Pneumatization Pattern in Squamousal Type of Chronic Otitis Media

Amitava Roy¹ · P. T. Deshmukh¹ · Chandrakant Patil¹

Received: 21 March 2015 / Accepted: 24 June 2015 / Published online: 2 July 2015
© Association of Otolaryngologists of India 2015

Abstract To study the pneumatization pattern of mastoid bone in cases of squamousal type of chronic otitis media and analyze pneumatization pattern of opposite normal ear in cases of unilateral chronic otitis media (COM). A total of 94 patients (104 ears) between the age group of 7–84 years attending the E.N.T outpatients, inpatients and casualty of Acharya Vinoba Bhave Rural Hospital, Sawangi (Maghe), Wardha, after applying inclusion and exclusion criteria were found suitable and hence selected for the present study and were subjected to bilateral X-ray mastoid (Schuller's view). HRCT temporal bone done in selected 55 patients. On analyzing patients radiologically (X-ray mastoid), it was found that out 104 ears, mastoid was pneumatized in 2 (1.92 %) diploic in 20 (19.23 %) and sclerotic in 82 (78.85 %) ears. Contralateral mastoid of 70 normal ears, mastoid was pneumatized in 30 (42.86 %) diploic in 22 (31.43 %) and sclerotic in 18 (25.71 %) ears. Most of the diseased ear demonstrated non pneumatized mastoid (98.08 %) whereas contra lateral mastoid of 70 normal ear, showed significantly more pneumatization This difference is statistically significant (P value < 0.0001). Significantly more sclerosis and non pneumatization in the ear with COM of squamousal type than the healthy contralateral ear supports the environmental theory.

Keywords Squamousal · Chronic otitis media · Pneumatization

Introduction

The diagnosis of chronic otitis media (COM) implies a permanent abnormality of pars tensa or flaccida, most likely a result of earlier acute otitis media, negative middle air pressure or otitis media with effusion. COM equates with the classic term chronic 'suppurative' otitis media which is no longer advocated as COM is not necessarily a result of 'the gathering of pus' [1].

Temporal bone pneumatization plays an important role in etiology, behaviour, course and outcome of COM. Of the parts of temporal bone namely the mastoid process, the petrous pyramid, the squamous, and tympanic portion, the pneumatization of the mastoid cells begins at the 33rd week and continues up to 8–9 years of age. The mastoid air cell system has been recognized as an important contributor to the pathophysiology of middle ear inflammatory diseases. Many studies have been reported the correlation between middle ear disease and mastoid air cell system. It is questionable whether hypocellularity result from previous middle ear disease (environmental pneumatization theory) [2–4] or the size of the cell system genetically determined [5–7]. Present study is undertaken to critically look at the association of mastoid pneumatization with COM.

Aim and Objective

- To study the pneumatization pattern of mastoid bone in cases of squamousal chronic otitis media.
- To analyze the pneumatization pattern of opposite ear in cases of unilateral COM.
- To study association of degree of retraction and mastoid pneumatization.

✉ Amitava Roy
dr.amitavaroy@gmail.com

¹ Department of ENT, AVBRH, Sawangi (Meghe), Wardha 442001, Maharashtra, India

- To study correlation of ossicular erosion with mastoid pneumatization.

Material and Method

A total of 94 patients (104 ears) between the age group of 7–84 years attending the E.N.T outpatients, inpatients and casualty of Acharya Vinoba Bhave Rural Hospital, Sawangi (Maghe), Wardha, after applying inclusion and exclusion criteria were found suitable and hence selected for the present study. Cases selected for our study were subjected to bilateral X-ray mastoid (Schuller's view with sagittal plane of the skull is parallel to the film and X-ray beam is projected 30° cephalocaudal). In select cases i.e. 55 patients and 58 ears HRCT temporal bone was done.

Inclusion Criteria

All the patients of COM (squamous type).

Exclusion Criteria

Mucosal type of COM, specific otitis media like (tuberculosis, syphilis). Granulomatous conditions of middle ear, malignancies of ear.

Study Design

A prospective observational study was carried out from July 2012 to August 2014. The study consisted of 94 patients (104 ears) of squamous type of COM.

