Mastoid Pneumatization and Otosclerosis-is there a Correlation

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Abstract

The environment versus the genetic influence on the size of the mastoid pneumatization has been debated for years. A concrete evidence of the influence of environmental factors (e.g. inflammation) or heredity on pneumatization is still lacking. In this study the extent to mastoid pneumatization in thirty otosclerotic ears was compared with control ears. The size of mastoid pneumatization was measured by the use of Law lateral x-ray projection with the help of planimetry. It was found that the average pneumatized area in otosclerotic ears was 14.73 ± 3.55 cm² compared to 10.60 ± 3.62 cm² in control ears which was statistically significant. In addition the mean area of mastoid air system was found to be more in the operated ears compared to the contralateral ears, the difference being statistically significant. However there was no correlation of mastoid pneumatization with degree and duration of hearing loss and type of otosclerotic focus. Our findings therefore show a link between otosclerosis and highly pneumatized mastoids thus indicating a likelihood of heredity playing a role in determining final type of pneumatization.

Key words. *Pneumatization, planimetry, Otospongiosis.*

Introduction

Mastoid air cell system constitute an important part of the anatomy of temporal bone. Its role in etiology of certain ear diseases and their prognosis as well as their surgical importance is well known to otologists. Mastoid pneumatization is an orderly process beginning with foetal development of Eustachian tube, progressing to middle ear and antrum development near term and continuing with cell tracks which expand from the antrum into the mastoid tip and surrounding part of petrous bone. This progressive pneumatization occurs at an average rate of 1.5 cm² per year in girls

and 1 cm² per year in boys and completed at the age of ten years in girls and fifteen years in boys (Robensohn, 1965).

Two theories of mastoid pneumatization have been debated in the otologic literature for years, one being environmental or endodermal theory (Wittmack. 1918, Tumarkin. 1957) and the other being hereditary or anatomic size variant theory (Diamant 1940) later supported by Sade (1979). The principal controversy is whether inflammatory disease can charge or inhibit mastoid pneumatization and secondly whether incomplete pneumatization represent

a pathological change. When a condition whose genetic character is well determined as in otosclerosis is found to be linked to an anatomic feature such as mastoid pneumatization, the conclusion that emerges is that this variable i.e. pneumatization is also genetically determined (Stern 1973). Radiographic technique is still the simplest and commonly used method for estimation of the size of the mastoid air cell system. (Fliserg and Zsigmond 1965). Planimetry means roentgenological area of the ear with a planimeter which is an instrument used to measure the area of irregular plane. The most representative projection for this purpose was found to be the Lateral oblique view of the mastoid. (Diamant 1940). However, one of the limitation of the planimetric determination of air cell size is two dimensional determination of a three dimensional structure.

Reports concerning pneumatization in otosclerosis are surprisingly scanty. Wittmack (1918), had claimed that patients with otosclerosis possess a normal pneumatized mastoid, a notion supported recently by Petrovic and Stanisavljevic (1983). Sade et al. (1989) studied the extent of mastoid pneumatization in otosclerosis. Their findings indicated a link between otosclerosis and highly pneumatized mastoid and suggested that the expression of mutant otosclerosis gene is linked to the degree of pneumatization. Sade (1992) also reported three cases in which atelectasis had developed in stapedectomized patients. In each case the mastoid was found to be non pneumatized and further analysis revealed that stapes fixation was of non otosclerotic origin. He suggested that otosclerosis may be considered to an unlikely cause of conductive deafness in cases of poor pneumatization.

Since no study has ever been done on mastoid pneumatization in otosclerosis in the Indian sub continent, in addition to paucity of similar studies in western literature, we decided to correlate mastoid pneumatization in patients hav-

ing clinical otosclerosis and assess the diagnostic value of mastoid radiograph in otosclerosis.

Material and Methods

The study population consisted of thirty patients of otosclerosis (Group I) who underwent unilateral stapedotomy in the department of otolaryngology, Post Graduate Institute Of Medical Education of Research, Chandigarh (India). Group II consisted of 30 randomized ears of 15 persons with normal otoscopy and hearing in the age group of 20-40 years acting as control.

After a thorough ear, nose and throat examination, the patients were subjected to impedance audiometry including reflex testing and pure tone audiometry to find out the cause of hearing loss. All the patients in the study group were taken up for anterior tympanotomy in the worse hearing ear and small fenestra stapedotomy carried out after noting the extent of the focus.

X-ray mastoids law's lateral view have been obtained for all the patients in each group. The area of mastoid air cells in each x-ray marked on transparent paper and copied on separate ordinary paper and the area measured twice by planimeter and the mean value noted (Fig. 1).

