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# Evaluation of articular eminence pneumatization using cone beam computed tomography

C. DELILBASI <sup>1</sup>, K. ORHAN <sup>2</sup>, M. ICEN <sup>3</sup>, S. AKSOY <sup>3</sup>, S. HORASAN <sup>5</sup>, S. KENAN KOSE <sup>6</sup>

**Aim.** Knowledge about the anatomy of the temporomandibular joint (TMJ) and its surrounding structures is mandatory for success in surgical interventions and for understanding the pathway of spread of infections in this region. This study aims to investigate the anatomy and morphology of pneumatized articular eminence (PAT) using cone beam computed tomography (CBCT) imaging in a group of patients.

**Methods.** A retrospective study on 825 patients (377 males, 448 females) aged between 18 and 91 years was performed using sagittal and coronal CBCT images. PAT was defined as non-expansile, nondestructive cyst-like radiolucency in the zygomatic process of the temporal bone, which appears similar to the mastoid air cells. It was classified in two groups as unilocular and multilocular. Statistical comparison of gender, age and localization was performed using chi-square test and correspondence analysis.  $P < 0.05$  was considered as significant.

**Results.** Twenty-eight pneumatized articular eminence were found in 21 patients, representing a prevalence of 2.54%. Patients with PAT had a mean age of 28.9 years with a range of 21-78 years. Ten cases (47.6%) occurred in females and 11 cases (52.4%) occurred in males. The results of statistical tests showed no significant differences among the groups with respect to gender, age, and localization ( $P > 0.05$ ).

**Conclusion.** Pneumatization of the articular eminence is a challenging entity for TMJ

<sup>1</sup>Department of Oral and Maxillofacial Surgery  
Istanbul Medipol University School  
of Dentistry Istanbul, Turkey

<sup>2</sup>Ankara University  
Department of Dentomaxillofacial Radiology  
Faculty of Dentistry, Ankara, Turkey

<sup>3</sup>Department of Dentomaxillofacial Radiology  
Faculty of Dentistry  
Bulent Ecevit University, Zongulelak, Turkey

<sup>4</sup>Teknodent Imaging Center, Istanbul, Turkey

<sup>6</sup>Department of Biostatistics Ankara University  
Faculty of Medicine Ankara, Turkey

surgery and spread of infections in this region. Practitioners who are dealing with TMJ surgery and pathology should have detailed information about this anatomical variation since it may cause serious complications.

**KEY WORDS:** Temporomandibular joint - Radiography, panoramic - Cone-beam computed tomography.

Pneumatization refers to the development of air-filled cavities in bone. In addition to the major paranasal sinuses, accessory air cells may arise in numerous locations in the skull, including the temporal, either singly or in cluster.<sup>1-5</sup> The phrase of pneumatized articular eminence (PAT) was introduced by Tyndall and Matteson to describe accessory air cells which occur in the root of the zygomatic arch and in the articular eminence of the temporal bone that are similar to air

Corresponding author: C. Delilbasi, Istanbul Medipol University School of Dentistry, Department of Oral and Maxillofacial Surgery, Ataturk Bulvari No:27, 34083 Fatih, Istanbul, Turkey. E-mail: cdelilbasi@yahoo.com

cells in the mastoid process and ethmoid bone.<sup>6</sup> Studies about the mastoid air cell system and temporal bone pneumatization have been discussed and the distribution of temporal bone pneumatization has previously been described in the literature.<sup>1, 2, 6-8</sup> Pneumatization in the articular eminence can be challenging to the surgeon during the surgery, since serious complications can be encountered.

Air cells in the articular eminence of the temporal bone can be seen on panoramic radiographs and most of the studies about the subject have been conducted using panoramic radiographs.<sup>1, 2, 6-8</sup> The use of cone beam computed tomography (CBCT) for identifying PAT is very limited in the literature.<sup>9</sup> Hence, it was considered worthwhile to determine the prevalence and characteristics of PAT in a group of Turkish patients in order to make a contribution to studies about pneumatization of the temporal bone.

