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Original Research Article

A STUDY OF MASTOID CELLULARITY IN CHRONIC OTITIS MEDIA

D. Bhima Rao[1], D. Sivasankaraiah[2], B.Nageswar Rao[3], G.Ramya[4]

[1]Assistant Professor ENT, Government Medical college Srikakulam, Andhra Pradesh, India.
[2]Assistant Professor ENT, Andhra Medical College Visakhapatnam, Andhra Pradesh, India.
[3]Associate Professor of ENT, Andhra Medical College Visakhapatnam, Andhra Pradesh, India.
[4]Senior Resident, Department of ENT, Government Medical college Kadapa, Andhra Pradesh, India.

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Corresponding Author:
Dr. D. Bhima Rao,
Email: bhimarao3642@gmail.com

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ABSTRACT

Background: The association between mastoid cellularity and middle ear pathology has to be well understood because it alters the course and management of the disease, mainly three types of cellularity i.e. 1 Pneumatic, 2. Diploic, 3. Sclerotic are observed. The type of cellularity depends upon its aeration through middle ear cleft. So, many pathology altering the pathway through eustachian tube and leads to change in the mastoid cellularity and further changes the course of the treatment. Though many studies have been conducted in order to understand the association between middle ear pathology and mastoid cellularity but none has given proper outcome of the studies. To some extent this study highlighted the correlation between middle ear pathology and mastoid cellularity pattern, which is necessary for the pathology and mastoid cellularity pattern, which is necessary for the planning of the surgical treatment. **Aim of the Study:** To study the pneumatization pattern of the mastoid air cells in cases of unilateral chronic otitis media, participants where the contralateral ear is normal. To correlate between type of chronic otitis media (COM)and extent of the mastoid cellularity in decreased ear. And finally to analyse the pneumatization pattern of contralateral normal ear. **Materials and Methods:** A group of 50 patients age group between 15 – 60 years with unilateral ear discharge , with normal asymptomatic contralateral ear, more than 6 weeks of recurrent ear discharge with small to subtotal , central to marginal type of perforation , with any type of chronic otitis media excluding intracranial complications and any benign or malignant disease of ear ; during the management the participants subjected to clinical and radiological evaluation by plain X ray mastoid , high resolution computerized scan (HRCT) temporal bones including coronal and axial cuts without contrast done depending upon the clinical features ,radiological and histopathological findings, all cases classified into pneumatic , diploic and sclerotic pattern based on the age group, qualitative data all expressed in number and percentage and quantitative data a means and standard deviation. **Result:** In the age group 15-60 years, commonly affected were among 15-45 years (86%) and common cause was bacteriological non specific infection and 2 cases (4%) were tuberculosis participants and (2%) were effected with fungal infection. In mastoid pneumatization pattern ,74.4% were sclerotic, followed by pneumatic 8% and diploic 4 %, sclerotic type commonly observed in squamosal (unsafe) type of disease % and in mucosal type %. In mucosal diseases the contralateral normal ear equally show pneumatization (43.7%) and sclerotic pattern (43.7%), but in squamosal disease (n=31) cases the normal ear shows more pneumatic pattern (n=22) 70% only 8 cases (25%) were sclerotic and one case (4%) was diploic pattern. **Conclusion:** In this study the result shows that CSOM effecting in young and middle aged group, sclerotic pattern pneumatization commonly observed in the diseased ears followed by pneumatic and diploic pattern, we also analysed that granulomatous condition and fungal (actinomycosis) infection were found in fifth and sixth decade. Contralateral normal ear shows more of the pneumatic pattern, followed by sclerotic and diploic. So sclerotic and diploic pattern also observed in non effected normal ear. Based upon pneumatic or sclerotic pattern of mastoid cellularity in a radiological investigation, we cannot predict about the type of surgical intervention or surgical extension.

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INTRODUCTION

Chronic otitis media is defined as chronic inflammation of mucoperiosteal lining of the middle ear cleft with recurrent otorrhoea through perforated tympanic membrane.

The association between mastoid cellularity and middle ear pathology has to be well understood because it alters the management of the disease. Mainly 3 types cellularity are described in mastoid, they are pneumatic, diploic and sclerotic.[1] The type of cellularity depends upon its aeration through middle ear cleft so any pathology altering its pathway causes the changes in mastoid cellularity and further changes the course of its treatment and vice-versa. In case even of the types of CSOM (inactive squamosal), mastoid cellularity and middle ear pathology causes for the formation of retraction pocket not only influenced by middle ear volume but also the status and size of mastoid antrum.

