

Prevalence and Characteristics of the Articular Tubercle on Cone Beam Computed Tomography: A Retrospective Study

SOUNDARYA RAMESH¹, POORNIMA GOVINDRAJU², BALAJI PACHIPULUSU³

ABSTRACT

Introduction: Pneumatisation represents areas of minimal resistance, making it easier for the expansion of numerous pathological processes such as tumours, infections, or fractures into the joint. Detection of these air-filled cavities is necessary before planning surgical intervention in order to prevent complications.

Aim: To assess the prevalence and characteristics of Pneumatisation of the Articular Eminence of the Temporal Bone (PAT) in the Bengaluru population.

Materials and Methods: A retrospective study was conducted in the Department of Oral Medicine and Radiology at an esteemed Dental College and Hospital in Bengaluru, Karnataka, India. The study lasted for 13 months, from March 2019 to February 2020. The study included Cone Beam Computed Tomography (CBCT) images of 133 patients (84 males and 49 females) aged between 20-80 years. Based on age, the study

group was divided into five groups with an age interval of 10 years, and the prevalence, laterality, and type of pneumatisation of the articular eminence were assessed. The obtained data were statistically analysed using the Chi-square test and McNemar's test with a significance level of p-value <0.05.

Results: Out of the 133 CBCT images evaluated, PAT was noticed in 62 subjects, with an overall prevalence of 46.6%. The highest prevalence of pneumatisation (62.5%) was present in the age group of 61-70 years, followed by 53.8% in the 31-40 years age group. A male predilection was noted with the maximum prevalence during the sixth decade, followed by the third decade of life. There was an equal distribution in terms of laterality, and the multilocular type of pneumatisation was more common than the unilocular type.

Conclusion: The prevalence of PAT was 46.6% and was predominantly seen in males compared to females. Multilocular PAT was more commonly seen than unilocular PAT.

Keywords: Articular eminence, Pneumatisation, Temporal bone, Temporomandibular joint

INTRODUCTION

Air-filled cavities that are generally found in the skull are termed as Pneumatisation [1]. According to Tyndall DA and Matteson SR, Paroxysmal Atrial Tachycardia (PAT) is defined as the appearance of air cells in the root of the zygomatic arch and in the articular eminence of the temporal bone [2]. The aetiology of PAT is not known but might be comparable to other pneumatised areas of bone within the body, such as the mastoid process. The pneumatisation of the temporal bone serves vital purposes, such as lowering the skull's weight and shielding the inner ear from external air pressure changes. However, when they are present near the Temporomandibular Joint (TMJ), they can lead to complications during surgical procedures of the TMJ and articular eminence. They reduce the bony resistance, leading to perforation, which can cause the invasion of the joints with infection, tumours, or other degenerative diseases [3]. PAT can be observed using CBCT, which provides superior results for TMJ imaging [4,5].

The prevalence of pneumatised articular tubercle using Orthopantomogram (OPG) has a strong body of literature supporting it [6]. Hence, the present research aimed to evaluate the prevalence and characteristics of articular eminence pneumatisation in the Bengaluru (South Indian) population using CBCT and to associate PAT with age and gender.

MATERIALS AND METHODS

A retrospective study was conducted in the Department of Oral Medicine and Radiology at Rajarajeswari Dental College and Hospital, Bengaluru, Karnataka, India. The study lasted for 13 months, from March 2019 to February 2020. Institutional Ethical Committee clearance (RRDCET/01OMR/2018) was obtained, following the

standardised ethical principles of the Helsinki Declaration. The data was collected from archives spanning from 2016 to 2019.

Inclusion criteria: The study included CBCT images of TMJ with the articular eminence visible in sagittal, axial, and coronal sections.

Exclusion criteria: CBCT images showing pathologies such as cysts or tumours in the TMJ region, evidence of fracture of TMJ and its surrounding areas and images with errors or artifacts obscuring visibility of structures in the TMJ region were excluded from the study.

Sample size calculation: The sample size was estimated using the formula:

$$N = Z^2(1-\alpha) \times PQ / \delta^2$$

$$Z(1-\alpha) = 1.96$$

(for 95% confidence interval) p-value=0.77 (based on literature suggesting a 76.7% prevalence of PAT in adults) [7] Q=1-P δ (margin of error)=0.10. Considering a design effect of 2.0 for sampling variation for the selected scans, the estimated total sample size for the study was 132.

Study Procedure

The study included 133 samples, comprising 84 males and 49 females, ranging in age from 20 to 80 years, who underwent CBCT radiographic examination at the Institute. The CBCT images of the samples were randomly selected from the archives which were taken for the purpose of implant assessment, orthodontics, or maxillofacial pathologies. Subjects signed informed consent forms, ensuring their privacy and understanding the use of their images for research. Patients were scanned using CBCT machines (Scanora 3D, Soredex Finland, ONDEMAND 3D, 4.0-12.5 mA, 60-90 kVp). The study group was divided into five age groups, with a 10-year difference between each group. The age and gender of

all subjects were recorded, and pneumatization was identified as a well-defined radiolucent area in the articular eminence posterior to the zygomaticotemporal suture [1,2]. The locularity and laterality of PAT were also noted in patients with pneumatization. PAT was classified as unilocular or multilocular based on Tyndall DA and Matteson SR's classification (1985) [2]. Unilocular PAT was defined as a single radiolucent area/cavity with well-defined bony borders [Table/Fig-1-3], whereas multilocular PAT [Table/Fig-2-4] consisted of numerous small radiolucent cavities. The prevalence of these structures was analysed based on age, gender, and sides, and the data was subjected to statistical analysis.



