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Article

Mastoid volume and its effects on extended high frequency hearing

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Abstract: This cross-sectional analytical study aimed to investigate the possible association between extended high-frequency hearing and mastoid pneumatization. A total of 206 patients were involved in the study, and a statistically significant difference was found that the patients with higher mean mastoid volume had a response to that particular frequency when compared to patients with lesser mean mastoid volume in both the right and left ear. However, there was no statistically significant association between various age groups and responses and between gender and responses at all frequencies. The study concludes that there is a correlation between mastoid pneumatization and extended high-frequency hearing.

Keywords: Mastoid; Pneumatization; Gender; Frequency.

1. Background

After birth, the mastoid air cells are readily visible as hollowed-out spaces lined by flattened, non-ciliated squamous epithelium [1]. These air cells exhibit variability in size and extent. At the superior and anterior parts of the mastoid process, air cells are large and irregular and contain air. Towards the inferior part of the process, they diminish in size, while those at the apex of the process are frequently quite small and contain marrow. As growth continues, mastoid air cells communicate with the middle ear via the mastoid antrum and the aditus ad antrum and extend variably to petrous parts and around the inner ear [2]. Air cells may also infiltrate the zygomatic, the squamous, the styloid, and the occipital regions, resulting in accessory pneumatization. Imperatively, there is a gradual reduction in air cells throughout life with additional loss in the elderly both at the base and more reduction at the apex [3].

The mastoid air cellular system plays an important role by performing various functions from reception of sound, resonance, insulation, air reservoir action, acoustic dissipation, protection from external violence, and lightening of the weight of the skull. With its most important role being performed in middle ear physiology by acting as the reservoir of air for middle ear and help regulate the middle ear pressure. Degree of pneumatisation of the mastoid air cell system in-turn determines the functions carried out by the mastoid air cell system. Further the condition of the middle ear also determines the degree of pneumatisation. Variation in degree of pneumatisation of the mastoid air cell system is associated with various otologic diseases such as otosclerosis, Meniere's disease, secretory otitis media, middle ear barotrauma, Shrapnell membrane retraction, traumatic tympanic membrane perforation, unilateral aural atresia, congenital cholesteatoma, position of the sigmoid sinus and patulous eustachian tube [4].

Other factors that could influence the mastoid air cell system include; genetics, environment, nutrition, and diseases [5].

Poor pneumatisation is being associated with increased predisposition to secretory otitis media, atelectasis and cholesteatoma. Further good mastoid pneumatisation is ascribed to better response of SOM to treatment, success of middle-ear surgery and regulating the middle ear pressure. Thus, mastoid pneumatisation is associated with various factors influencing the middle ear functioning and pathologies which lead to various further complications including its influence on hearing. Therefore, knowledge of the size of mastoid air cells with age is beneficial to researchers in Otorhinolaryngology and Clinical Anatomy. Therefore, the degree of mastoid pneumatization can be said to have an important role in its function [6].

CT scan is the best technique to measure the volume (3-dimensional size) of the mastoid pneumatisation by allowing the reconstruction of window by three- dimensional multi-planar volume rendering (3-D MPVR) technique.

Further, the hearing sensitivity is assessed by pure tone audiometry, which is then plotted on an audiogram, displaying intensity as a function of frequency. Extended high frequency hearing threshold ranges from 9 to 20kHz. EHF testing may be a way for research opportunities by addressing the questions as in what is the impact of EHF loss generally and in specific populations (e.g. older people, ototoxicity, tinnitus, chronic OME) [7].

With this scenario, the present study was designed to estimate the mastoid pneumatization volume and its relation with extended high-frequency hearing.

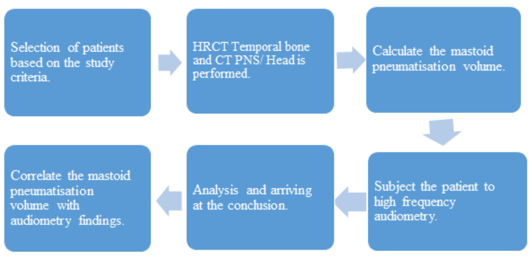
2. Method

2.1. Study Design

Cross-sectional analytical study.