Statistical Analysis

Statistical significance was evaluated using Chi square test.

Result and Observation

The finding thus obtained were entered in the proforma meant for this study and were analyzed. Here are the observation.

1. *Age and sex* Of the total of 94 patients, the youngest patient in our study was 7 years old while the eldest was 84 years with the mean age 28.59 ± 15.44 years. The most common age group affected with squamous type of chronic otitis media was 11–20 years (36.17 %) followed by 31–40 years (22.34 %). The detail age wise distribution of patients is given in Graph 1. In our total 94 patients 46 were males and 48

were females. Thus male to female ratio was 1:1.04. This is shown in Graph 2.

2. *Pneumatization pattern of mastoid* All of our 94 patients were subjected to X-ray mastoid lateral oblique view (Schuller's View) in order to know cellularity of mastoid. On analyzing it was found that out of 104 ears, mastoid was pneumatized in 2 (1.92 %) diploic in 20 (19.23 %) and sclerotic in 82 (78.85 %) ears. This is depicted in Table 1.
3. *Pneumatization pattern of contralateral normal mastoid* On analyzing it was found that out of 70 normal ears, mastoid was pneumatized in 30 (42.86 %) diploic in 22 (31.43 %) and sclerotic in 18 (25.71 %) ears This is shown in Graph 3.
4. *Postsuperior retraction of pars tensa and pneumatization* It has been observed that out of 104 diseased ears, 20 (19.23 %) ears had posteriosuperior retraction of pars tensa. Out of 20 ear 17 ears (85 %) had sclerotic mastoid and 3 ears (15 %) had diploic mastoid. It is displayed in Graph 4.
5. *Retraction of pars flaccida and pneumatization* During ear examination which also included otoscopy and otomicroscopy, it was observed that out of 104 diseased ear, 64 (61.54 %) ears had retraction in pars flaccid. It was observed that out of 64 ear, mastoid was diploic in 11(17.19 %) and sclerotic in 52 (81.25 %). Thus majority of the pars flaccida retraction in squamous COM were associated with sclerotic mastoid. It is shown in Graph 5.
6. *Ossicular status and pneumatization* In 55 patients (58 ears) CT scan was done. The involvement of malleus were in 42 (72.41 %) ears, incus in 57 ear (98.28 %), stapes in 17 (29.31 %) ears. It is shown in Graph 6. Among the 58 ears only incus involvement was in 15 ears (25.86 %), malleus and incus involvement was in 25 ears (43.10 %), all the ossicles involvement were in 17 ears (29.31 %) was observed. Only 1 ear (1.72 %) did not have ossicular erosion. It is shown in Graph 7. In 58 ears, in which ossicular status was studied, 47 (81.03 %) ears were sclerotic, and 10 (17.24 %) ears were diploic and none was pneumatized. It is displayed in Graph 8.

Discussion

In the present study we observed a very wide age bracket with youngest patient of 7 years of age while oldest of 84 years. The large group i.e. 34 patients (36.17 %) were in 2nd decade of life followed by 21 patients (22.34 %) in 4th decade. Ginni et al. [8] noted that patients of squamous COM are mostly affected in 3rd decade. According

Graph 1 Age wise profile of patients **Graph 2** Gender wise distribution of patients**Table 1** Pneumatization pattern of mastoid

Cellularity pattern	Right	Left	Total	Percentage (%)
Pneumatized	2	0	2	1.92
Diploic	12	8	20	19.23
Sclerotic	34	48	82	78.85
Total	48	56	104	100.00

Graph 3 Pneumatization pattern of contralateral normal mastoid

to the observations of Memon [9], chronic suppurative otitis media is a disease of young adults and about 50 % of patients were between the ages of 11–30 years. Observation that the squamousal COM is most common in third decade has also been made by Gomaa et al. [10]. Predominant presence of COM in younger decades of life observed by other investigators matches with findings of our study. Mean age of 27.9 years observed by Gerami [11] is also in close agreement with our observation. Marginally

Graph 4 Postero-superior retraction of pars tensa and pneumatization **Graph 5** Retraction of pars flacida and pneumatization

high occurrence of COM in females was found in our study with male to female ratio was 1:1.04. Gomaa et al. [10] observed in his study of squamousal COM, higher occurrence in females (53.6 %) than males (46.4 %) Similarly gender ratio in favour of females (1:1.27) was reported by Ginni et al. [9], thus endorsing our findings. Contrary to our observations Aquino et al. [12] found strong male predilection in squamousal COM (males 64.7 % and females 35.3 %).

