



RESEARCH ARTICLE

EVALUATION OF PNEUMATIZATION OF THE ARTICULAR EMINENCE USING CONE BEAM  
COMPUTED TOMOGRAPHY IMAGING

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ABSTRACT

**Objectives:** This study was conducted with an objective to determine the prevalence and characteristics of pneumatization of articular eminence (PAT) using Cone Beam Computed Tomography (CBCT) imaging.

**Material and Methods:** A retrospective observational study was carried out in the Department of Oral Medicine and Radiology, which included CBCT images of 62 patients in which TMJ region was completely visualized. The demographic details of the patient viz. age, gender were retrieved from their records. These scans were evaluated in sagittal, coronal and axial section using Kodak dental imaging software. Tyndall and Matteson criteria were used for diagnosis and characterization of PAT. Evaluation of both right and left side was done and the frequency and characteristics of PAT were recorded. Frequencies/percentages and chi-square test were used for statistical analysis.

**Results:** Of the 62 patients included in the study 40.3% showed presence of PAT. Of these pneumatization, 38% were unilocular whereas 26% were multilocular in characteristic. Presence of pneumatization was correlated with unilocular and multilocular variety of PAT was statistically significant ( $p < 0.05$ ) for both.

**Conclusion:** To avoid serious complications that may arise due to pneumatization, all surgeries related to TMJ should be carried out after evaluation with CBCT. CBCT is a good tool for imaging TMJ and related structures with the added advantage of low radiation dose compared to CT.

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INTRODUCTION

Pneumatization is defined as the asymptomatic presence or development of air filled cavities in the bone. Pneumatization is seen to occur in the mastoid process of the temporal bone after puberty. When pneumatization is seen within the zygomatic process of the temporal bone, they are known as the pneumatized articular eminence (Khojastepour et al., 2015). There are about ten locations where accessory air cells can be found within the temporal bone, including an area in the zygomatic process of the temporal bone (Miloglu et al., 2011). The term pneumatized articular eminence (PAT) was introduced by Tyndall and Matteson in 1985 to describe accessory air cells which occur in the zygomatic arch and in the articular eminence of the temporal bone which is similar to air cells in the mastoid process (Orhan et al., 2006). Carter et al in 1999 re-emphasized the occurrence of this phenomenon and

named these air cells as zygomatic air cell defect (ZACD) (Stoopler et al., 2003; Romano-Sousa and Garritano-Papa, 2015). Pneumatization of the temporal bone can be divided into five regions namely the middle ear, mastoid (squamosmastoid), perilyabyrinthine, petrous apex and accessory (Khojastepour et al., 2015; İlgüy et al., 2015; Virapongse et al., 1985). Detection of pneumatization close to the TMJ is important as they represent site of minimal resistance and thus facilitate the spread of various pathologies into the joint such as inflammation, tumor or fractures (Groell and Fleischmann, 1999). Also, in cases where it is necessary to surgically manipulate the articular eminence, PAT should be considered a complicating factor. Determination of these structures prior to surgical intervention may be helpful in the prevention of possible complications (Miloglu et al., 2011; Srikanth et al., 2010; Wafaa Al-F and Ibrahim, 2005; Roser et al., 1976).

MATERIALS AND METHODS

After approval from Institutional ethical committee and Scientific advisory committee, a retrospective observational study was conducted in the Department of Oral Medicine and

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Radiology. It included CBCT scans of 62 patients, with complete visualization of the articular eminence of right and left side. Images of low resolution quality or with metallic artifacts obscuring articular eminence visualization and scans of patients with a fracture or pathology in the region of the articular eminence were excluded. 62 full FOV (17X13 cm) CBCT scans of 124 TMJ, made with Kodak CS 9300 machine (76-100kVp, 12 mA, 18.6 rotation time resolution 90-300  $\mu$ m, slice thickness 0.09mm to 0.3mm) were evaluated between 1 June 2016 to 31 July 2016 using Carestream software. Scan images were assessed by calibrated Oral and Maxillofacial Radiologists under standard viewing conditions on a monitor for the presence and characteristics of PAT on axial, sagittal and coronal section. Diagnosis of PAT was done as per the characteristics described by Tyndall and Matteson which indicated that the pneumatized articular eminence (PAT) of the temporal bone represents an asymptomatic radiolucent defect in the zygomatic process of the temporal bone with an appearance similar to mastoid air cells (Tyndall and Matteson, 1985).

#### The common characteristics of PAT include

- 1) "An asymmetric radiolucent defect in the zygomatic process of the temporal bone with the appearance similar to mastoid air cells".
- 2) "Extension of the defect anteriorly as far as the articular tubercle but not beyond the zygomatico-temporal suture" and

- 3) "No enlargement or cortical destruction of the zygoma" (Khojastepour *et al.*, 2015).

The parameters considered and recorded in the present study were:

1. Pneumatization of articular eminence was present or absent.
2. Pneumatization was unilocular (Fig. 1) or multilocular (Fig. 2).
3. Pneumatization was unilateral or bilateral (Fig. 3)

The data thus collected was tabulated and subjected to statistical analysis, which included Frequencies/percentages and chi-square test.