[Table/Fig-1]: Unilocular pneumatization of articular eminence (sagittal section of CBCT).



[Table/Fig-2]: Bilateral pneumatization of articular eminence (coronal section of CBCT) unilocular pneumatization on right-side and multilocular pneumatization on left-side.



[Table/Fig-3]: Bilateral pneumatization of articular eminence (axial section of CBCT) multilocular pneumatization on right-side and unilocular pneumatization on left-side.



[Table/Fig-4]: Multilocular pneumatization of articular eminence (sagittal section of CBCT).

STATISTICAL ANALYSIS

In the present study, descriptive and inferential statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 22.0, 2013, published by (IBM Corp., Armonk, NY). The purpose was to compare the prevalence, laterality, and locularity of pneumatization based on the age and gender of the study subjects. The Chi-square test was used for comparisons. To assess the locularity of pneumatization between the right and left sides of the study subjects, McNemar's test was used. The level of significance (p-value) was set at p<0.05.

RESULTS

Out of the 133 CBCT scans evaluated, PAT was observed in 62 subjects, resulting in an overall prevalence rate of 46.6% [Table/Fig-5]. The age group of 61-70 years had the highest prevalence of pneumatization at 62.5%, followed by 53.8% in the 31-40 years age group [Table/Fig-6]. When comparing genders, pneumatization was more common in male subjects compared to females [Table/Fig-7].

Variable	Category	n (%)
Pneumatization	Absent	71 (53.4)
	Present	62 (46.6)

[Table/Fig-5]: Prevalence of Pneumatization among study subjects.

Age (in years)	Absent	Present	χ^2 value	p-value
	n (%)	n (%)		
20-30	24 (58.5)	17 (41.5)	4.165	0.38
31-40	18 (46.2)	21 (53.8)		
41-50	10 (58.8)	7 (41.2)		
51-60	13 (65.0)	7 (35.0)		
61-70	6 (37.5)	10 (62.5)		

[Table/Fig-6]: Age-wise comparison of prevalence of pneumatization in study subjects by using Chi-square test.

Gender	Absent	Present	χ^2 value	p-value
	n (%)	n (%)		
Males	44 (52.4)	40 (47.6)	0.092	0.76
Females	27 (55.1)	22 (44.9)		

[Table/Fig-7]: Gender-wise comparison of prevalence of pneumatization among study subjects using Chi-square test.

Among the 62 subjects with pneumatization, 31 showed unilateral PAT, while bilateral PAT was present in the remaining 31 subjects, indicating an equal distribution in terms of laterality [Table/Fig-8]. Out of these patients, 64 exhibited a multilocular appearance, while 29 displayed unilocularity [Table/Fig-9], signifying a higher prevalence of the multilocular type of PAT [Table/Fig-9]. Specifically, 18 subjects on the right side and 11 subjects on the left side showed unilocularity,

whereas 31 subjects on the right side and 33 subjects on the left side exhibited multilocularity [Table/Fig-10].

Variable	Category	n (%)
Laterality	Unilateral	31 (50)
	Bilateral	31 (50)

[Table/Fig-8]: Distribution of laterality of pneumatization among study subjects.

Locularity	Total	p-value
Unilocular	29	0.55
Multilocular	64	

[Table/Fig-9]: Comparison of locularity between right and left-sides among study subjects using McNemar's test (N=133).

Locularity	Right-side	Left-side	p-value
	n (%)	n (%)	
Unilocularity	18 (36.7)	11 (25)	0.55
Multilocularity	31 (63.3)	33 (75)	

[Table/Fig-10]: Comparison of locularity between right and left-sides among study subjects using McNemar's test.

DISCUSSION

The present study revealed the prevalence of PAT to be 46.6%. In the literature, its prevalence has been reported to range between 8% and 51% using Computed Tomography (CT) or CBCT [6]. The initial CBCT study by Miloglu O et al., found a prevalence rate of 8% in the Turkish population [6]. The study done by Ladeira DB et al., also showed an increased prevalence rate of 21.3% in the Brazilian population [8]. The prevalence of PAT on CBCT scans in the present study was almost similar to the study conducted by Ilguy M et al., in the German population [9]. Other studies by Kalyani AV et al., in the Indian population, Mosavat F and Ahmadi A in the Iranian population [10,11], Khojastepour L et al., in the Iranian population, Delilbasi C et al., in the Turkish population, Bhalchim SG et al., in the Indian population, Ferrer R et al., in the Venezuelan population, Heim N et al., in the German population as shown in [Table/Fig-11] [6-9,11-15]. The discrepancy may be explained by a number of variables, such as sample size, sample type, ethnicity, demographic mix, and imaging modality type [7].