2.2. Data collection

This was a study on 206 patients over a period of 18 months (October 2020 - June 2022) at the Department of Radiodiagnosis, J.S.S. Hospital, Mysuru.



3. Selection Criteria

3.1. Inclusion Criteria

1. Patients undergoing HRCT temporal bone and CT PNS/ CT head scans in the Radiology department.
2. Patients willing to undergo audiometry analysis.
3. Patients between 18 - 65 years of age.

3.2. Exclusion Criteria

1. Patients with a previous history of ear infections, trauma & CVA.
2. Pathologic conditions of the internal auditory canal.
3. Malformations of the temporal bone.
4. Prior neurological disorders.
5. Patients below 18 and above 65 years of age.

After selecting the patients according to the inclusion criteria, relevant clinical history and consent from the patient was obtained and were subjected to HRCT temporal bone and CT PNS imaging using a 128 SLICE MDCT SCANNER (Philips Healthcare - Ingenuity Core 128 v3.5.7.25001). Reconstructed slice thickness was 1.0-2.0 mm, with an increment of 0.5-1mm. The images were analyzed and the volume of mastoid air cell pneumatization was measured using SAVS / paintbrush common window.

The volume of mastoid pneumatisation was calculated and was correlated with the audiometry findings to see relationship mastoid pneumatisation and hearing at an extended range of frequencies.

4. Statistical analysis

Data was entered in MS Excel and analyzed using SPSS 21.0 version software. Qualitative data was presented in the form of proportions, and pie diagrams and bar charts were used to represent graphically. Quantitative data were presented as mean and standard deviation. Correlation coefficient with Pearson correlation, Student's t-test for the mean difference between two groups, and one-way ANOVA for mean difference over multiple groups (age groups, air cell volume categories) was used to test significance. P-value <0.05 was considered as statistically significant.

5. Results

In the present cross-sectional analytical study, a total of 206 patients satisfying the inclusion criteria were enrolled at the Department of Radio-diagnosis, J.S.S. Hospital, Mysuru, for HRCT bone and CT PNS / head.

The mean age of the patients was 35.51 years (SD 12.529 years), with a minimum age of 18 years and maximum age of 63 years. (Table 1).

Table 1. Mean age distribution of the patients

	N	Minimum	Maximum	Mean	SD
Age (years)	206	18	63	35.51	12.529

Out of 206 patients, the majority of the patients, i.e., 57 (27.7%) patients, were aged between 26 to 35 years, followed by 56 (27.2%) patients in the age range of 18 to 25 years, 42 (20.4%) patients aged 36 to 45 years, 35 (17%) patients in the age range of 46 to 55 years and 16 (7.8%) patients aged > 55 years. (Table 2 and Figure 1)

Table 2. Distribution of the patients based on age groups

Age groups	Frequency	Percent
18 to 25 yrs	56	27.2
26 to 35 yrs	57	27.7
36 to 45 yrs	42	20.4
46 to 55 yrs	35	17.0
>55 yrs	16	7.8
Total	206	100.0

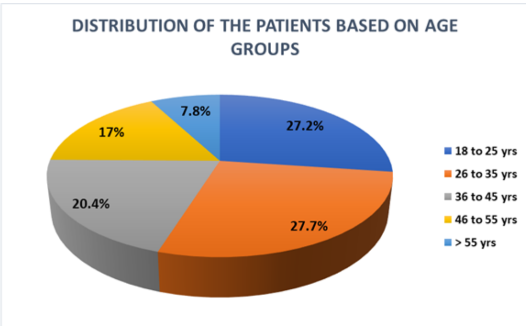


Figure 1. Distribution of the patients based on age groups

Out of 206patients, 122(59.2%) were males and 84(40.8%) were females showing male predominance. (Table 3 and Figure 2)

Table 3. Distribution of the patients based on gender

Gender	Frequency	Percent
Females	84	40.8
Males	122	59.2
Total	206	100.0

Table 4. Comparison of the mean mastoid volume based on the response to different frequencies (right ear) using independent sample t-test