## RESULTS

Total 62 CBCT scan including 38 males and 24 females were included in the study. The age range was from 19 year to 65 year and the mean age was 33.8. Out of 62 CBCT scans, pneumatization of articular eminence was found in 25 (40.3%) scans. Out of 38 males, 16 males (42.1%) showed presence of pneumatization. Out of 24 females, 9 females (37.5%) showed PAT (Table 1). Out of 25 scans, 18 (72%) scans had unilateral pneumatization of which 12 (63.15%) were unilocular and 6 (33.33%) were multilocular. Out of 25 scans, 7 (28%) scans showed bilateral pneumatization of which 2 (28.57%) were unilocular, 2 (28.57%) were multilocular and 3 (42.85%) were

**Table 1. Prevalence of Pneumatization**

S.No.	Pneumatization		Unilocular		Multilocular	
	Male	Female	Right	Left	Right	Left
1.	25 (40.3%)		19(38%)		13(26%)	
2.	16(42.1%)	9(37.5%)	14(73.63%)	5(26.31%)	7(12.4%)	6(88.57%)

**Table 2. Pneumatization according to Characteristics**

	Unilocular	Multilocular	Mixed	Total
Unilateral	12	6	-	18
Bilateral	2	2	3	7
Mixed	3	3	-	-

**Table 3. Statistical correlation**

	Gender	Age	Pneumatization	Unilocular	Multilocular
Gender	r = 1	r = -0.083 p= 0.52	r = -0.46 p = 0.724	r = -0.117 p= 0.364	r = -0.083 p= 0.819
Age	r = -0.083 p= 0.52	r = 1	r = -0.028 p = 0.831	r = 0.001 p= 0.995	r = -0.150 p= 0.246
Pneumatization	r = -0.46 p= 0.724	r = -0.028 p = 0.831	r = 1	r = 0.600** p = 0.00	r = 0.513** p = 0.00
Unilocular	r = -0.117 p= 0.364	r = 0.001 p = 0.995	r = 0.600** p = 0.00	r = 1	r = -0.27 p = 0.838
Multilocular	r = -0.083 p= 0.819	r = -0.150 p = 0.246	r = 0.513** p = 0.00	r = -0.27 p = 0.838	r = 1

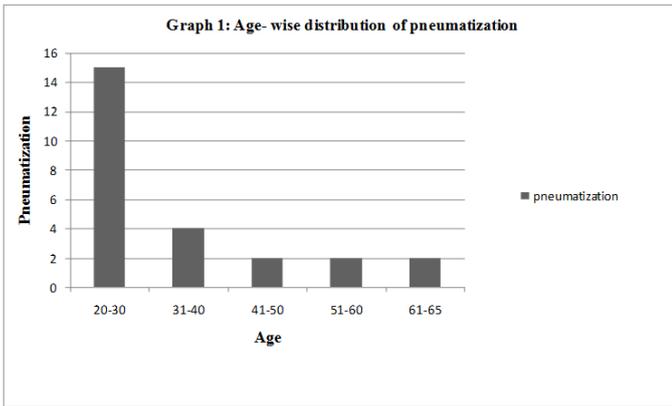
\*\* correlation is significant at the level 0.01 level (2 tailed)

r = pearson correlation, p = statistical significance.

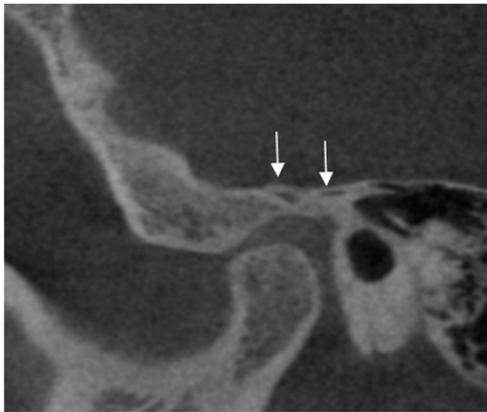
**Table 4. Comparison of present study with previous studies with respect to age & gender distribution and characteristics of pneumatization**

Parameter	Present study (CBCT)	Mehmet et al (CBCT)	Leila et al (Panoramic)	Shrikant et al (Panoramic)	Miloglu (CBCT)	Groell et (CBCT)
Pneumatization (% prevalence)	40.3%	65.8%	2.10%	2.5%	8.0%	25.5%
Gender wise prevalence of Pneumatization	M-42.10% F-37.5%	M-51.3% F-73.6%	M-0.3% F-1.8%	M-1.1% F-1.3%	M-39.0% F-61.0%	-
Age wise prevalence of Pneumatization	33.8	48.86	33.23	34.12	30.6	-
Unilocular variant	38%	13.9%	-	0.3%	41.5%	-
Multilocular variant	26%	86.1%	3.5%	2.1%	58.5%	-

M-male, F-female, CBCT-Cone Beam Computed Tomography.