### Materials and methods

Eight-hundred and twenty-five patients (377 men and 448 women) ranging in age from 18 to 91 years (mean: 37.82 years) who had craniofacial CBCT scans were retrospectively investigated. The age distribution of the study population was presented in Figure 1. CBCT images were taken for

various purposes such as preimplant imaging, paranasal sinus examinations, temporomandibular joint (TMJ) examinations or orthodontic purposes. CBCT scans were made with Newton 3G (Quantitative Radiology s.r.l., Verona, Italy). The imaging protocol used a 9-inch field of view to include the mandibular and maxillary anatomy. The axial slice thickness was 0.3 mm, and the voxels were isotropic. Cases in which the zygomatic arch was not adequately seen for technical reasons and the cases, that had maxillofacial fracture history or having maxillofacial anomalies, were not included. The study protocol was approved by the local Ethical Committee.

Blind fashion to the clinical status of the patient, an oral and maxillofacial radiologist examined the radiographs. The age and sex were recorded for all patients and for the cases of PAT; gender, age, localization and radiographic appearance were noted as well. Diagnosis of PAT on the radiographs was done only if unequivocal pneumatization of the articular eminence could be seen or if the defect was located in the articular eminence posterior to the zygomaticotemporal suture as a well-defined uni- or multilocular radiolucency. PAT was classified as unilocular or multilocular as in the study by Tyndall and Matteson.<sup>6</sup> Unilocular PAT was identified as single radiolucent oval defect with well-defined bony borders. Multilocu-

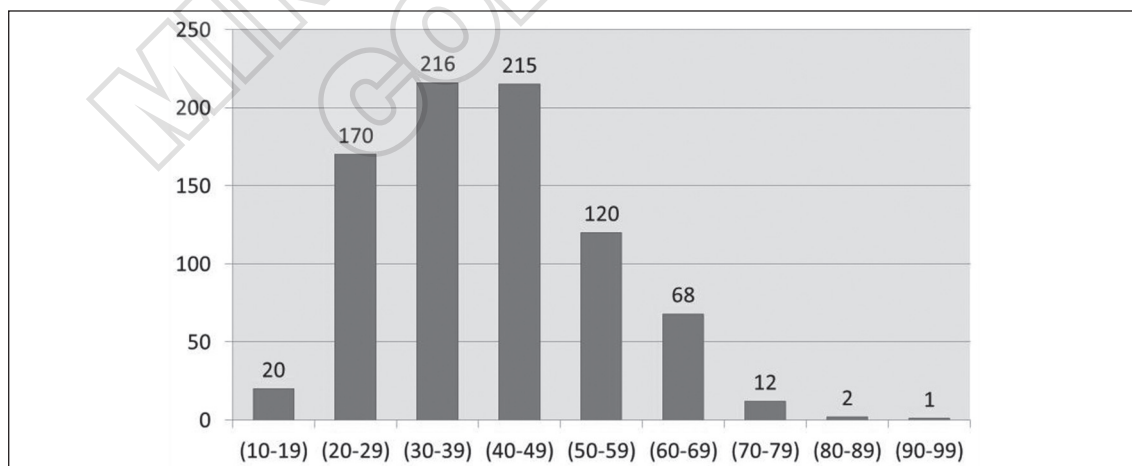


Figure 1.—Age distribution of 825 patients by decade.

lar PAT was identified as numerous radiolucent small cavities.

*Statistical analysis*

Statistical analyses were performed using the SPSS 15.0 program (SPSS Inc, Chicago, IL, USA) for WINDOWS. Comparison of gender, age and localization in patients with PAT was performed using chi-square test and correspondence analysis.  $P < 0.05$  was considered significant.