Frequency	Response	N and %	Mastoid volume			S.D	Mean diff	p-value
			Minimum	Maximum	Mean			
8 kHz	No Response	8(3.9%)	2.2	7.9	5.05	1.76	-1.24	0.037*
	Response Present	198(96.1%)	2.1	10.4	6.30	1.64		
10 kHz	No Response	16(7.8%)	2.2	8.0	5.04	1.67	-1.30	0.002*
	Response Present	190(92.2%)	2.1	10.4	6.35	1.62		
12 kHz	No Response	23(11.2%)	2.2	8.0	5.17	1.59	-1.22	0.001*
	Response Present	183(88.8%)	2.1	10.4	6.39	1.62		
14 kHz	No Response	34(16.5%)	2.1	8.0	5.06	1.59	-1.42	0.001*
	Response Present	172(83.5%)	2.5	10.4	6.48	1.57		
16 kHz	No Response	42(20.4%)	2.1	8.6	5.21	1.66	-1.30	0.001*
	Response Present	164(79.6%)	2.5	10.4	6.51	1.56		
18 kHz	No Response	59(28.6%)	2.1	9.5	5.41	1.64	-1.17	0.001*
	Response Present	147(71.4%)	2.5	10.4	6.59	1.55		
20 kHz	No Response	77(37.4%)	2.1	9.5	5.55	1.53	-1.12	0.001*
	Response Present	129(62.6%)	2.5	10.4	6.67	1.60		

*Significant

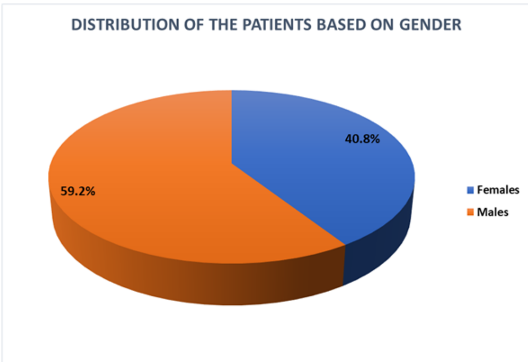


Figure 2. Distribution of the patients based on gender

In the right ear, observation was noted that the patients with higher mastoid volume (mean) had response to all the frequencies. Independent sample t-test showed a statistically significant difference between the groups (based on response) at all the frequencies ($p \leq 0.05$). (Table 4 and Figure 3)

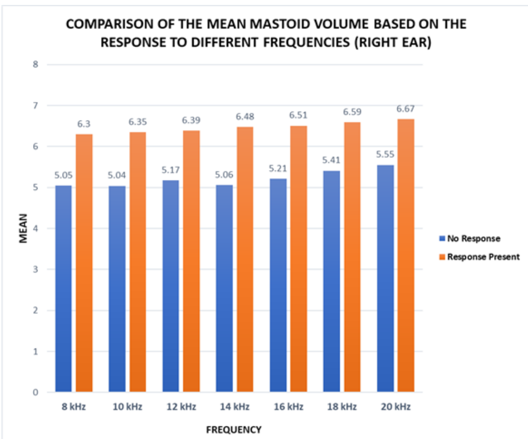


Figure 3. Comparison of the mean mastoid volume based on the response to different frequencies (right ear) using independent sample t-test

In the left ear, observation was noted that the patients with higher mastoid volume (mean) had response to all the frequencies. Independent sample t-test showed a statistically significant difference between the groups (based on response) at all the frequencies ($p \leq 0.05$). (Table 5 and Figure 4)

Table 5. Comparison of the mean mastoid volume based on the response to different frequencies (left ear) using independent sample t-test

Frequency	Response	N and %	Mastoid volume			S.D	Mean diff	p value
			Minimum	Maximum	Mean			
8 kHz	No Response	8(3.9%)	2.2	7.9	5.05	1.76	-1.25	0.037*
	Response Present	198(96.1%)	2.1	10.4	6.30	1.64		
10 kHz	No Response	16(7.8%)	2.2	8.0	5.04	1.67	-1.30	0.002*
	Response Present	190(92.2%)	2.1	10.4	6.35	1.62		
12 kHz	No Response	24(11.7%)	2.2	8.0	5.05	1.65	-1.35	0.001*
	Response Present	182(88.3%)	2.1	10.4	6.41	1.60		
14 kHz	No Response	34(16.5%)	2.1	8.0	5.06	1.59	-1.42	0.001*
	Response Present	172(83.5%)	2.5	10.4	6.48	1.57		
16 kHz	No Response	42(20.4%)	2.1	8.6	5.21	1.66	-1.30	0.001*
	Response Present	164(79.6%)	2.5	10.4	6.51	1.56		
18 kHz	No Response	59(28.6%)	2.1	9.5	5.41	1.64	-1.17	0.001*
	Response Present	147(71.4%)	2.5	10.4	6.59	1.55		
20 kHz	No Response	77(37.4%)	2.1	9.5	5.55	1.53	-1.12	0.001*
	Response Present	129(62.6%)	2.5	10.4	6.67	1.60		