**Fig.1. Unilocular pneumatization of articular eminence**



**Fig.2. Multilocular pneumatization of articular eminence**



**Fig.3. Axial section showing bilateral pneumatization**



**Fig.4. Coronal section showing unilocular pneumatization**

of mixed variety (Table 2). 19 (38%) scans showed unilocular radiolucencies, 14 (73.68%) on right side and 5 (26.31%) on left side. 13 (26%) scans showed multilocular radiolucencies, 7 (12.4%) on right side and 6 (88.57%) on left side (Table 1). Presence of pneumatization was correlated with unilocular and multilocular variety of PAT and was found to be statistically significant ( $p < 0.05$ ) and ( $p < 0.05$ ) respectively (Table 3).

## DISCUSSION

Diagnosis of PAT has become increasingly important as their presence may lead to spread of infection into the joint area and fractures owing to minimal resistance and surgical procedures of temporal bone and even lead to surgical complications (Miloglu *et al.*, 2011; Kulikowski *et al.*, 1982). Though many studies have been carried out using Orthopantomography and CT, imaging with CBCT image will give better visualization of the area with low dose of radiation dose to the patient as well as increased multiplanar imaging accuracy. This study was conducted to find out the prevalence and characteristics of pneumatization of articular eminence using CBCT Scans. Prevalence of pneumatization in our study was found to be 40.3% which was slightly less than study conducted by Mehmet *et al.* (65.8%) and higher than the studies by Leila *et al.* (2.10%) Shrikant *et al.* (2.5%) O Miloglu (8.0%) and Groell *et al.* (25%) (Table 3) (Khojastepour *et al.*, 2015; Miloglu *et al.*, 2011; Orhan *et al.*, 2006; İlgüy *et al.*, 2015; Groell and Fleischmann, 1999; Roser *et al.*, 1976). Pneumatization can be divided into three stages, the infantile which is from birth to two years of age, the transitional from two to five years, and thereafter in adulthood. In infantile stage mastoid undergoes gradual enlargement with migration of air cell towards the periphery. Pneumatization ceases during adulthood. Age group included in our study was between 19-65 years i.e. in adulthood stage. In our study youngest patient who had pneumatization was of 20 years of age. Accessory air cells begin to pneumatize after puberty (Shokariand Naruzi, 2013). In the current study, maximum number of pneumatization was found between age group 21-30 years (Graph 1) and the mean age was 33.8 which was similar to Tyndall and Matteson and various other studies by Leila *et al.*, Shrikant *et al.* and Miloglu *et al.* Mean age was higher in study conducted by Mehmet *et al.* 48.86. (Table 4) (Khojastepour *et al.*, 2015; Orhan *et al.*, 2006; İlgüy *et al.*, 2015; Groell and Fleischmann, 1999; Tyndall and Matteson, 1985). 22 males and 15 females were present in the study, and 16 (42.10%) males and 9 (37.5) females showed

presence of pneumatization. Female to male ratio in our study was 1:2. Male predilection was seen in our study where 61.3% males and 38.7% females had pneumatization, where as in other studies female predilection was seen. There is no basis for this to be correlated to sex.

As far as characteristics of pneumatization was concerned, higher percentage of unilocular pneumatization was seen in O Miloglu's study which was 41.5% where as in our study it was 38%. Most of the pneumatization in our study was unilocular. Mehmet *et al* and Shrikant *et al* had reported the prevalence of unilocular variants as 13.9% and 0.3% respectively. Higher percentage of multilocular pneumatization was seen in study done by Mehmet *et al* which was 86.1%, where as in our study it was 26%. All the other studies showed higher percentage of multilocular radiolucency where as in our study, unilocular radiolucency was more prevalent (Table 4) (Miloglu *et al.*, 2011; Stoopler *et al.*, 2003; İlgüy *et al.*, 2015; Groell and Fleischmann, 1999). Presence of pneumatization was correlated with unilocular and multilocular variety of PAT and was found to be statistically significant ( $p < 0.05$ ) and ( $p < 0.05$ ) respectively. PAT also must be differentiated from other radiolucent images within the zygomatic bone which many time have unilocular and multilocular appearance e.g. aneurysmal bone cyst, hemangiomas, metastatic tumors, giant cell tumor, myxoma as many of them are destructive lesions (Miloglu *et al.*, 2011). And also in many cases they may give an indication for route of spread of infection. Hence a careful evaluation of the imaging characteristics must be carried out. Etiological correlation and relevance of presence of PAT in TMJ disorders was not included in the scope of present study and subsequent studies are required for the same. We also recommend further studies with larger sample size to establish this correlation.

### Conclusion

Prevalence of pneumatization in our study is 40.3%. CBCT is a good tool for evaluation of pneumatization of articular eminence, as it is better visualized than in any other imaging techniques. Though they are present as incidental findings, the Oral and Maxillofacial Radiologist and Surgeons should be aware of pneumatization and be able to diagnose it to avoid future complications prior to any surgery related to TMJ. Because of the seriousness of complications that may be expected, all surgeries related to TMJ especially that which involves articular eminence and its neighbouring structures CBCT evaluation of the area should be carried out.

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None

### No conflicts of interest

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