Major pathology which affects the middle ear is chronic suppurative otitis media (CSOM). It has a prevalence of 46/1000 in rural population and 16/1000 in case of urban population areas. It has an incidence of 3% to 57%.[2] It mostly associated with poor hygiene habits and because of lack of health awareness.

Though many studies have been conducted in order to understand the association between middle ear pathology and mastoid cellularity, but none has given proper outcome of the studies and management planning depending upon it. Mastoid air cell system which is a part of the middle ear cleft has been recently identified as significant component in course, genesis, behaviour and outcome of middle ear inflammatory diseases. Chronic otitis media is observed to be more in association when there is poorly pneumatized mastoid, but acute otitis media is observed to be more in well pneumatized mastoid.

Different types of mastoid air cells are observed which include squamous mastoid air cells among it antrum is the biggest. Petrous cells, infra labyrinthine cells, supra labyrinthine, perilabyrinthine, apical cells, accessory air cells etc.

The mastoid antrum communicates with middle ear cavity by auditus. Mastoid antrum may be only air-filled space in mastoid process when non cellular or sclerotic is applied and it is only present at birth later during pneumatization process occurs in which epithelium infiltrates developing bone and creates epithelium lined air cell cavities.

Therefore this study has been taken up in order to give a brief clarity regarding the middle ear pathology and cellularity. In this study patients with chronic disease are subjected to X-Ray mastoid, and HRCT temporal bone to know association of middle ear pathology with mastoid cellularity. Most hypocellularity is observed in patients with chronic middle ear pathology. This hypocellularity is because of chronic inflammation in middle ear but not due to the congenital abnormalities.

Tympanomastoid system appears in third week of life as an outpouching from first pharyngeal pouch called tubo tympanic recess. Auditory tube and middle ear cavity arise from the first pharyngeal pouch.[6] This pouch expands in a lateral direction and comes in contact with floor of first pharyngeal cleft. Later the distal part of this leads to formation of tubo tympanic recess and proximal part of it forms auditory tube.

Pneumatization is process where epithelium infiltrates developing bone and creates epithelium lined air cell cavities.[15] In the mastoid air cell system sub mucosal capillary network helps in gas exchange. Because the gas exchange occurs in cellular mucosa the mucosal surface area effects the gas exchange. So, because of this it works as a reservoir. The process by which air filled spaces evolve inside the bone is known as pneumatisation.[15] The supply of air occurs mainly through eustachian tube to middle ear and to mastoid of temporal bone.

Mastoid pneumatization starts at 33rd week of gestation and occurs up until age of 8 or 9 yrs.

From birth to puberty three phases of mastoid pneumatization will occur.[18]

Phase I (0 – 1 year): antrum will be at birth with mean surface of 1 cm². In the first year of life there is rapid development of air cells as result there be addition of 3 cm² making a total 4 cm² by the year of 1 year. During same duration, mastoid process also increases in length by 1 cm and width and depth by 0.5 cm,[19]

Phase II (1 – 6 year): during this period mastoid pneumatization follows linear pattern so that it will add 1 cm² per year. As a result of this by the age of 2 years mastoid tip covers emergence of facial nerve at stylomastoid foramen.[20] In this period mastoid process increases by 0.5 cm in length and width and depth by 0.25 cm.[21]

Phase III (6 years – puberty): in this period pneumatization becomes very slow. This process continuous up until puberty. By this time aerated mast cell also reaches its adult size.[22] Mean adult surface of mastoid air cell system is 12 cm².[23] last to develop are air cells around petrous bone. These accounts for 35 – 40 % of adult temporal bones.[24]

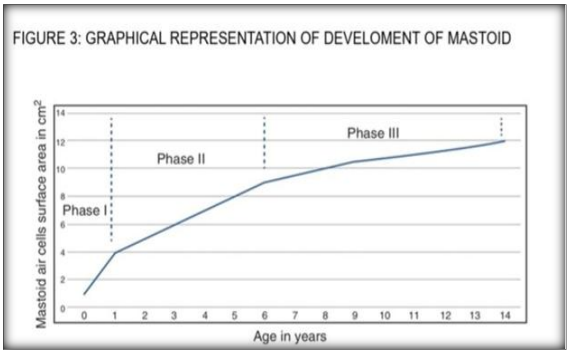

Figure 3: Graphical representation of Development of Mastoid

Mastoid air cells include antrum, sinodural sinus, tegmental, tip cells, petrous cells, apical cells, accessory air cells.