**Results**

Twenty-eight pneumatized articular eminences were found in 21 patients, representing a prevalence of 2.54%. Patients with PAT

had a mean age of 28.9 (SD 3.13) years with a range of 21-78 years. Ten cases (47.6%) occurred in females and 11 cases (52.4%) occurred in males. All cases were located in the zygomatic process of the temporal bone, did not extend anteriorly beyond the zygomaticotemporal suture, and lacked expansile or destructive characteristics. The mean age of males was 32.7 (SD 2.54) years with a range of 21-78 years while mean age of females was 24.6 (SD 3.9) years with a range of 21-25 years (Figure 2). A total of 28 PATs were detected; unilateral PAT was found in 14 cases (66.6%), with 6 cases on the right and 8 cases on the left. Bilateral PAT was found in 7 cases (33.4%) and an example of this finding was shown in Figure 3.

Two subgroups of PAT were examined;

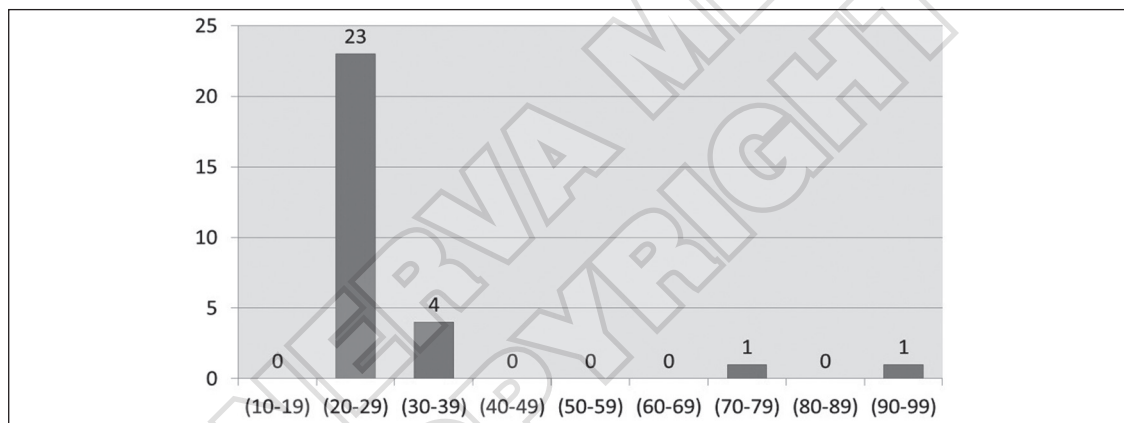


Figure 2.—Age distribution of patients with PAT (N.=28).



Figure 3.—Bilateral appearance of PAT.

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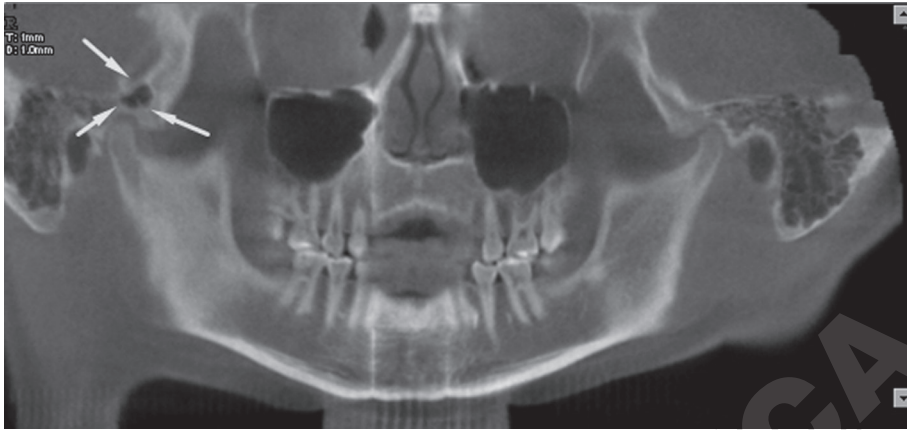


Figure 4.—Unilocular appearance of PAT.