S. No.	Author's name and year	Place of study	n	Type of imaging modality	Prevalence (%)	Age distribution (in years)
1	Miloglu O et al., 2011 [6]	Turkey	514	CBCT	8	15-62
2	Ladeira DB et al., 2013 [8]	Brazil	658	CBCT	21.3	11-85
3	Delilbasi C et al., 2013 [12]	Turkey	825	CBCT	2.54	18-91
4	Ilguy M et al., 2015 [9]	Germany	111	CBCT	65.8	17-81
5	Mosavat F and Ahmadi A, 2015 [11]	Iran	239	CBCT	14	18-81
6	Khojastepour L et al., 2018 [7]	Iran	327	CBCT	76.7	7-65
7	Bhalchim SG et al., 2018 [13]	Mumbai, India	200	CBCT	12.5	5-91
8	Heim N et al., 2018 [15]	Germany	300	HRCT	10	10-60
9	Ferrer R et al., 2019 [14]	Venezuela	200	CT	15.5	1-79
10	Present study	Bengaluru, India	133	CBCT	46.6	20-70

[Table/Fig-11]: Prevalence of Pneumatization of Articular eminence of Temporal bone (PAT) in the literature [6-9,11-15].

CBCT: Cone beam computed tomography; HRCT: High-resolution computed tomography

In the present study, the distribution of articular eminence air cells with respect to age is found to be statistically non-significant (p=0.38), which is in agreement with previous studies by Miloglu O et al., Khojastepour L et al., Ladeira DB et al., Ilguy M et al., Kalyani AV et al., Mosavat F and Ahmadi A, Delilbasi C et al., [6-12]. The distribution of pneumatized articular eminence with respect to gender is found to be statistically non-significant (p=0.76). This conclusion is reasonable given that the phenomenon is not sex-related [8]. However, the present study revealed that male subjects (47.6%) showed a slightly higher prevalence when compared to females (44.9%). This is in accordance with previous studies by Khojastepour L et al., Kalyani AV et al., Delilbasi C et al., Heim N et al., [7,10,12,15]. In contrast to the present study, Miloglu O et al., Ladeira DB et al., Ilguy M et al., Mosavat F and Ahmadi A reported a higher female prevalence of PAT [6,8,9,11].

The prevalence of unilateral and bilateral PAT in the current study is 31 (50%) and 31 (50%) respectively, and statistically non-significant. This is consistent with the previous study conducted by Dina M and Beshlawy EL [16]. Previous studies by Miloglu O et al., Ladeira DB et al., Kalyani AV et al., Mosavat F and Ahmadi A, Delilbasi C et al., showed a slightly higher unilateral distribution, and Khojastepour L et al., showed a slightly higher bilateral distribution when compared to the present study [6-8,10-12]. This difference in ratio could result from the difference in the region of interest [8].

In terms of the type of pneumatization, the present study reported a higher prevalence of the multilocular type, which is consistent with previous studies by Miloglu O et al., Khojastepour L et al., Ladeira DB et al., Delilbasi C et al., [6-8,12]. The previous study conducted by Mosavat F and Ahmadi A revealed a higher prevalence of the unilocular type, and this difference may be due to CBCT's use, which can clearly show images of air cells around the TMJ, enabling a closer examination of finer details of the anatomical structure [11].

PAT should be differentiated from other unilocular/multilocular radiolucencies such as aneurysmal bone cyst, hemangioma, giant cell tumour, eosinophilic granuloma, fibrous dysplasia, and metastasis. The distinguishing feature is that all these lesions are symptomatic and may show destructive radiographic features compared to PAT [8].

From the present study, given the significance of temporal air cells, it is recommended that the prevalence of PAT be evaluated in every population. CBCT images are precise and reliable for identifying the type of pneumatization and their relationship to adjacent tissues. For a more realistic picture of PAT, additional research should be conducted in large population and with particular patient groups.

Limitation(s)

The limitations of the present study include a limited sample size and a retrospective research design. Therefore, further studies need to be conducted using a larger sample size.

CONCLUSION(S)

The prevalence of PAT was 46.6% and was predominantly seen in males compared to females. Multilocularity was more commonly observed than unilocularity. The presence of PAT can predict the presence of large pneumatized areas in other portions of the temporal bone, which increases the risk of postoperative complications. Therefore, having a complete understanding of these pneumatized structures is crucial during surgical procedures to avoid serious complications. CBCT can be considered the finest imaging modality for evaluating PAT due to its diagnostic accuracy.

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PARTICULARS OF CONTRIBUTORS:

1. Consultant, Department of Oral Medicine and Radiology, AM Medical Centre, Kolkata, India.
2. Professor, Department of Oral Medicine and Radiology, Rajarajeswari Dental College and Hospital, Bangaluru, Karnataka, India.
3. Professor, Department of Oral Medicine and Radiology, Rajarajeswari Dental College and Hospital, Bangaluru, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Balaji Pachipulusu,
Professor, Department of Oral Medicine and Radiology, Rajarajeswari Dental College and Hospital, Bangaluru-560074, Karnataka, India.
E-mail: drbalaji_24@rediffmail.com

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