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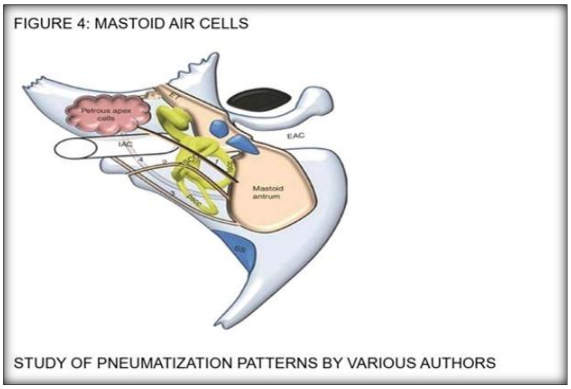

Figure 4: Mastoid Air Cells

TABLE:1 PNEUMATIZATION PATTERN – DIFFERENT STUDIES

AUTHORS	PNEUMATIC	DIPLOIC	SCLEROTIC
Sunitha et al. [36]	33.3%	3.7%	53.7%
Datta et al. [37]	4%	0%	96%
Kanotra et al. [38]	0%	0%	100%
Rai et al. [39]	44%	6%	50%

Radiological Imaging and Mastoid Pneumatization

Imaging plays a key role in understanding the mastoid bone anatomy. Various pneumatization patterns can be identified easily with this. It is not only used to study the pathology but also used to study normal anatomy. Many anatomical variants can be studied through imaging (for example korner's septum)

Initially X-rays are used for imaging of mastoids but with advent of CT scan bony structures are well evaluated especially bony outlines. CT is most frequently used tool for evaluating temporal bones.[40] It is not only used to detect pathology but used as a tool for evaluating preoperative and during operative procedures. Preoperatively it is useful in taking decisions regarding the most optimal surgical approach so that it helpful in minimizing the complications.

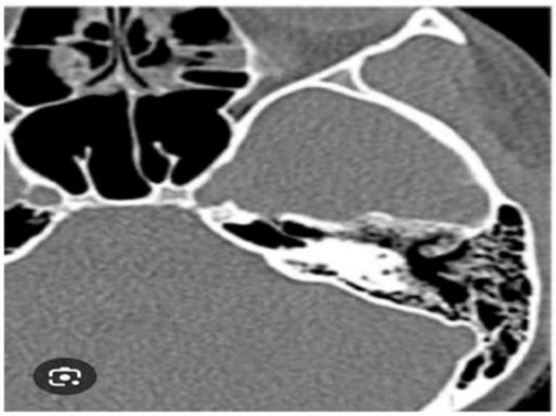

Figure 5: HRT imaging of Temoral Bone

In documenting the CT finding we should give not only regarding the pathological aspects but also regarding the normal anatomical structures. Following are the points to be given in CT in relation to mastoid region

Presence and extension of the pneumatization.

Contents of the mastoid cells (air, fluid, soft tissue)

Position of the sigmoid sinus

Aspect of bony border of the posterior and middle cranial fossa.

Integrity and position of the mastoid segment of facial nerve canal.

MIDDLE EAR VENTILATION PATHWAYS AND FACTORS EFFECTING IT

Middle ear ventilation

plays an important role in mastoid pneumatization. So, we should understand how middle ear gets ventilated and factors controlling it. Because these factors indirectly influence mastoid air cell system. For understanding and spread of any disease in middle ear aeration of middle ear is required.[45]

Middle ear and mastoid cleft are mainly ventilated through eustachian tube. The air from the outside atmosphere enters middle ear through eustachian tube.

CHRONIC OTITIS MEDIA:[61]

CSOM classified into mucosal (active, inactive),squamosal (active ,inactive),healed

Common etiological factors for CSOM including:

Repeated upper respiratory tract infection, Low socioeconomic status, Eustachian tube dysfunction, Craniofacial deformity Anomalies etc.

Recurrent infection in middle ear then will be irreversible changes in mucosa which may produce inflammatory mediators. There is metaplasia of the

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epithelium resembling that of the respiratory tract with increased number of goblet cells and sclerosis.

MATERIALS AND METHODS

The prospective study was conducted from October 22 to April 2024, involving patients attending the OPD of Govt ENT Hospital Visakhapatnam, a tertiary care centre, on average 70–80 out of 350 daily OPD patients were diagnosed with CSOM.

Inclusion Criteria

- Patients with age group between 15–60 years unilateral CSOM all types for a minimum of 6 weeks.
- Patients with normal Eustachian tube function.
- CSOM with Tuberculosis and fungal infection.

Exclusion Criteria

CSOM with intracranial complications.

All benign tumors and malignancies of the ear.