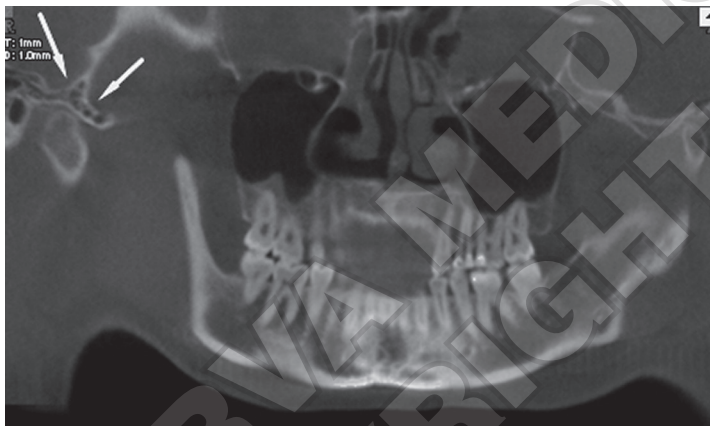


Figure 5.—Multilocular appearance of PAT.

unilocular PAT was identified as single radiolucent oval defect with well-defined bony borders (Figure 4). Seven of the PATs were unilocular type. Multilocular PAT was identified as numerous radiolucent small cavities, which resemble mastoid air cells (Figure 5). Twenty-one of the PATs were multilocular type. The Chi-square tests showed no statistical significant differences with respect to gender, localization and age ( $P>0.05$ ).

### Discussion

The first study on the prevalence of PAT was reported by Tyndall and Matteson in 1985 by using panoramic radiographs. They reported a prevalence of 2.6% (28 cases) in 1061 cases.<sup>6</sup> Orhan *et al.* conducted a study

on 1006 panoramic radiographs. They reported PAT prevalence of 1.88% (19 cases) of which 63.1% (12 cases) was in females and 36.9% in males (7 cases). Bilateral PAT was found in 36.9% of cases (7 cases).<sup>2</sup> Yavuz *et al.* investigated the prevalence of PAT in 8107 panoramic radiographs. The prevalence was found to be 1.03% (83 cases). Forty-one of the cases were females and 42 were males. PATs were located on the right side in 60 cases and on the left side in 50 cases. A total of 110 PATs were observed of which 44 were unilocular and 66 were multilocular. Fifty-six cases had unilateral and 27 cases had bilateral PATs.<sup>8</sup> Miloglu *et al.* carried out a study using CBCT in 514 cases. PAT was found in 8% of cases (41 cases) of whom 61% was female (25 cases) and 39% was male (16 cases). Age range

of patients with PAT was 15-62 years with a mean of 30.6 years. Bilateral PAT was detected in 24.4% cases (10 cases) and unilateral PAT was detected in 75.6% cases (31 cases). Detected PATs were unilocular in 41.5 cases (17 cases) and multilocular in 58.5% cases (24 cases). The authors mentioned that prevalence of PAT is higher than suspected; therefore, panoramic radiographs should be supported with CBCT before surgical interventions in the region.<sup>9</sup> Recently, Laderia *et al.* investigated pneumatization of the glenoid fossa (PGF) and articular eminence (PAT) with CBCT in 658 patients. The prevalence of PGF and PAT was 38.3% and 21.3%, respectively. Considering the TMJ, PAT was found in 15.5% of the patients and PGF was found in 30.2% of the patients. They concluded that prevalence of PAT and PGF is higher than previously reported.<sup>10</sup>

We found a PAT prevalence of 2.54% which is higher than most of the studies using panoramic radiographs but lower than that of Miloglu *et al.*<sup>9</sup> and Laderia *et al.*<sup>10</sup> This study contributes to a few studies about CBCT and anatomical variations of the TMJ and emphasizes the use of CBCT for detecting such entities.