Pneumatization Pattern in Patients of COM

All of our 94 patients (104 ears) were subjected to X-ray mastoid lateral oblique view.

(Schuller's) in order to know cellularity of mastoid. On analyzing it was found that out of 104 ears, mastoid was pneumatized in 2 (1.92 %) diploic in 20 (19.23 %) and sclerotic in 82 (78.85 %) ears. Association of low or non-

Graph 6 Ossicular erosion in squamous COM (n = 58)

Graph 7 Ossicular involvement in COM (n = 58)

Graph 8 Distribution of ossicles according to pneumatization pattern with COM (n = 58)

pneumatized mastoid with squamousal COM reported by Sade [6, 8] (82.3 %) and Gomaa et al. [10] (60.7 %) is in consonance with our observations. But contradicting most of the studies and also the present study, Isma et al. [13] found that incidence of cellular mastoid was much higher in CSOM. Comparison shown in Table 2.

Pneumatization Pattern in Contralateral Normal Ears

In one of the studies, Fatma et al. [22] reported poorly pneumatized mastoid and pneumatized mastoid in 40.7 and 60.3 % respectively, in contra lateral ears of COM with cholesteatoma. In yet another study of pneumatization pattern of contralateral ears of severe COM, in Brazil, Mauricio [23] observed 65.3 % well pneumotized, 6.7 % diploic and 28 % sclerotic. Thus our findings are not only in agreement with other studies but also supports the doctrine that pneumatization gets poorer with growing chronicity of the disease. Comparison shown in Table 3.

Retraction and Pneumatization: A Correlation

Out of 20 ears with posterosuperior retraction, mastoid was diploic in 3 (15 %) and sclerotic in 17 (85 %). whereas out of 64 ears with attic retraction, mastoid was diploic in 11 (17.19 %) and sclerotic in 52 (81.25 %), pneumatized in 1 (1.56 %). Thus majority of the postero-superior retraction and pars flaccida retraction in squamousal COM were associated with sclerotic mastoid. This result is statistically significant (P value < 0.0001).

Sade [20], in his study of pneumatization in retraction pocket noted sclerotic mastoid in 49 % and diploic mastoid in 51 % in patients. In another study of 595 ears, with intact pars tensa, of 332 adult patients. Sade [24] made a remarkable observation that degree of PF retraction was

Table 2 Comparative display of pneumatization pattern in COM

Study	Non pneumatized mastoid (%)	Pneumatized mastoid (%)
Joselito et al. [14]	100	—
Tiwari et al. [15]	92.59	7.41
Ahamed et al. [16]	92	8
Abhjeet et al. [17]	89	10.9
Shah et al. [18]	85.6	14.4
Vishawanata et al. [19]	82.7	17.3
Sade et al. [20]	82.2	17.8
Tripti et al. [21]	56	44
Isma et al. [13]	39.7	60.3
In our study	98.08	1.92

Table 3 Comparative display of pneumatization pattern in contralateral ear

Study	Contralateral ear	
	Non pneumatized mastoid (%)	Pneumatized mastoid (%)
Fatma et al. [22]	40.7	60.3
Mauricio et al. [23]	34.7	65.3
Present study	57.14	42.86

found to be inversely related to the level of mastoid pneumatization. He further noted that poorly pneumatized mastoids were associated with PF retractions. He also commented that the poorer the pneumatization, the deeper the retraction and well-pneumatized mastoids were associated with normal position of the Pars flaccida. Our observations of sclerotic mastoid in 81 % of patients with attic retraction and 68 % with postero-superior retraction lend credence to the theory of Sade.