Patients were treated between October 2022–April 2024 are subjected to comprehensive history and clinical evaluation and radiological evaluation as per the proforma designed for the study

Records of the patients treated between the time period were retrieved from medical section of Andhra medical college, Government ENT hospital, Visakhapatnam to get the required data.

adiological scans were retrieved from department of radiology and reviewed by radiologist

Data obtained from these records were complied to meet the requirement of the study

Investigations

Haematological investigations like HB%, total leukocyte count, differential count, absolute eosinophile count, bleeding time, clotting time, blood grouping and typing, and urine examination were done

1. Radiological investigations included
2. Plain x-ray mastoids (Schuller's view)

High resolution computerised scan of temporal bones (coronal and axial without contrast) were done

Study Pattern

Depending on the clinical features, radiological and histopathological findings all CSOM are classifies into pneumatic, diploic, sclerotic patterns based on their age groups.

Statistical Methods

1. Data entry will be done in Microsoft excel spread sheet
2. The qualitative data will be expressed as numbers and percentages and quantitative data as means and standard deviation
3. T-test will be applied for test association
4. Further, relevant statistical tests will be applied whenever necessary.

RESULTS

Total of 50 patients were studies during 1 year 6 months and following observations were made and they are analysed. The patient group were ranged from 15–60 years. They were divided into 3 sets of age groups and in each group, observations were made.

Table 1: Age distribution related with number of cases

AGE IN NUMBER	NUMBER OF CASES
15 -25	19(38%)
26-35	10(20%)
36-45	14(28%)
46-60	7(14%)

Table 2: Distribution of cases in relation to their diagnosis

DIAGNOSIS	CSOM	T.B	ACTINOMYCOSIS
NUMBER OF CASES (n =50)	47(94%)	2(4%)	1(2%)

Table 3: Distribution of pneumatization pattern in all csom cases

DISEASE TYPE	PNEUMATIC	DIPLOIC	SCLEROTIC
CSOM (n=47)	8 (17%)	4 (8.51%)	35 (74.4%)

Distribution of pneumatization in the diseased ears

Table 4: Pattern of pneumatization in contralateral (non diseased)

DISEASE TYPE	PNEUMATIC	DIPLOIC	SCLEROTIC
MUCOSAL(n=16)	5 (31.2%)	2 (12.5%)	9 (56.2%)
SQUAMOSAL(n=31)	3 (9.6%)	2 (6.45%)	26 (83.8%)
TB OTITIS MEDIA(n=2)	0	1 (50%)	1 (50%)
ACTINOMYCOSIS(n=1)	0	0	1 (100%)

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EAR) SIDE IN ALL AGE GROUPS

DISEASE TYPE	PNEUMATIC	DIPLOIC	SCLEROTIC
MUCOSAL(n=16)	7(43.7%)	2(12.5%)	7(43.7%)
SQUAMOSAL(n=31)	22(70.9%)	1(3.22%)	8(25.8%)
TB OTITIS MEDIA(n=2)	1(50%)	1(50%)	0
ACTINOMYCOSIS(n=1)	0	0	1(100%)

DISCUSSION

Of all the age groups a greater number of cases were seen in 15-25 years of age group of about 38% followed by 36-45 (28%) then 26-35 (20%) and lastly 46-60 (14%).

Interestingly in our study we also included the TB otitis media and Actinomycosis cases also which were reported in our hospital. There are 2 cases of TB otitis media and 1 case of actinomycosis case reported. These cases were predominantly seen in the 46-60 years of age group.

Majority of cases included in our study are CSOM about 94% followed by TB otitis media which is about 4% and then actinomycosis which is 2%.

Among 50 patients which were subjected to our study 47 are CSOM cases among them further we divided them into Mucosal type of CSOM which are 16 cases and Squamosal type of CSOM which are 31. Then pneumatization patterns were studied among them using x-ray mastoids and HRCT temporal bones.

Among 47 CSOM cases pneumatization pattern were compared using x-ray and HRCT which shows predominantly of sclerotic pattern about 74.4% followed by pneumatic pattern about 17% and lastly diploic which shows 8.5%. this pattern in our study is compared with other studies and following table represents it.

Table 11: Comparison of pneumatization patterns in csom cases with other studies

AUTHORS	PNEUMATIC	DIPLOIC	SCLEROTIC
Sunitha et al.(n=45) [36]	33.3%	3.7%	53.7%
Datta et al. [37]	4%	0%	96%
Kanotra et al.(n=47) [38]	0%	0%	100%
Rai et al. (n=50) [39]	44%	6%	50%
Our study (n=47)	17%	8.5%	74.4%

According to our study there is more of sclerotic pattern in mastoid bone sin CSOM cases which were similar results compared to most of the other studies. In our case sclerotic accounts for 74.4% which is similar association with Sunitha et al. where it has 53.7% of sclerotic pattern, according to other studies like datta et al. 96% of their cases are sclerotic, kanotra et al. study shows 100% of sclerotic, rai et al. shows 50% of sclerotic cases.