Panoramic radiograph is a useful technique to diagnose the PAT, since posterior aspect of the zygomatic arc is usually displaced. Computed tomography (CT) can be used for evaluating bone surface and air spaces in the skull. CT is not subject to superimposition, and it is superior to plain radiographs for evaluating temporal air spaces. Also less superficially located (*i.e.*, medial portion of the articular eminence) air cells, adjacent to TMJ may only be visible on CT.<sup>3</sup> CBCT provides high-resolution multiplanar images and delivers substantially lower radiation dose, compared with multislice CT. CBCT is useful for TMJ evaluation without superimposition and distortion for bone morphology analysis. The diagnostic efficacy of CBCT is as good as conventional CT and better than panoramic radiography. More accurate images and a lower radiation dose enable CBCT to be commonly preferred modality. These quali-

fications make CBCT a growing imaging technique to evaluate osseous components of TMJ.<sup>11-13</sup>

It is not necessary to perform a treatment for PAT, but it can be an obstacle when eminoplasty or eminectomy is planned. Although small pneumatizations may not be contraindication for surgical interventions, Lindenmuth and Clark warned the surgeons about knowing the details of PAT.<sup>3</sup> PAT is important as it is on the pathway of spread of pathological lesions and infections, fractures may occur in the TMJ region owing to minimal resistance due to pneumatization. During TMJ surgery, perforation can occur because of firm dissection or forceful flap retraction. Besides, while inserting fossa-eminence prosthesis between condyle and skull base, special care is needed to avoid screw perforation. During the operation, special care must be taken while using osteotoms and burs to avoid unintentional penetration into the defect.<sup>8, 14, 15</sup> In order to be safe, the anesthesiologist should perform Valsalva manoeuvre on the patient to control dural tear. The defect must be observed for the presence of cerebrospinal fluid leakage.<sup>4, 15</sup>

Temporal air spaces play an important role in suppuration of various pathological processes. Tumors of the mastoid process and ear may extend into the TMJ, whereas otitis media or otomastoiditis may involve the TMJ and may result in ankylosis.<sup>1, 2, 15, 16</sup>

## Conclusions

In this study, it is figured out that pneumatization of accessory air cells can be accurately detected using CBCT. Practitioners who are interested in TMJ surgery and pathology should have detailed information about anatomical variations in the region. This will prevent misdiagnose and operative complications thus will enhance the result of treatment. Furthermore, advanced radiological techniques such as CBCT are useful to support panoramic radiographs to detect anatomical variations in the bone.

## Riassunto

*Valutazione della pneumatizzazione dell'eminanza articolare tramite tomografia computerizzata a fascio conico*

**Obiettivo.** La conoscenza dell'anatomia dell'articolazione temporo-mandibolare (ATM) e delle strutture circostanti è indispensabile per il successo degli interventi chirurgici e per la comprensione del percorso di diffusione delle infezioni in questa regione. Questo studio si propone di indagare l'anatomia e la morfologia dell'eminanza articolare pneumatizzata (PAT) tramite tomografia computerizzata a fascio conico (CBCT) in un gruppo di pazienti.

**Metodi.** Uno studio retrospettivo su 825 pazienti (377 maschi, 448 femmine) di età compresa tra i 18 ei 91 anni è stato eseguito utilizzando immagini CBCT sagittali e coronali. La PAT è stata definita come radiotrasparenza simil-cistica non espansiva e non distruttiva nel processo zigomatico dell'osso temporale, che appare simile alle cellule mastoidee. È stata classificata in due gruppi come uniloculare e multiloculare. Il confronto statistico di genere, età e localizzazione è stato effettuato utilizzando il test del chi-quadrato e l'analisi delle corrispondenze.  $P < 0,05$  è stato considerato significativo.

**Risultati.** Ventotto casi di eminanza articolare pneumatizzata sono stati riscontrati in 21 pazienti, che rappresentano una prevalenza del 2,54%. I pazienti con PAT avevano un'età media di 28,9 anni, con un range di 21-78 anni. Dieci casi (47,6%) si sono verificati nelle femmine e 11 casi (52,4%) nei maschi. I risultati dei test statistici non hanno mostrato differenze significative tra i gruppi per quanto riguarda sesso, età e localizzazione ( $P > 0,05$ ).