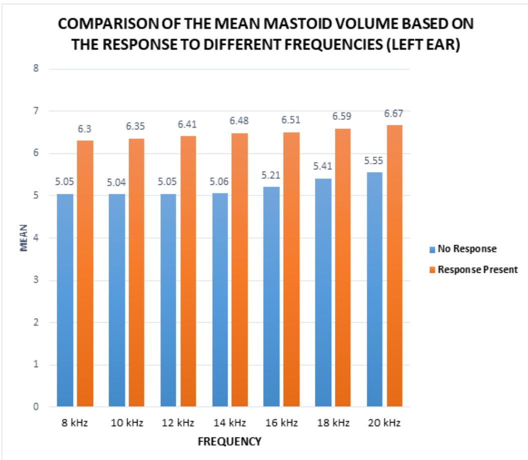


Figure 4. Comparison of the mean mastoid volume based on the response to different frequencies (left ear) using independent sample t-test

Out of 206 patients, 129 (62.6%) patients had response to 20 kHz. In the present study, Chi-square test was applied to find the association between age groups and responses at different frequencies which showed no statistically significant association between age groups and responses at all the frequencies. (Table 6 and Figure 5)

Table 6. Distribution of the responses based on age groups

Frequencies			Age groups					Total	Chi-square value	p value
			18 to 25 yrs	26 to 35 yrs	36 to 45 yrs	46 to 55 yrs	>55 yrs			
8kHz	No response	Count	2	3	0	3	0	8	4.7	0.318
		%	3.6%	5.3%	0.0%	8.6%	0.0%	3.9%		
	Response Present	Count	54	54	42	32	16	198		
		%	96.4%	94.7%	100.0%	91.4%	100.0%	96.1%		
10kHz	No response	Count	5	6	0	4	1	16	4.95	0.29
		%	8.9%	10.5%	0.0%	11.4%	6.3%	7.8%		
	Response Present	Count	51	51	42	31	15	190		
		%	91.1%	89.5%	100.0%	88.6%	93.8%	92.2%		
12kHz	No response	Count	7	7	3	5	1	23	1.59	0.81
		%	12.5%	12.3%	7.1%	14.3%	6.3%	11.2%		
	Response Present	Count	49	50	39	30	15	183		
		%	87.5%	87.7%	92.9%	85.7%	93.8%	88.8%		
14kHz	No response	Count	10	9	5	8	2	34	1.95	0.74
		%	17.9%	15.8%	11.9%	22.9%	12.5%	16.5%		
	Response Present	Count	46	48	37	27	14	172		
		%	82.1%	84.2%	88.1%	77.1%	87.5%	83.5%		
16kHz	No response	Count	13	10	7	10	2	42	2.97	0.56
		%	23.2%	17.5%	16.7%	28.6%	12.5%	20.4%		
	Response Present	Count	43	47	35	25	14	164		
		%	76.8%	82.5%	83.3%	71.4%	87.5%	79.6%		
18kHz	No response	Count	21	15	8	13	2	59	7.47	0.113
		%	37.5%	26.3%	19.0%	37.1%	12.5%	28.6%		
	Response Present	Count	35	42	34	22	14	147		
		%	62.5%	73.7%	81.0%	62.9%	87.5%	71.4%		
20kHz	No response	Count	25	19	10	17	6	77	6.83	0.145
		%	44.6%	33.3%	23.8%	48.6%	37.5%	37.4%		
	Response Present	Count	31	38	32	18	10	129		
		%	55.4%	66.7%	76.2%	51.4%	62.5%	62.6%		