After sclerotic pattern next most, common pattern is pneumatic. In our study it is observed to be about 17%, which is similar to results observed in other studies also such as in Sunitha at et al. it is 33.3%, according to datta et al. it is 4%, in case of rai et al. 44% of cases seen to be pneumatic pattern, no pneumatic pattern was observed in kanotra et al. study.

The least pattern observed was diploic. In our study diploic accounts for 8.5%, the results were similar with other studies which shows about 6% according to rai et al, which has the most association with our study where as other studies has 3.7% of diploic for Sunitha et al., but no diploic patterns were observed in cases of datta et al. and kanotra et al.

In our study we compared the pneumatization patterns in subtypes of CSOM cases also. That includes squamosal type and mucosal type. These results were compared with other studies and following table represents it.

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Table 12: Comparision of pneumatization pattern in squamosal type of CSOM with other studies

STUDY	NON-PNEUMATIZED MASTOID (%)	PNEUMATIZED MASTOID (%)
Tiwari et al.(n=54)[62]	92.59	7.41
Isma et al [63]	39.7	60.3
Abhjeet et al [64]	89	10.9
Shah et al.(n=35) [65]	85.6	14.4
Ahamed et al.(n=50) [66]	92	8
Tripti et al.(n=50) [39]	56	44
Sade et al.(n=190) [67]	82.2	17.8
Vishawanata et al. [68]	82.7	17.3
In our study (n=31)	90.25	9.6

Table 13: Comparision of pneumatization pattern in opposite (contralateral ear) with other studies

STUDY	CONTRALATERAL EAR NON-PNEUMATIZED PATTERN (%)	PNEUMATIZED PATTERN (%)
Fatma et al. [69]	40.7	60.3
Mauricio et al.(n=75) [70]	34.7	65.3
Our study(n=47)	38.3	61.7

Our study shows more of pneumatization pattern in case of contralateral ear in middle ear CSOM cases accounting for 61.7% pneumatization and 38.3% of non-pneumatization pattern.

Our study has association with that of the Fatma et al which has 60.35 of pneumatized mastoid and 40.7% has non-pneumatized pattern in contralateral ear.

Other study also has similar association with our study where Mauricio et al study shows 65.3% of pneumatization pattern and 34.7% non-pneumatization pattern in contralateral ear.

In our study we also compared pneumatization pattern in TB otitis media. Only about 2 cases were reported to our hospital of both we studied mastoid pneumatization in them which shows diploic in one case (50%) and sclerotic in another case (50%) in diseased ear.

We also compared the pneumatization of mastoid in contralateral ear also in this TB otitis media which shows pneumatic in one case (50%) and diploic in another case (50%).

We also included one case of actinomycosis of ear which is a rarest presentation in the ear. Pneumatization in diseased ear shows sclerotic (100%) and in the contralateral ear also it shows sclerotic pattern (100%) of mastoid pneumatization.

In our study we have also seen the distribution of pneumatization patterns in various age groups which we have divided among our patients.

Among them sclerotic pattern is mostly seen in 15-25 years of age group which has 78.94% followed by 36-45 years of age group which shows 78.5% and then in 46-60 years of age group which has 75% and finally 26-35 years of age group has 70%.

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Similarly pneumatic pattern mostly observed in 26-35 years of age group which shows 30% of pneumatization followed by 36-45 years of age group which has 21.4% and 15-25 years age group shows 10.52% pneumatization pattern. No pneumatization pattern were seen among 46-60 years of age group.
Least common pattern observed was diploic which mostly seen among 46-60 years of age group 25% and followed by in 15-25 years of age group has 10.52% of diploic pattern. In other groups no pattern of diploic was observed in our study.

CONCLUSION

Finally, after analysing our study, we found out that there is more of CSOM affecting the younger age group. After thorough radiological investigations we observed that there is more of the sclerotic pattern among the diseased ears followed by the more of pneumatic pattern and least is the diploic pattern. We also observed that certain granulomatous conditions which we included in our study are TB and actinomycosis were found to be more common in the fifth to sixth decade. Among them also we observed in the affected side is more of sclerotic pattern.
We have also seen on the non-affected ears shows more of the pneumatic pattern followed by sclerotic pattern. Among all mastoids we have observe both the effected and non-effected side least number of pattern observed is diploic.

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