Fig 1. Showing planimetry in progress

Results

On comparing the mastoid air cell area between otosclerotic and normal ears, it was seen that the mean area of mastoid air cell system in control group was $10.62 \pm 3.62 \text{ cm}^2$ whereas the mean area in the otosclerotic ears was $14.73 \pm 3.55 \text{ cm}^2$. Statistical analysis using student t test (t value 4.39) revealed a highly significant difference between the two groups ($p < 0.01$). Table I

Table I.

Comparison of mastoid air cell area between otosclerotic and normal ears.

Group	Patients (ears)	Mean value (cm^2)	Range (cm^2)	SD	t value
Group I	30	14.73	8.30-23.50	3.55	4.39*
Group II	30	10.60	1.80-16.40	3.62	do

*Highly significant ($p < 0.01$)

Comparing the pneumatization in operated versus contralateral ears in the otosclerotic patients, we found the mean area of mastoid air cell system to be $14.73 \pm 3.55 \text{ cm}^2$ in operated ears and $12.71 \pm 3.65 \text{ cm}^2$ in contralateral ears. Statistical analysis using the student t test (t value 2.13) revealed a significant difference between the two sides. ($p < 0.05$). Table II

Table II

Comparison of mastoid air cell area between operated and contralateral ears (otosclerosis).

Otosclerosis	number	mean value (cm^2)	Range (cm^2)	SD	t value
Operated	30	14.73	8.30-23.50	14.73	2.13*
Contralat	30	12.71	5.90-20.10	12.71	do

* Significant ($p < 0.05$)

The diameter of mastoid air cell system was compared between the males and females in both groups. In control group of normal ears, males had better pneumatization i.e. $11.84 \pm 2.62 \text{ cm}^2$ to $8.75 \pm 4.34 \text{ cm}^2$ for females. The difference between the two sexes was 3.09 cm^2 which is statistically significant ($p < 0.05$). Simi-

larly in otosclerotic patients the mean difference between the two sexes was 2.89 cm^2 with better pneumatization in males i.e. $15.60 \pm 3.42 \text{ cm}^2$ as compared to $12.71 \pm 2.98 \text{ cm}^2$ for females, which was statistically significant ($p < 0.05$).

There was no significant correlation between mastoid pneumatization and duration of hearing loss, degree of hearing loss and type of focus in otosclerotic patients.

The values of mastoid air cell system for normal and otosclerotic patients obtained in this study are found to be lower compared to other studies. Table III

Table III

Mastoid air cell area in normal and otosclerotic patients reported by various authors.

Study	number	Normal ears	otosclerosis
Diamant (1940)	328	12.3 ± 6.70	—
Flisberg,			
Zsigmond (1965)	11	12.69 ± 2.60	—
Andreasson (1976)	9	12.70 ± 2.58	—
Arora et.al (1978)	100	10.91 ± 5.58	—
Sade et.al (1989)	150	12.90 ± 4.64	17.4 ± 5.00
Present study	30	10.60 ± 4.00	14.73 ± 3.55

Discussion

Several studies have been done in which the functional importance of air cell system as well as the microscopic and macroscopic shape have been considered (Wittmack 1918, Tumarkin 1957, Diamant 1964). The origin of the difference in size and type of pneumatization has become highly controversial over the years.

Wittmack (1918) and Petrovic et. al (1983) claimed that patients with otosclerosis possess a normal pneumatized mastoid. Moreover, they did not provide any measurements to support their argument. Recently Sade et. al (1989) on the basis of their study claimed that in otosclerotic ears pneumatization is larger and more developed than in normal ears. Our results too are in agreement with those of Sade

et al (1989). The mean value of mastoid air cell system for otosclerotic ears in our study was significantly higher than the value obtained for normal ears. The smallest measured mastoid air cell area in otosclerotic ears was found to be 8.30 cm² compared to 1.80 cm² in normal ears. It can thus be presumed that possibility of otosclerosis occurring in an ear with mastoid air cell area of 8 cm² or less is very low.

Comparing the pneumatization in operated and contralateral ears in otosclerotic patients, we found the mastoid air cell system to be significantly larger in operated ears compared to the contralateral one. X-ray mastoids may therefore be helpful to the clinician in selecting the ear to be operated in cases of bilateral otosclerosis with a symmetrical hearing loss. In such circumstances, the ear with better pneumatization could be selected for surgery. We found larger mastoid air cell system in

males as compared to females in both normal and otosclerotic ears. This finding is in contrast to Diamant's (1940) observations who found no sex difference in adult population. It was also seen that patients with a more prolonged history of hearing loss had slightly better pneumatization, but statistically the duration of disease had no significant relation with degree of mastoid pneumatization. In addition, we did not find any relation between mastoid pneumatization and type of hearing loss and the kind of otosclerotic focus.

Conclusions

Mastoid pneumatization has been found to be more extensive in otosclerotic ears compared to normal ears in our study. Mastoid radiography may therefore be useful in diagnosis of otosclerosis and in selecting the ear for surgery in bilateral otosclerosis with symmetrical hearing loss.

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