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Original Research Article

ASSOCIATION OF EUSTACHIAN TUBE DYSFUNCTION IN CHILDHOOD WITH MASTOID PNEUMATIZATION

Samanwita Basak *[1], Subhojit Mondal [2], Satabdi Sarkar [3], Sudipto Konar [4], Moulik Debnath [5], Manimay Bandopadhyay [6].

*[1,2] Demonstrator, Department of Anatomy, Murshidabad Medical College, West Bengal, India.

[3] Assistant professor, Department of Anatomy, Murshidabad Medical College, West Bengal, India.

[4] Assistant professor, Department of Anatomy, Burdwan Medical College, West Bengal, India.

[5] Assistant professor, Department of Anatomy, Murshidabad Medical College, West Bengal, India.

[6] Professor & Head, Department of Anatomy, Murshidabad Medical College, West Bengal, India.

ABSTRACT

Background: Degree of temporal bone pneumatization plays a very crucial role to assess the prognosis of different inflammatory middle ear diseases and the success of middle ear surgeries. There are debates regarding theories of the control of mastoid pneumatization. While the 'Hereditary theory' says that mastoid size is independent of status of mesotympanum the 'Environmental theory' supports the fact that the size of mastoid air cell system (MACS) is dependent on the degree of pathological involvement of middle ear mucosa in childhood.

Materials and Method: 100 subjects(n=100) of more than 6 years age (irresepective of sex) were selected who had no h/o past or present chronic or recurrent middle ear infection though subjects with one or two episodes of middle ear ailments in childhood were not excluded. Then by routine ENT examinations it was confirmed that they were having clinically healthy middle ear. Afterwards their bilateral mastoid x-rays were taken and typing (pneumatic/ diploic/ sclerotic/asymmetric) was done.

Results and Discussion: From the obtained data it was found that 31.58% of cases with bilateral diploic mastoid; 80% of cases with bilateral sclerotic mastoid and 75% of cases with asymmetric mastoid provided the h/o infantile ET dysfunction. This significant association of childhood ET dysfunction with depressed pneumatization (bilateral / unilateral) supports the 'environmental theory'. This study also estimated that individual with infantile ET dysfunction is 7 times more prone to develop non-pneumatic mastoid than an unexposed one. It emphasises on the importance of early diagnosis and prompt treatment of childhood ET dysfunction and also enlightens and encourages future research works in this regard.

KEY WORD: Eustachian tube dysfunction, Mastoid air cell system, Mastoid pneumatization, Sclerotic mastoid.

Address for Correspondence: Dr. Samanwita Basak, MBBS, MD. Demonstrator, Department of Anatomy, Murshidabad Medical college, West Bengal, India. Pin-742101
E-Mail: dr.samanwitabasak@yahoo.co.in

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INTRODUCTION

The word "Mastoid" means "Breast like". This is a part of temporal bone situated behind middle ear cavity. It undergoes pneumatization forming air space within. Change of air pressure within the middle ear is buffered by the air within the air cells of pneumatized mastoid and thus plays a vital role in maintenance of integrity of the tympanic membrane in different situations [1-4]. Thus degree of mastoid pneumatization

is a crucial factor in formation and prognosis of different inflammatory middle ear diseases [5,6] It also plays an important role in the outcome of the surgeries in this region [7-9].

According to pneumatization it might be one of three varieties- Pneumatic (mastoid air cells large, well developed and numerous), Diploic (small, less numerous and narrow air cells interspersed with marrow containing spaces) and Sclerotic (mastoid antrum as a single air space within dense bone). But aetiology of individual variation in pneumatization of mastoid has different explanations. As for according to Albrecht et al (1930) birth injury or suffocation might prevent pneumatization [10] whereas Diamant et al (1945) accepted heredity as the only influencing factor [11].

Middle ear as communicates with nasopharynx via eustachian tube (ET), any infection of pharyngeal region or dysfunction of ET may affect middle ear and in turn mastoid antrum which was mentioned by Tumarkin(1959) in his "environmental theory" where he clearly stated that "frustration of pneumatization" results from failure of aeration of the middle ear cleft due to blockage of eustachian tube [12].

