

Prevalence and characteristics of pneumatized articular tubercle: First large series in Iranian people

Abbas Shokri¹, Maruf Noruzi-Gangachin¹, Maryam Baharvand², Hamed Mortazavi^{2,*}

¹Department of Oral and Maxillofacial Radiology, Dental School, Hamadan University of Medical Sciences, Hamadan, Iran

²Department of Oral and Maxillofacial Medicine, Dental School, Shahid Beheshti University of Medical Sciences, Tehran, Iran

ABSTRACT

Purpose: This study was performed to determine the prevalence and characteristics of pneumatized articular tubercle or eminence among a defined group of Iranian people.

Materials and Methods: Digital panoramic radiographs of 1694 patients in the Department of Oral and Maxillofacial Radiology, Hamadan Dental School, Iran were evaluated retrospectively to detect the above lesion. Finally, 1563 radiographs were selected according to inclusion criteria. Then, a review was done of 10 large case series found using a MEDLINE search of the literature. Chi-squared test was used to analyze the differences in variables such as age, gender, laterality, and locularity in our case series.

Results: The average age of our samples was 32.6 ± 7.63 years. Pneumatized articular tubercle was found in 98 cases, representing a prevalence of 6.2% with a mean age of 22.8 ± 7.9 and a range of 8 to 60 years. Sixty-four (65.3%) pneumatized articular tubercles were unilateral, with 30 lesions on the right and 34 on the left side. Bilateral lesions were found in 34 (34.7%) patients. 52 (53.06%) of the pneumatized articular tubercles were of the unilocular type and 46 (46.94%) were multilocular. The results showed no statistically significant differences regarding age ($p=0.454$), gender ($p=0.634$), laterality ($p=0.252$), or locularity ($p=0.807$) among the samples.

Conclusion: Among ten large case series from other countries, the prevalence of pneumatized articular tubercle (6.2%) in Iranian patients was higher than that of all eight of the case series that used the same detection method as the present study of panoramic radiography. (*Imaging Sci Dent* 2013; 43 : 283-7)

KEY WORDS: Temporal Bone; Mastoid; Tubercle; Iran

Introduction

Pneumatization refers to the development of air cell-like cavities in bone. In addition to major paranasal sinuses, accessory air cells may arise in numerous locations in the skull including the temporal bone.^{1,2} Pneumatization of the temporal bone can be divided into five regions, which in turn are subdivided into different areas. The common sites of involvement consist of the middle ear, mastoid process,

perilabyrinthine bone, petrous apex, and accessory region.^{2,3}

The term “pneumatized articular tubercle” or “eminence” (PAT) was first used by Tyndall and Matteson to describe an asymptomatic radiolucent lesion in the zygomatic process of the temporal bone with an appearance similar to the mastoid air cavities. The defect might extend anteriorly as far as the articular tubercle but not beyond the zygomaticotemporal suture with no enlargement or cortical destruction of the zygoma.⁴ This entity was re-emphasized by Carter et al and named as zygomatic air cell defect (ZACD).⁵

Panoramic radiographs are usually considered useful for visualizing a PAT, that is why almost all case reports and prevalence studies on the PAT are based on this method.⁴⁻⁷ However, Miloglu et al demonstrated that the medial portion of the articular eminence could only be detected on

Received June 1, 2013; Revised June 23, 2013; Accepted June 28, 2013

*Correspondence to : Prof. Hamed Mortazavi

Department of Oral and Maxillofacial Medicine, Dental School, Shahid Beheshti University of Medical Sciences, Daneshjoo Blvd, Chamran High Way, 1983963113, Tehran, Iran

Tel) 98-21-29902311, Fax) 98-21-22403194, E-mail) hamedmortazavi2013@gmail.com

Copyright © 2013 by Korean Academy of Oral and Maxillofacial Radiology

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Imaging Science in Dentistry · pISSN 2233-7822 eISSN 2233-7830

computed tomography (CT).⁸ In a recent study, Ladeira et al pointed out that cone-beam computed tomography (CB CT) provided high quality images with three-dimensional views and a lower number of artifacts.⁶

Pneumatization may help spread inflammation, tumors, and fractures of the temporomandibular joint due to minimal bony resistance.^{6,8} In addition, the need for surgical intervention of the articular eminence should be considered a complicating factor because of the higher likelihood of perforation.^{4,6}

The purpose of this study was to determine the prevalence and characteristics of pneumatized articular tubercle among a defined group of Iranian patients and present a review of ten large case series of PAT in other countries in order to help clinicians understand the nature of this phenomenon.

