

Pneumatization of Mastoid Air Cells: Role of Acquired Factors

Neumatización de las Células Mastoideas: Rol de Factores Adquiridos

*Ashwani Sethi; **Ishwar Singh; ***A. K. Agarwal & ****Deepika Sareen

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SUMMARY: The exact mechanism of the pneumatization of the mastoid air cell system and the factors influencing the pneumatization are poorly understood. Both genetic as well as acquired factors have been implicated to influence this pneumatization process. Since pneumatization of the mastoid air cell system is considered an important prognostic factor in the outcome of reconstructive ear surgeries, a cohort study was carried out to assess the role of two important acquired factors i.e. duration of chronic otitis media and auditory tube functional status on the pneumatization of mastoid air cells. 50 individuals with unilateral chronic otitis media underwent assessment of their mastoid air cell system using planimetry and auditory tube functions using fluorescein dye nasopharyngoscopy. The results were in accordance with the previous studies indicating a definite influence of chronic middle ear disease on the pneumatization process, although the duration of disease was not significant. In contrast to some of the previous studies, no influence of auditory tube functional status was found on the mastoid pneumatization.

KEY WORDS: Temporal bone; mastoid air cells; Pneumatization; Auditory tube; planimetry.

INTRODUCTION

The mastoid air cell system represents a more or less extensive system of interconnecting air filled cavities arising from the walls of the mastoid antrum and walls of the middle ear. Allam (1969) classified the pneumatized spaces of the temporal bone into five different regions: middle ear region, mastoid region, perilabyrinthine region, petrous apex region and accessory region. This air cell system is lined by a flattened, non-ciliated squamous epithelium.

Ventilation of middle ear is an essential predictor of the functional results following middle ear reconstruction. The role of mastoid pneumatization in the middle ear aeration is not exactly known. But it forms an air reservoir and acts as a surge tank to minimize pressure fluctuation (Ars & Ars-Piret, 1994).

The exact mechanism of the pneumatization of the mastoid air cell system and the factors influencing the pneumatization are poorly understood. The pneumatization has been linked to hereditary and genetic factors (Stern, 1973). It has also been related to the size of the skull (Graham &

Brackmen *et al.*, 1978) and the height of the individual (Rudin *et al.*, 1987). The functional status of the auditory tube has been correlated to the pneumatization of the mastoid air cells by some authors (Pakira *et al.*, 1998), whereas, others do not confirm a significant correlation between the two (Siedentop *et al.*, 1970). However, ears with chronic suppurative otitis media have consistently shown a reduction in the size of mastoid air cell system (Zaidi, 1991; Arora *et al.*, 1978).

MATERIAL AND METHOD

The study involved 50 cases with unilateral chronic otitis media. The cases underwent a thorough history and examination with special reference to the duration of disease. The patients also underwent:

Assessment of the size of mastoid air cell system: The area of the cell system was determined by planimetry of the X-ray picture of the ear in a lateral projection. The measurement

* Senior Resident, Dept. of ENT & Head and Neck Surgery, Maulana Azad Medical College & Associated LN Hospital, New Delhi, India.

** Professor, Dept. of ENT & Head and Neck Surgery, Maulana Azad Medical College & Associated LN Hospital, New Delhi, India.

*** Director Professor, Department of ENT & Head and Neck Surgery, Dean, Maulana Azad Medical College & Associated LN Hospital, New Delhi, India.

**** Junior Resident, Dept. of ENT & Head and Neck Surgery, Maulana Azad Medical College & Associated LN Hospital, New Delhi, India.

errors are less than 3% according to Diament (1940). There is a good correlation between planimetric and volumetric measured size of mastoid air cell system as reported by Flisberg & Zsigmond (1965).

Assessment of the tubal function: The tubal function was tested by nasal endoscopy following instillation of 15 drops of fluorescein sodium dye (1 in 5 dilution of 20% solution) into the external auditory canal of the ear with perforated tympanic membrane. Cases in which the dye was seen at the nasopharyngeal end of the tube within 10 minutes of its instillation into the ear were classified as having patent tubes and the others as having blocked tubes.

RESULTS

Auditory tube function (Figs 1a and 1b): 34 cases (68%) had a patent tube and 16 cases (32%) had a blocked tube as assessed by endoscopy.