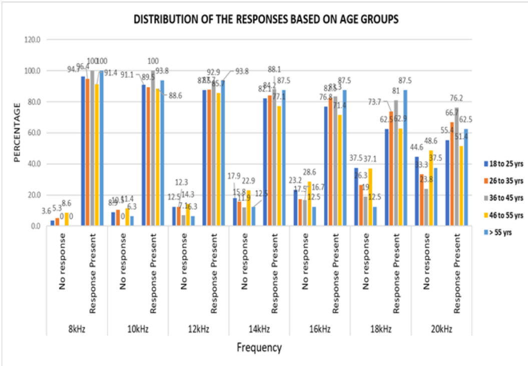


Figure 5. Distribution of the responses based on age groups

Chi-square test was applied to find the association between gender and responses at different frequencies which showed no statistically significant association between gender and responses at all the frequencies. (Table 7 and Figure 6)

Table 7. Distribution of the responses based on gender

Frequencies			Gender		Total	Chi-square value	p value
			Females	Males			
8kHz	No response	Count	5	3	8	1.62	0.202
		%	6.0%	2.5%	3.9%		
	Response Present	Count	79	119	198		
		%	94.0%	97.5%	96.1%		
10kHz	No response	Count	10	6	16	3.39	0.06
		%	11.9%	4.9%	7.8%		
	Response Present	Count	74	116	190		
		%	88.1%	95.1%	92.2%		
12kHz	No response	Count	13	10	23	2.65	0.103
		%	15.5%	8.2%	11.2%		
	Response Present	Count	71	112	183		
		%	84.5%	91.8%	88.8%		
14kHz	No response	Count	18	16	34	2.49	0.11
		%	21.4%	13.1%	16.5%		
	Response Present	Count	66	106	172		
		%	78.6%	86.9%	83.5%		
16kHz	No response	Count	19	23	42	0.43	0.51
		%	22.6%	18.9%	20.4%		
	Response Present	Count	65	99	164		
		%	77.4%	81.1%	79.6%		
18kHz	No response	Count	24	35	59	0.001	0.98
		%	28.6%	28.7%	28.6%		
	Response Present	Count	60	87	147		
		%	71.4%	71.3%	71.4%		
20kHz	No response	Count	31	46	77	0.014	0.907
		%	36.9%	37.7%	37.4%		
	Response Present	Count	53	76	129		
		%	63.1%	62.3%	62.6%		

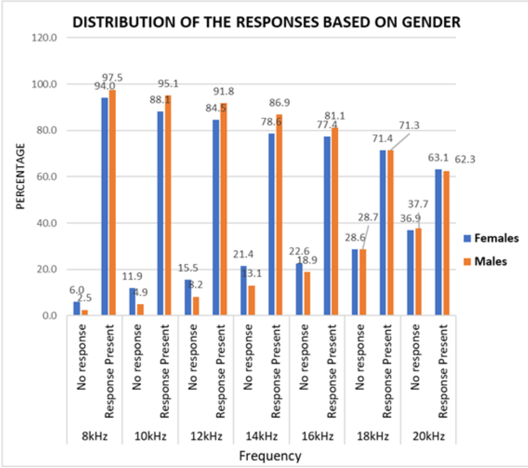


Figure 6. Distribution of the responses based on gender

6. Discussion

After birth, the mastoid air cells are readily visible as hollowed-out spaces lined by flattened, non-ciliated squamous epithelium. These air cells exhibit variability in size and extent [8]. At the superior and anterior parts of the mastoid process, air cells are large and irregular and contain air. Towards the inferior part of the process, they diminish in size, while those at the apex of the process are frequently quite small and contain marrow. As growth continues, mastoid air cells communicate with the middle ear via the mastoid antrum and the aditus ad antrum and extend variably to petrous parts and around the inner ear [9]. Air cells may also infiltrate the zygomatic, the squamous, the styloid, and the occipital regions, resulting in accessory pneumatization. Imperatively, there is a gradual reduction in air cells throughout life with additional loss in the elderly both at the base and more reduction at the apex [10].