Ossicular Erosion and Pneumatization: A Correlation

We attempted to correlate the ossicular status in squamousal COM with pneumatization pattern. For this purpose CT scan was done in 58 ears in order to know the ossicular destruction. Out of the 58 ears in which CT scan was done, 57 ears showed ossicular involvement.

All of them with ossicular involvement had either sclerotic (47 ears, 81.03 %) or diploic (10 ears, 17.24 %) mastoid. This observation in our study is comparable to the study done by the Jeng [25] wherein 77.77 % ossicular erosion was found in poorly pneumotized mastoid.

In the present study ossicular erosion was observed in 98.28 % of cases. In the similar endeavour Josilito et al. [14] found ossicular erosion in 92.19 % of cases. On

deciphering the CT scan, malleus involvement in 42 (72.41 %) ears, incus involvement in 57 ears (98.28 %) and stapes involvement in 17 (29.31 %) ears was observed. Incus was more frequently involved followed by malleus and stapes. Similar observations were echoed in the study carried out by Shah et al. [18], (incus 85.7 %, malleus 45.7 %, and stapes 31.4 %). Gomma et al. [10] noted that the incus was the most commonly eroded, in 88.2 % of patients, followed by malleus, in 67.9 %. Aasma et al. [26] found ossicular chain was eroded in 91 % out of them the malleus in 54 %, incus in 87 % and stapes in 41 % were affected. Sourabh et al. [27] in study of 60 patients found involvement of in 85 % malleus in 45 % and stapes in 51.67 %. Josilito et al. [14] in study of 62 patients found erosion incus in 75 % malleus in 40.64 % and stapes in 65.62 %. As it is evident from observations of above investigators [10, 18, 26, 27], in the chronic inflammatory process of middle ears, it is incus which bears the brunt. Among the 58 ears only incus involvement in 15 ears (25.86 %), malleus and incus involvement in 25 (43.10 %) ears, all the three ossicular involvement in 17 ears (29.31 %) was observed. Only one ears (1.72 %) did not have ossicular erosion.

Conclusion

Incus was most commonly affected of all the ossicles. Most of the diseased ear demonstrated non pneumatized mastoid (98.08 %) whereas contralateral mastoid of 70 normal ear, showed significantly more pneumatization. This difference is statistically significant ($\chi^2 = 48.20$, P value < 0.0001 , S). Significantly more sclerosis and non pneumatization in the ear with COM of squamousal type than the healthy contralateral ear supports the environmental theory. In this study we observed that non pneumatized mastoid are more commonly associated with higher degree of retraction, thus it can be stated that poorer the pneumatization deeper the retraction. All the patients having ossicular involvement had non pneumatized mastoid. Thus we would like to conclude that there exists a strong relationship between the ossicular erosion and depressed pneumatization. Further studies on this count may probably throw more light on this issue.