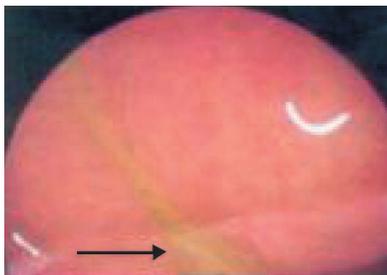


Fig. 1a. Endoscopic view showing dye in the nasopharynx in a case with patent auditory tube.

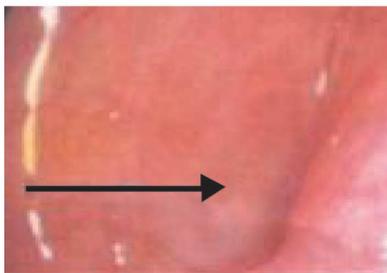


Fig. 1b. Endoscopic view showing no dye in the nasopharynx in a case with blocked auditory tube.

Size of mastoid air cell system (Figs. 2a and 2b):

a) In the diseased ear: 24 cases out of 50 (48%) had well pneumatized mastoid air cell system in the diseased ear as opposed to 26 cases (52%) that had poor pneumatization.

b). In the normal ear: 42 cases out of 50 (84%) had well pneumatized mastoid air cell system in the normal ear as opposed to 8 cases (16%) that had poor pneumatization.

Correlation between auditory tube function and mastoid pneumatization (Table I):



Fig. 2a. Radiogram showing sclerotic (poorly pneumatized) mastoid air cells.



Fig. 2b. Radiogram showing well-pneumatized mastoid air cells.

Table I. Showing correlation between auditory tube function and mastoid pneumatization.

Auditive tube status	Well pneumatized mastoid	Poorly pneumatized mastoid
Patent	15	19
Blocked	08	08

Table II. Showing correlation between chronic otitis media and mastoid pneumatization.

Condition of ear	Well pneumatized mastoid	Poorly pneumatized mastoid
Otitic ear	24 (48%)	26 (52%)
Non-otitic ear	42 (84%)	08 (16%)

-Out of the 34 cases with patent auditory tube, 15 cases (44%) had well pneumatized mastoid air cells and 19 cases (56%) had poorly pneumatized mastoid air cell system. Whereas, out of the 16 cases with blocked auditory tube, 8 cases (50%) had well pneumatized mastoid air cells and 8 cases (50%) had poorly pneumatized mastoid air cells.

Statistical conclusion: Chi Square test applied with p-value>0.05, implying insignificant correlation.

Correlation between chronic otitis media and mastoid pneumatization (Table II):

-The mean area of mastoid air cell system was found to be 6.8 sq.cm. in ears suffering from chronic otitis media, whereas, it was found to be 10.8 sq. cm. in non-otitic ears.

- 48% of the cases had a well pneumatized mastoid air cell system in the otitic ears as compared to 84% of the cases had a well pneumatized mastoid air cell system in the non-otitic ears.

Statistical conclusion: Chi Square test applied with p-value<0.05, implying significant correlation.

Correlation between duration of chronic otitis media and mastoid pneumatization:

-No significant correlation was noted.

DISCUSSION

The present study was undertaken to evaluate the influence of presence and duration of chronic otitis media and auditory tube functional status on the pneumatization of mastoid air cell system.

Planimetry of the X-ray picture of the mastoid in lateral projection was used for assessing the size of mastoid air cell system. The measurement errors using this method are less than 3% (Diament). Also there is a good correlation between the planimetric and volumetric measured size of mastoid air cell system (Flisberg *et al.*). The range of area of mastoid air cells in the diseased ears (ears with C.S.O.M.) was found to be 2 to 13 sq. cm with the mean area being 6.8 sq. cm It was found to be more than what was observed by Flisberg *et al.* in their study of 49 cases with otitic ears in which the mean size of the mastoid air cell system was found to be 4.4 sq. cm. The mean area of mastoid air cell system in otitic ears was found to be 6.3 sq. cm by Holmquist (1970), 5.5 sq. cm by Siedentop and 1.3 sq. cm by Arora *et al.* So, our result is similar to that obtained by Holmquist and Siedentop.

The range of area of mastoid air cells in non-otitic ears was found to be 4 to 22 sq. cm with the mean at 10.8 sq. cm. in this study. Chaterjee *et al.* (1990), in their study on 50 Indian cases, found the mean size of the mastoid air cell system to be 11.45+0.70 sq. cm It was found to be 12.04+0.37 sq. cm by Diament, 12.69+0.81 sq. cm by Flisberg and 12.05+0.67 sq. cm by Arora *et al.* The results of the present study are similar to these studies.