The mastoid air cellular system plays an important role by performing various functions from reception of sound, resonance, insulation, air reservoir action, acoustic dissipation, protection from external violence, and lightening of the weight of the skull. With its most important role being performed in middle ear physiology by acting as the reservoir of air for middle ear and help regulate the middle ear pressure. Degree of pneumatisation of the mastoid air cell system in-turn determines the functions carried out by the mastoid air cell system. Further the condition of the middle ear also determines the degree of pneumatisation. Variation in degree of pneumatisation of the mastoid air cell system is associated with various otologic diseases such as otosclerosis, Meniere's disease, secretory otitis media, middle ear barotrauma, Shrapnell membrane retraction, traumatic tympanic membrane perforation, unilateral aural atresia, congenital cholesteatoma, position of the sigmoid sinus and patulous eustachian tube [11].

Other factors that could influence the mastoid air cell system include; genetics, environment, nutrition, and diseases [12].

Poor pneumatisation is being associated with increased predisposition to secretory otitis media, atelectasis and cholesteatoma. Further good mastoid pneumatisation is ascribed to better response of SOM to treatment, success of middle-ear surgery and regulating the middle ear pressure. Thus, mastoid pneumatisation is associated with various factors influencing the middle ear functioning and pathologies which lead to various further complications including its influence on hearing. Therefore, knowledge of the size of mastoid air cells with age is beneficial to researchers in Otorhinolaryngology and Clinical Anatomy. Therefore, the degree of mastoid pneumatization can be said to have an important role in its function.

CT scan is the best technique to measure the volume (3-dimensional size) of the mastoid pneumatisation by allowing the reconstruction of window by three- dimensional multi-planar volume rendering (3-D MPVR) technique.

Further, the hearing sensitivity is assessed by pure tone audiometry, which is then plotted on an audiogram, displaying intensity as a function of frequency. Extended high frequency hearing threshold ranges from 9 to 20kHz. EHF testing may be a way for research opportunities by addressing the questions as in what is the impact of EHF loss generally and in specific populations (e.g. older people, ototoxicity, tinnitus, chronic OME).

With this scenario, the present study was designed to estimate the mastoid pneumatization volume and its relation with extended high-frequency hearing.

In the present cross-sectional analytical study, a total of 206 patients satisfying the inclusion criteria were enrolled at the Department of Radio-diagnosis, J.S.S. Hospital, Mysuru, for HRCT temporal bone and CT PNS / CT head. The mean age of the patients was 35.51years (SD: ±12.529), with a minimum age of 18 years and maximum age of 63 years. Out of 206 patients, the majority of the patients were aged between 26 to 35 years (27.7%) with the least being the patients aged > 55 years (7.8%).

Only one study utilized a 10-year age grouping utilized volumetric measurements of mastoid air cells among the Korean population, showed that mastoid aeration grows and increases at a faster rate from birth to the early 2nd decade of life. Between the late 2nd and 3rd decades of life, the air cells continue to grow slowly. It slowly declines after the 3rd decade of life, then rapidly after the 7th decade of life. The volume of air cells among females increases rapidly but experiences an earlier slow growth rate [14].

Aladeyelu *et al.*, is the first coping review on the size of mastoid air cells with respect to age. Since the first study conducted on the growth of the mastoid air cell system with age conducted by Diamant, very few studies have reported the size of mastoid air cells with respect to age involving different age groupings and measurement methods [15].

Yavuz Selim Pata *et al.*, in 2004, conducted a study to possibly investigate the relationship between the presbycusis and volume of mastoid pneumatization, which was carried out on 21 patients with presbycusis and 21 normal subjects of similar ages. The pneumatized volume was measured by computed tomography of temporal bone with slice thickness of 2mm. They concluded that no significant difference was found between the presbycusis patients and normal subjects in terms of volume of mastoid pneumatization [16].

O. Cirpar *et al.*, in 2014, conducted a study which involved 46 subjects employed in the press and montage department of a gun factory with 28 subjects in the study group with noise-induced hearing loss and 18 subjects in the control group with no hearing loss. The volume of mastoid pneumatization was measured with computed tomography. They concluded that there was no significant correlation between mastoid pneumatization volume and chronic noise-induced hearing loss. However, they cited limitation owing to small number of subjects with a suggestion that there could possibly be a significant correlation in further studies with large number of subjects [17].