Material and Methods

Digital panoramic radiographs of 1694 patients referred to the Department of Oral and Maxillofacial Radiology, Hamadan Dental School, Iran were evaluated retrospectively from January 2010 to January 2012 to detect the presence of PAT. Cases in which the zygomatic process was not adequately visible for technical or anatomic reasons and subjects with a history of fractures or maxillofacial anomalies were excluded from the study. In the end, 1563 radiographs were selected.

Radiographs were obtained by a digital panoramic X-ray unit CranexD (Sordex, Helsinki, Finland) set to 66-70 kVp, 10 mA, and 17.6 s for adults and 57-60 kVp, 10 mA, 13.8 s for children. All of the images were displayed on a 17-inch Samsung monitor (SyncMaster 740N, Samsung Co., Seoul, Korea) with the screen resolution set at 1280 × 1024 pixels and color set to 32-bit depth and analyzed by Scanora software version 5.1 (Sordex Co., Helsinki, Finland).

An experienced oral and maxillofacial radiologist evaluated the radiographs. The diagnosis of PAT was based on the presence of unequivocal pneumatization of the articular eminence or posterior to the zygomaticotemporal suture as a well-defined uni- or multilocular radiolucency. PAT was classified as uni- or multilocular, according to the study of Tyndall and Matteson.⁴ Unilocular PAT was described as a single radiolucent oval defect with well-defined bony borders, whereas multilocular PAT was defined as small numerous radiolucent cells.

In this study, a total of 400 randomly selected radiographs were re-evaluated 10 weeks after the initial examina-

tion in order to test intra-observer reliability. Intra-observer agreement was determined using the Wilcoxon matched pairs signed-rank test.

Through searching the MEDLINE, we reviewed 10 large case series of PAT in the literatures,^{4-6,8-14} In addition, we used SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA) and the chi-square test to analyze differences in the variables of age, gender, laterality, and locularity within our own cases. A P-value less than 0.05 was considered statistically significant.

Results

There was no significant intra-observer difference ($p > 0.05$), and the intra-observer consistency was rated as 95.5%.

The average age of our 1563 patients was 32.6 ± 7.6 , ranging from 5 to 76. There were 642 (41.1%) males and 921 (58.9%) females (Table 1). The mean age of the male and female patients was 30.22 ± 11.3 and 34.25 ± 9.3 , respectively.

PAT was found in 98 patients, representing a prevalence of 6.2%. Patients with PAT had a mean age of 22.8 ± 7.9 years with a range of 8 to 60 years (males: 9-45 years, mean age: 19.9 ± 7.6 years and females: 8-60 years, mean age: 24.2 ± 10.2). The youngest patient with PAT was an 8-year-old girl. The patients were categorized according to their age as follows: younger than 10 years (6.0%), 11-20 years (40.8%), 21-30 years (37.0%), 31-40 years (8.2%), 41-50 years (5.1%), and 51-60 years (2.0%). Thirty-three (33.7%) lesions occurred in males and 65 (66.3%) in females.

None of the PATs located in the zygomatic process of the temporal bone extended anteriorly beyond the zygomaticotemporal suture, and none had any expansive or destructive characteristics. Sixty four (65.3%) of the PATs were unilateral, with 30 on the right and 34 on the left side.

