Hearing loss
Group 1	Pneumatized	Large	26.66dB
Group 2	sclerotic	Large	37.15dB

**Figure 1: Comparison of Large Sized Tympanic Membrane Perforations with Well-Pneumatized and Sclerotic Mastoids to Degree of Hearing Loss.**

In our study, we had mainly 2 groups of 25 subjects each Group 1 and group 2 had mean values of hearing loss to be 26.66 and 37.15 decibels hearing loss The p value was <0.005.

Patients having sclerotic mastoids had more hearing loss as compared to patients with well pneumatized mastoids

Well pneumatized mastoids with more space for gaseous exchange and more air volume add to resonance of hearing whereas sclerotic mastoids have lesser volume and thereby lesser capacity to act as a buffer. Therefore, magnitude of hearing loss is inversely proportional to the pneumatization status of mastoid.

DISCUSSION

At birth, mastoid process presents only the antrum. The mastoid air cells develop as an outgrowth of the antrum ; epithelial air tracts bud from the antrum and extend to adjacent areas of temporal bone to form mastoid air cells. This air cell extension , called mastoid pneumatization, is facilitated by differentiation of bone marrow into loose mesenchyme. Thereafter, mastoid becomes the site of an air-containing cavity called mastoid air cells. The residual dense bone forms the septations between the mastoid air cells.[1]

Radiological evaluation of temporal bone can be done to assess the mastoid air cell system and type of pneumatization into sclerotic that is poorly pneumatized mastoids and pneumatic mastoids.

The mastoid air cells play an important role in the physiology and mechanics of middle ear. The mastoid air cell system closely resembles that of lung alveolus where extensive gas exchange takes place. The effective surface area of this epithelium is greatly increased by the remnant bony septa thus providing multiple small gas exchange units that altogether contribute large cell volume A larger air space decreases the acoustic stiffness of middle ear system, allowing better ossicular mobility and more efficient sound transmission. The total area of mucosal surface affects the gas exchange rates; thus increased mastoid pneumatization enhances ability of regulating middle ear pressure.[1]

In large central perforations, sound enters the middle ear directly and can stimulate both oval and round windows and thus create phase cancellation and thereby diminished cochlear stimulation. A larger middle ear volume provided by pneumatic mastoid attenuates this effect. The mastoid air cell system acts as a buffer system to replace air

in the middle ear cavity temporarily in case of eustachian tube dysfunction.

Pneumatic mastoids are usually associated with better eustachian tube function and healthier middle ear mucosa due to enhanced middle ear ventilation. Conversely, mastoid pneumatization acts as a marker of long standing disease, reduced middle ear ventilation and chronic eustachian tube dysfunction. and thereby act as an indirect marker for chronicity of middle ear disease.

Our study findings are in agreement with Manjuran DJ et al. who concluded similar findings with medium sized tympanic membrane perforations.[2] Authors Voss SE et al. did experiments on temporal bones of the cadavers and found similar results.[3] Mehta et al. did study of similar kind but used tympanometry as a method for estimating middle ear space volume. [4] Our study is comparable with findings of above authors.

Park et al. , 2015 evaluated 42 patients with tympanic membrane perforation and found that air-bone gap increased significantly as middle ear and mastoid pneumatization decreased. They concluded that degree of hearing loss depends on both perforation size and middle ear-mastoid pneumatization.[5]

CONCLUSION

Mastoid pneumatization can be used as an additional predictor of degree of conductive hearing loss. This explains why two patients with seemingly similar perforations may have different audiograms. Mastoid air space volume is inversely proportional to conductive hearing loss.

Knowledge about pneumatization status of mastoid can help with improved patient counselling providing more individualized explanation of their condition.

Poor mastoid pneumatization can be used as surrogate marker for chronicity of middle ear disease.

Mastoid air space volume has significant role to play in sound transmission along with other middle ear structures. While treating patients with tympanic membrane perforations , evaluation of mastoid air space volume helps in predicting hearing improvement outcomes and choosing appropriate line of surgical management and thus improve quality of life for patients.

Future studies can be done to investigate whether mastoid pneumatization also predicts postoperative hearing , graft uptake , recurrent perforations and its effect on long term middle ear ventilation.

Funding: No funding sources

Conflict of Interest: None declared

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