MATERIALS AND METHODS

The study was carried out with a sample size of 100 subjects who were selected from the patients attending the outdoor of Otorhinolaryngology, IPGME&R with some ENT complaints other than ear and also from the staffs of the Department of Anatomy of Murshidabad Medical College who volunteered themselves in this study. The cases were mainly from West Bengal, Bihar, Jharkhand and Orissa i.e. mainly from the eastern part of India. The cases were selected irrespective of sex and all age groups except below 6 years as it takes 4-6 years to complete 90% development of mastoid pneumatization and only after this age the pattern or type of mastoid pneumatization can be determined [13].

A detailed history of the cases was taken. The patients with present, recurrent or chronic ear problem or any congenital ear problem were not included in this study. But cases with previous one or two episodes of acute earache, nasal blockage, severe upper respiratory tract infection (URTI) etc. that causes temporary eustachian tube dysfunction were not excluded from this study. A thorough routine ENT examination was performed to exclude any pathology of ear clinically at the time of the study or in recent past which can interfere with the result of this study (pearly white tympanic membrane with normal features is the most definitive finding of normal middle ear). It is also noted that the rest of the ENT examinations (particularly nose, sinus, nasopharynx, tonsil and throat) were within the normal limits. After that x-ray mastoid of both sides was performed on these subjects either by Schuller's lateral oblique view or by Town's view. The x-ray mastoids having some positive findings like bone erosion, cavity etc. (suggestive of silent middle ear disease) were excluded from this study. Finally by the method of exclusion based upon history, clinical examination and x-ray findings 100 subjects were selected who had completely normal middle ear though some of them gave h/o previous attacks of temporary eustachian tube (ET) dysfunction.

From the x-rays the type of mastoid pneumatization was noted in all study subjects and both side mastoids of same individual were compared also. Afterwards an attempt was made to correlate the non-pneumatic mastoid (unilateral / bilateral) with previous h/o temporary ET dysfunction in childhood by appropriate statistical method (Fisher's exact test with Freeman–Halton extension).

RESULTS

In this study it was found that among 72 individuals with bilateral pneumatic mastoid only 8 (11.11%) provided the h/o one or two attacks of acute otalgia, nasal blockage, severe URTI i.e. temporary ET dysfunction in childhood. On the other hand among 19 subjects with bilateral diploic mastoid 6 (31.58%), 4(80%) out of 5 bilateral sclerotic mastoid and among 4 cases of asymmetric mastoid (different degree of pneumatization in both ear) 3(75%) provided h/o ET dysfunction in infancy [Table 1]. So from these data it was clearly found that past h/o ET dysfunction is more associated with diploic, sclerotic and asymmetric mastoid than pneumatic variety [Figure-1].

Table 1: Distribution of Pneumatic, Diploic, Sclerotic & Asymmetric Mastoid with / without past H/o Eustachian Tube dysfunction.

Past H/o Eustachian Tube dysfunction	Subjects with Bilateral Pneumatic Mastoid	Subjects with Bilateral Diploic Mastoid	Subjects with Bilateral Sclerotic Mastoid	Subjects with Asymmetric Mastoid
Yes	8 (11.11%)	6 (31.58%)	4 (80%)	3(75%)
No	64 (88.89%)	13 (68.42%)	1 (20%)	1 (25%)
Total	72	19	5	4

Further, to establish the relationship between non-pneumatic mastoid and past h/o ET dysfunction it was found that among 21 subjects who had provided h/o one or two episodes of ET dysfunction in childhood 13(61.9%) presented with non-pneumatic mastoid (either unilateral/bilateral)[Table 2]. So by calculating odd's ratio from this data it can be said that a person having ET dysfunction in childhood has almost 7 times more risk of developing non-pneumatic mastoid than others.

Table 2: Risk of developing pneumatic/non-pneumatic mastoid in Eustachian tube dysfunction.