The ears were divided into two groups on the basis of the size of mastoid air cell system i.e. those with areas > 8 sq. cm. and those with areas < 8 sq. cm as assessed by planimetry. This division was based on the study by Chaterjee *et al.*, who found out the range of area of mastoid air cell system to be 8 to 22 sq. cm in their study on 50 Indian cases. In the present study, 24 cases were found to have an area > 8 sq. cm, whereas, 26 cases had area <8 sq. cm in the otitic ears.

Flourescein nasopharyngoscopy was used to assess the auditory tube function as it gives useful information regarding the auditory tube patency as well as its ability to clear the middle ear secretions. In a normally functioning auditory tube, the dye is seen at the nasopharyngeal end of the tube within 10 minutes of its instillation into the middle ear. Any delay of more than 10 minutes signifies a blocked or hypofunctioning tube as described by Rogers *et al.* (1962). In the present study, auditory tube was found to be patent in 34 cases (68%) and blocked in 16 cases (32%).

Diament was of the view that pneumatization of the mastoid bone is determined by hereditary factors. Genetic factors were also implicated by Stern (1973). The size of each mastoid also depends upon the final size of the skull in an individual; as for instance an acromegalic skull has a thick, large expansive mastoid, and a microcephalic, a small underdeveloped mastoid (Graham & Brackmen).

Amongst the acquired factors, chronic otitis media has been significantly seen to be associated with a poor pneumatization of the mastoid air cell system (Pakira *et al.*; Arora *et al.*; Shea *et al.*, 1990). Most of these studies also suggest a direct relationship between the duration of the disease and degree of pneumatization. The probable explanation for this correlation is the inhibitory effect of low grade infection on the osteoblastic activity of the mastoid bone (Zaidi). Our study also revealed a significant correlation between chronic otitis media and mastoid pneumatization, but there was no correlation seen between the duration of the disease and degree of pneumatization.

The role of auditory tube function in mastoid pneumatization has been controversial. Most of the studies in the past report a correlation between the two (Pakira *et al.*; Shimada *et al.*, 1990; Tsuji *et al.*, 2000). Takasaka *et al.* (1985) and Giebink *et al.* (1987) have postulated that one of the contributing causes of repeated otitis media, and hence poorly pneumatized mastoid process, is poorly functioning mucociliary system. Whereas, only a few investigators (Siedentop *et al.*) report no correlation between the two. Our results were thus similar to Siedentop *et al.*

In conclusion, pneumatization of the mastoid air cell system depends upon multiple factors. Chronic middle ear infection seems to have a definite influence on the pneumatization process as evidenced by the smaller size of

the mastoid air cell system in our study. Although the duration of the infection does not seem to have a direct correlation with the degree of pneumatization, auditory tube function seems to have no direct influence on the pneumatization.

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RESUMEN: El mecanismo exacto de la neumatización del sistema de células mastoideas y los factores que influyen en este proceso es pobremente comprendido. Factores genéticos, como también adquiridos, han sido implicados en el proceso de neumatización del sistema de células mastoideas. Esta neumatización es considerada un factor de importante pronóstico en la conducción de las cirugías reconstructivas de oído. Hemos llevado a cabo un estudio para explicar el rol de dos importantes factores adquiridos en la duración de la otitis media crónica y el status funcional de la tuba auditiva en la neumatización de las células mastoideas.

En 50 individuos, con otitis media crónica unilateral, se estudió su sistema de células aeríferas mastoideas usando la planimetría y las funciones de la tuba auditiva usando fluoresceína, vía nasofaringoscopia. Los resultados concuerdan con estudios previos, indicando una influencia definida de enfermedades crónicas del oído medio en el proceso de neumatización, aunque la duración de la enfermedad no fue significativa. En contraste con los estudios previos, no se encontró influencia del status funcional de la tuba auditiva en la neumatización mastoidea.

PALABRAS CLAVE: Hueso temporal; Células mastoideas; Neumatización; Tuba auditiva; Planimetría.

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Correspondence to:
Dr Ashwani Sethi,
E-80, Naraina Vihar
New Delhi
INDIA
E mail- dr_sethi@rediffmail.com

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