In the present study, patients with higher mean mastoid volume of both right and left ear had response at all the frequencies with statistically significant difference between the groups (based on response) at all the frequencies ($p \leq 0.05$) using Independent sample t-test. That is, the patients with higher mean mastoid volume had response to that particular frequency when compared to patients with lesser mean mastoid volume.

Out of 206 patients, 129 (62.6%) patients had full response to 20 kHz. However, there was no statistically significant association between age groups and response and between gender and responses at all the frequencies based on Chi-square test.

From age-related studies that considered sex, the size of mastoid air cells was larger in females until puberty with rapid growth. This could be a reflection of females' early initiation of general physical growth . However, studies that considered ages above puberty reported that the mastoid air cells in males became larger after puberty with a corresponding increase in size and growth rate. In the present study, no significant association was noted between the gender and response at all the frequencies.

In ENT and its related surgeries, the interest in the size of mastoid air cells and its importance arose from the association between temporal bone aeration and otitis media either as a cause or a consequence. It may also be considered when planning chronic ear and middle ear surgeries. This is because the mastoid air cell system has been noted as an air reservoir for the middle ear and the volume of air cells governs the capacity of this reservoir. A small mastoid air cell has also been linked to chronic middle ear disease. In human development and growth, the size of mastoid air cells has been well-documented to increase with age. Both areas and volumes can measure the size of mastoid air cells. However, volumetric measurements likely give the foremost comprehensive insight to appreciate the estimate of mastoid air cells because it measures three-dimensional space while area gives only surface (2D) information [18].

Volumetric estimation of mastoid air cells with age was limited to three studies. Although the study reported the mean volume of air cells in children (0-10 years) to be 3813.85 mm3 and adults (19-44 years) to be 7095.20 mm3, there is a lack of information on the volume of air cells in the suggested three stages of development of temporal bone pneumatization owing to the large age grouping employed in their study.

This is the first study to examine the possible effects of mastoid pneumatization volume on extended high frequency hearing. In our study, the patients with higher mean mastoid pneumatization volume had response at all frequencies compared to patients with smaller mean mastoid volume with significant correlation. However, statistical association could not be demonstrated between the age group, gender with respect to response to different frequency.

7. Conclusions

Based on the results of the present cross sectional analytical study following conclusions could be drawn.

- Statistically significant difference is observed in the mean mastoid volume of the right and left ear based on responses between the groups at all frequencies.
- No statistical difference was noted between age groups and response and between gender and responses at all frequencies with respect to mastoid volume and extended high-frequency hearing.
- On an average, response to extended high frequency hearing was noted with percentage of 92.2% to 10kHz, 88.8% to 12kHz, 83.5% to 14kHz, 79.6% to 16kHz, 71.4% to 18kHz and 62.6% to 20kHz.

8. Limitations

Though this study was performed in order to establish the relation between the mastoid volume and its effect on extended high frequency hearing, certain limitations were noted: This study did not include the elderly age group (age > 65years).

- This study did not include the presbycusis cases.
- This study did not include subjects with inner ear injuries.
- This study did not consider the evaluation of subgroups challenged by certain ototoxic factors - ototoxic drugs, loud nose aging, genetic defects of inner ear.

9. Recommendations

Based on our study, assessment, statistical analysis and results we have come to the afore- described conclusions and wish to make the following recommendations:

- Subjects with low mastoid volume are likely to encounter high frequency hearing loss and need to be worked up with high frequency audiometry.
- Noise induced high frequency hearing loss is well established and incidental/ additional low mastoid volume in these subjects may contribute as independent risk factor.
- Further studies with higher patient volume to assess various risk factors contributing to high frequency hearing loss is needed to better understand etiopathogenesis.

List of abbreviations

DM -Diploic mastoid
EAC - External auditory canal
SCC - Semi-circular canals
SS - Sigmoid sinus
TMJ - Temporomandibular joint
NSS - National sample survey
EHFA - Extended high-frequency audiometry
NIHIL - Noise-induced hearing loss
BMI - Body mass index
CNKI - China national knowledge infrastructure
DRHT - Detection rate of hearing threshold
HRCT - High resolution computed tomography
PNS - Paranasal sinuses
TM - Tympanic membrane
kHz- Kilo Hertz
DHL - Disabling hearing loss

MACS - Mastoid air cell system

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Conflicts of Interest: "Authors declare no conflict of interests."