Compliance with Ethical Standards

Conflict of interest Dr. Amitava Roy, Dr. P.T. Deshmukh, Dr. Chandrakant Patil declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Browning GG, Merchant SN, Gerad Kelly, Swan LRC, Canter R, Mckerrow WS (2008) Chronic otitis media. In: Gleeson M, Browning GG, Burton MJ, Clarke R, Hibbert J, Jones NS et al (eds) *Scott-Brown's otorhinolaryngology, head and neck surgery*, 7th edn. Edward Arnold, Great Britain, pp 3395–3445
- Tumarkin A (1959) On the nature and significance of hypocellularity of mastoid. *J Laryngol Otol* 73(1):34–44
- Gans H, Wlodyka J (1966) Mastoid pneumatization in chronic otitis media. *Acta Otolaryngol* 83(4):343–346
- Palva T, Palva A (1966) Size of the human mastoid air cell system. *Acta Otolaryngol* 62(3):237–251
- Diamant M (1940) Otitis and pneumatization of the mastoid bone. *Acta Otolaryngol* 41:1–149
- Ueda T, Eguchi S (1961) Distribution of pneumatization of the temporal bone in chronic otitis media seen during the age of antibiotic therapy. *J Otol Rhinol Laryngol* 64:1539–1542
- Schulter-Ellis F (1979) Population differences in cellularity of the mastoid process. *Acta Otolaryngol* 87(5–6):461–465
- Datta G, Baisakhiya N, Mendiratta V (2014) Unsafe CSOM still a challenge in rural areas. *Otolaryngol Online J* 4(2):1–16
- Memon MA, Matiullah S, Ahmed Z, Marfani MS (2008) Frequency of unsafe chronic suppurative otitis media in patients with discharging ear. *JLUMHS* 7(2):102–105
- Gomma MA, Karim ARAA, Ghany HSA, Elhiny AA, Saadek AA (2013) Evaluation of temporal bone cholesteatoma and the correlation between high resolution computed tomography and surgical finding. *Clin Med Insights* 6:21–28
- Gerami H, Naghavi E, Wahabi-Moghadam M, Forghaparast K, Akbar MH (2009) Comparison of preoperative computerized tomography scan imaging of temporal bone with the intra-operative findings in patients undergoing mastoidectomy. *Saudi Med J* 30(1):104–108
- Aquino JEAPD, Cruz Filho NA, Aquino JNPD (2011) Epidemiology of middle ear and mastoid cholesteatomas. Study of 1146 cases. *Braz J Otorhinolaryngol* 77(3):341–347
- Iqbal IZ, Watson C (2012) A study of cholesteatoma and mastoid pneumatization. *Otolaryngol—Head Neck Surg* 147(2):P79
- Joselito L (2004) Middle ear cholesteatoma: characteristic CT findings in 64 patients. *Ann Saudi Med* 24(6):442–447
- Tiwari R, Samant HC, Verma DN (1991) A clinicoradiological study of cholesteatoma. *Indian J Otolaryngol* 43(3):130–135
- Ahmed MN, Kumar MM, Prasad AS, Ahmed SM, Kumar MP, Rao CV, Aghiri Nagaraju, Durga Prasad B (2014) A study of intact canal wall technique in paediatric cholesteatoma patients for 2 years in GGH, Kurnool. *J Evol Med Dent Sci* 3(34):9057–9066
- Sinha AK, Sharma AK, Ahmad Raushan E, Kumar G (2014) Bone resorption in chronic otitis media. *Int J Sci Study* 2(6):82–86
- Shah C, Shah P, Shah S (2014) Role of HRCT temporal bone in pre-operative evaluation of cholesteatoma. *Int J Med Sci Public Health* 3(1):69–72
- Viswanatha B, Naseeruddin K (2014) Complications of attic-conchal otitis media-revisited. *Adv Res* 2(11):666–695
- Sade J, Fuchs C (1994) A comparison of mastoid pneumatization in adults and children with cholesteatoma. *Eur Arch Otorhinolaryngol* 251(4):191–195
- Rai T (2014) Radiological study of the temporal bone in chronic otitis media: prospective study of 50 cases. *Indian J Otol* 20(2):48–55
- Kayhan FT, Sayin İ, Cakabay T, Yazici ZM, Kaya KH (2011) Chronic otitis media-evaluation of the contralateral ear. *KBB-Forum* 10(4):50–56
- da Silva MNL, Muller JS, Selaimen FA, Oliveira DS, Schmidt Rosito LP, Costa SSD (2013) Tomographic evaluation of the contralateral ear in patients with severe chronic otitis media. *Braz J Otorhinolaryngol* 79(4):475–479
- Jacob S, Camil F, Michal L (1997) Shrapnel membrane and mastoid pneumatization. *Arch Otolaryngol Head Neck Surg* 123(6):584–588
- Jeng FC, Tsai MH, Brown CJ (2003) Relationship of pre operative findings and ossicular discontinuity in chronic otitis media. *Otol Neurotol* 24(1):29–32
- binti Abdullah A, ORL HNS MS, Hashim SM, ORL-HNS MS, Awang MA, Saim L (2013) Outcome of canal wall down mastoidectomy: experience in sixty three cases. *Med J Malaysia* 68(3):217–221
- Varshney S, Nangia A, Bist SS, Singh RK, Gupta N, Bhagat S (2010) Ossicular chain status in chronic suppurative otitis media in adults. *Indian J Otolaryngol Head Neck Surg* 62(4):421–426