**Conclusione.** La pneumatizzazione dell'eminanza articolare è una materia difficile per la chirurgia dell'ATM e la diffusione delle infezioni in questa regione. I professionisti che si occupano di chirurgia e patologia ATM dovrebbero avere informazioni dettagliate su questa variante anatomica in quanto può causare gravi complicazioni.

**PAROLE CHIAVE:** Articolazione temporo-mandibolare - Radiografia panoramica - Tomografia Computerizzata a fascio conico.

## References

1. Orhan K, Delilbasi C, Orhan AI. Radiographic evaluation of pneumatized articular eminence in a group of Turkish children. *Dentomaxillofac Radiol* 2006;35:365-70.

2. Orhan K, Delilbasi C, Cebeci I, Paksoy C. Prevalence and variations of pneumatized articular eminence: a study from Turkey. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005;99:349-54.
3. Lindenmuth JE, Clark MS. Pneumatization of the articular eminence. *Cranio* 1986;4:86-7.
4. Hofmann T, Friedrich RE, Wedl JS, Schmelzle R. Pneumatization of the zygomatic arch on pantomography. *Mund Kiefer Gesichtschir* 2001;5:173-9.
5. Ganc DT, Jyung RW. Temporal bone pneumatization in otosclerosis. *Otolaryngol Head Neck Surg* 2008;139:850-3.
6. Tyndall DA, Matteson SR. Radiographic appearance and population distribution of the pneumatized articular eminence of the temporal bone. *J Oral Maxillofac Surg* 1985;43:493-7.
7. Orhan K, Oz U, Orhan AI, Ulker AE, Delilbasi C, Akcam O. Investigation of pneumatized articular eminence in orthodontic malocclusions. *Orthod Craniofac Res* 2010;13:56-60.
8. Yavuz MS, Aras MH, Güngör H, Büyükkurt MC. Prevalence of the pneumatized articular eminence in the temporal bone. *J Craniomaxillofac Surg* 2009;37:137-9.
9. Miloglu O, Yilmaz AB, Yildirim E, Akgul HM. Pneumatization of the articular eminence on cone beam computed tomography: prevalence, characteristics and a review of the literature. *Dentomaxillofac Radiol* 2011;40:110-4.
10. Ladeira DB, Barbosa GL, Nascimento MC, Cruz AD, Freitas DQ, Almeida SM. Prevalence and characteristics of pneumatization of the temporal bone evaluated by cone beam computed tomography. *Int J Oral Maxillofac Surg* 2013;42:771-5.
11. Barghan S, Merrill R, Tetradis S. Cone beam computed tomography imaging in the evaluation of the temporomandibular joint. *J Calif Dent Assoc* 2010;38:33-9.
12. Barghan S, Tetradis S, Mallya S. Application of cone beam computed tomography for assessment of the temporomandibular joints. *Aust Dent J* 2012;57(Suppl 1):109-18.
13. Hill CA, Richtsmeier JT. A quantitative method for the evaluation of three-dimensional structure of temporal bone pneumatization. *J Hum Evol* 2008;55:682-90.
14. Kaugars GE, Mercuri LG, Laskin DM. Pneumatization of the articular eminence of the temporal bone: prevalence, development, and surgical treatment. *J Am Dent Assoc* 1986;113:55-7.
15. Kulikowski BM, Schow SR, Kraut RA. Surgical management of a pneumatized articular eminence of the temporal bone. *J Oral Maxillofac Surg* 1982;40:311-3.
16. de Rezende Barbosa GL, Nascimento MD, Ladeira DB, Bomtorim VV, da Cruz AD, Almeida SM. Accuracy of digital panoramic radiography in the diagnosis of temporal bone pneumatization: A study in vivo using cone-beam-computed tomography. *J Craniomaxillofac Surg* 2013 [In press].

**Conflicts of interest.**—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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