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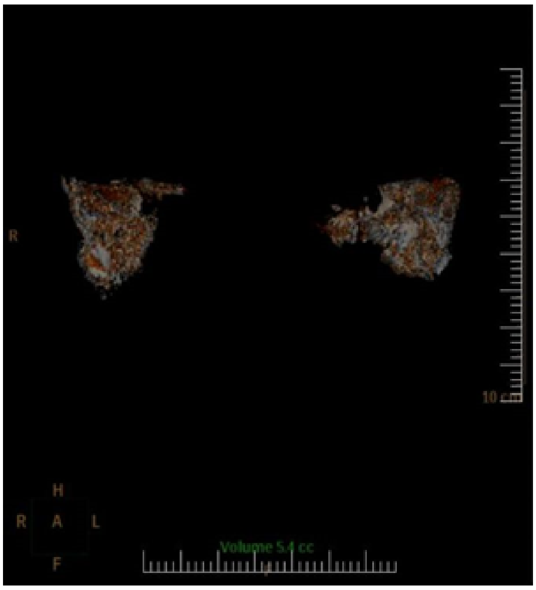

Figure 7. Case of 27 year old male, with 3D volumetric reconstruction image showing average volume of 5.4cc (Right ear - 5.3cc; Left ear - 5.5cc)

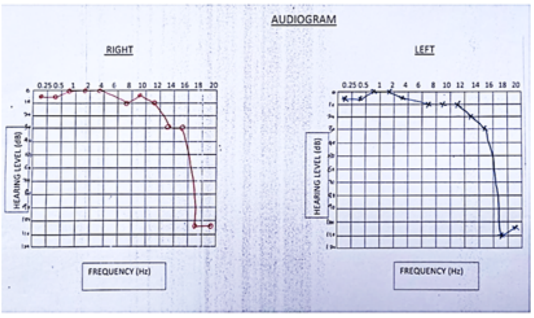

Figure 8. Audiogram depicting response to frequency of 20kHZ (Hearing level : Right -105 dB; Left: 105dB) in the same patient

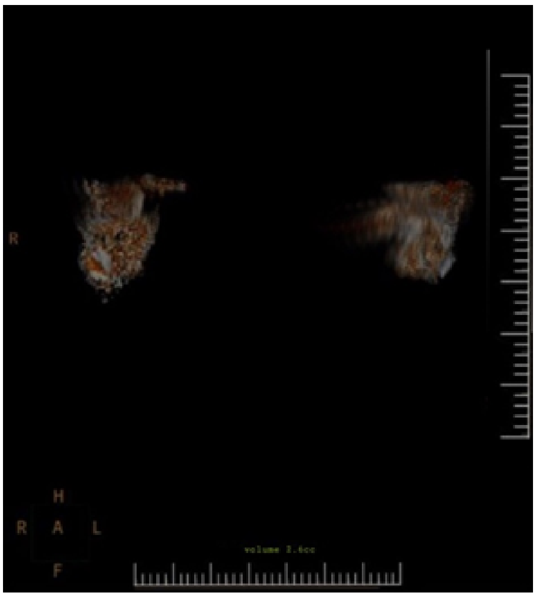

Figure 9. Case of 23 year old male, with 3D volumetric reconstruction image showing average volume of 2.6cc (Right ear - 3.0cc; Left ear - 2.2cc)

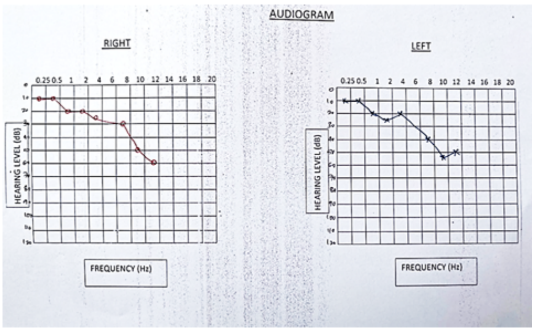

Figure 10. Audiogram depicting response to frequency of 12kHZ (Hearing level: Right - 60dB ; Left: 50dB) in the same patient

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