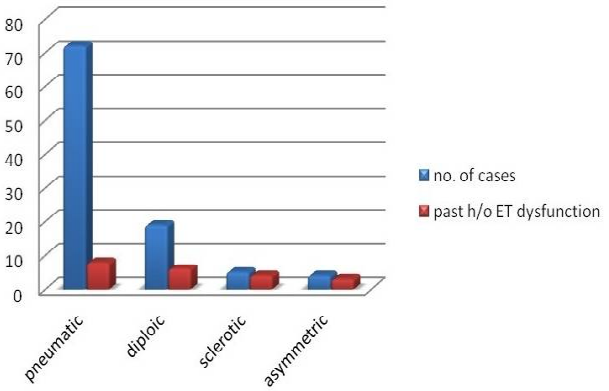
Past h/o ET dysfunction N=100	Non-pneumatic Mastoid		Pneumatic Mastoid	
Yes 21	13	61.90%	8	38.10%
No 79	15	18.90%	64	81.10%

DISCUSSION AND CONCLUSION

Degree of mastoid pneumatization is an important factor for determining middle ear pressure which plays a crucial role in prognosis of different inflammatory middle ear diseases. Frisberg (1963) was the first who discussed the relation between the largeness of the mastoid air cell system and prognosis of the middle ear disease [14]. Later Nakano (1990), Sui et al (1996) and Sade (1997) supported this theory by stating that if volume of MACS of children with SOM is large then the prognosis becomes more favourable[5,6,15].

Besides, degree of mastoid pneumatization has much importance in middle ear surgery. Bonding (1988) and Bonding-Satage (1994) reported the failures of tympanoplasty in children with under developed mastoid air cell system [8,9]. Patients with a poorly pneumatized mastoid may make mastoidectomy more complicated as certain anatomical landmarks (otic capsule, facial nerve etc.) may be more challenging to identify. Degree of mastoid pneumatization also plays a crucial role in cochlear implant candidates [16].

Fig. 1: Histogram showing comparison between different mastoid types with past H/o Eustachian tube dysfunction.



In context to the development of mastoid pneumatization Wittmaack (1918) hypothesised that the healthy lining of the entodermal tubo-tympanic recess is the key factor for the well developed MACS ("endodermal theory")[17] which was contradictory to the previous Diamant's 'Hereditary theory'.

Further, Tumarkin (1959) extended the view of Wittmack's endodermal theory by concluding "frustration of pneumatization" results from failure of aeration of the middle ear cleft due to blockage of eustachian tube. He called this theory "environmental"[12].

Kolihova (1966) again concluded that infection is the primary cause of retarded pneumatization of MACS[18]. Siedentop (1968), Holmquist (1970) and Andreasson (1976) proved in their respective studies that there is a close correlation between tubal function and growth as well as size of MACS [19,7,20].

Later Aoki (1990) carried an experimental animal study by instilling 1.5 ml paraffin liquid into the left tympanic cavity of 7 pigs 2 or 7 days after birth and produced inflammation of the middle ear and tubal dysfunction. After 6 months, the length and area of the mastoid process were significantly smaller on the instilled side than on the normal side. So this study again enhanced the environmental theory by concluding that

anatomical variations of temporal bone are due to inflammation, occurring at early postnatal period [21]. Ikarashi (1994) showed that the more severe the inflammation found, the greater was the inhibition of pneumatization in another animal model [22].

Now in this study 31.58% subjects of bilateral diploic mastoid, 80% subjects of bilateral sclerotic mastoid and 75% of asymmetric mastoid provided the h/o previous ET dysfunction. Hence among eastern Indian normal population a significant association was found in between childhood eustachian tube dysfunction with depressed pneumatization (either bilateral or unilateral) which goes in the support of Wittmaack's environmental theory and the findings of all related previous works. In addition to that this study measured that the estimated risk of developing non-pneumatic mastoid in an individual with tubal occlusion in infancy (once or twice) was 7 times higher than other unexposed individual. It is noteworthy that no such data was found in any literature of recent past. So here lies the uniqueness of this study opening the scope of further research work in this regard.

So in conclusion it can be stated that if childhood eustachian tube dysfunction (no matter how minor the attack may be) is diagnosed early and treated properly then it can prevent the development of non-pneumatic mastoid; thus modifying the grave prognosis of future middle ear inflammation and outcome of middle ear operations.

Conflicts of Interests: None

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