Table 1. Characteristics of pneumatized articular eminence (PAT) cases in the present study

| | Male | Female | Total |
|-------------------|----------------|-----------------|----------------|
| Assessed patients | 642 (41.1%) | 921 (58.9%) | 1563 (100.0%) |
| PAT cases | 33 (33.6%) | 65 (66.4%) | 98 (100.0%) |
| PAT prevalence | 2.1% | 4.1% | 6.2% |
| Age of PAT cases | 19.9 ± 7.6 | 24.2 ± 10.2 | 22.8 ± 9.7 |
| Unilateral | 19 (57.6%) | 45 (69.2%) | 64 (65.3%) |
| Bilateral | 14 (42.4%) | 20 (30.8%) | 34 (34.7%) |
| Right side | 5 (15.2%) | 25 (38.5%) | 30 (30.6%) |
| Left side | 14 (42.4%) | 20 (30.8%) | 34 (34.7%) |
| Unilocular | 18 (54.5%) | 37 (57.0%) | 52 (53.1%) |
| Multilocular | 15 (45.4%) | 31 (47.6%) | 46 (46.9%) |



Fig 1. A cropped panoramic radiograph shows a unilocular pneumatized articular tubercle.



Fig 2. A cropped panoramic radiograph shows a multilocular pneumatized articular tubercle.

Bilateral PATs were found in 34 (34.7%) patients. Fifty two (53.1%) of the PATs were unilocular (Fig. 1) and 46 (46.9%) were multilocular (Fig. 2). The results of the chi-square test showed no statistically significant differences regarding age ($p=0.454$), gender ($p=0.634$), laterality ($p=0.252$), or locularity ($p=0.807$).

Discussion

The development of air cells preceded by the formation

of bone cavities is a normal physiologic process related to periosteal activity. The five regions of the temporal bone that undergo pneumatization include the middle ear, mastoid process, perilabyrinthine bone, petrous apex, and accessory region. The squamomastoid region is composed of two areas, the mastoid antrum and the periantral areas. The tegmental periantral cavities lie superior to the mastoid antrum and may pass upward into the squamotemporal region or extend into the zygomatic arch producing the PAT.⁸

Roser et al published the first case report of PAT in 1976.¹⁵ About 10 years later, Tyndall and Matteson reported the first detailed data on the radiographic features and population distribution of PAT.⁴

In addition to the current series, we found 10 large case series (Table 2) surveyed by Tyndall and Matteson in 1985,⁴ Kaugars et al in 1986,⁹ Carter et al in 1999,⁵ Hofmman et al in 2001,¹⁰ Orhan et al in 2005,¹¹ 2006,¹² and 2010,¹⁴ Yavuz et al in 2009,¹³ Miloglu et al in 2011,⁸ and Ladeira et al in 2013.⁶ According to these studies, the prevalence of PAT was estimated to be between 1.0% and 21.3%. It was noteworthy that in almost all previous reports (8 of 10), panoramic radiography was used to detect PAT. The prevalence of PAT using conventional panoramic radiography was found to be between 1.0% and 3.42%. Only two studies by Miloglu et al⁸ and Ladeira et al⁶ used CBCT images to evaluate the frequency of PAT. The prevalence of PAT increased to 8% and 21.3% with CBCT in their studies, respectively.^{6,8} In our study, the evaluation of PAT was performed using digital panoramic radiography and the prevalence of PAT was found to be 6.2%.

Panoramic radiography is a useful method for diagnosing PAT.^{7,10-14} Trans-maxillary or trans-orbital radiographs can also be adjunctive projections in the visualization of PAT. However, other radiographic projections such as the submentovertex view, transcranial view for TMJ, Towne's view, or Water's view do not provide adequate visualization of the articular eminence.¹¹ In recent studies, computed tomography (CT) has also been considered a method of choice for the evaluation of bony structures and air cells in the skull.^{6,8} On the other hand, Maloglu et al pointed out that since CBCT did not present superimposition, it exceeded the diagnostic accuracy of panoramic radiographs in the evaluation of temporal air spaces. In addition, it was noted that the medial portion of the articular eminence might only be visible on computed tomography.⁸

In our study, the number of women with PAT was higher than that of men, but this difference was not significant. This finding was in agreement with Tyndall and Matteson,⁴

Table 2. Prevalence and characteristics of pneumatized articular tubercle (PAT) cases in the literature and current study

| Series | Number of Samples | PAT cases | Male | Female | Age range (years) | PAT prevalence (%) | Unilateral (%) | Bilateral (%) | Review source |
|--------------------------------------|-------------------|-----------|--------------|--------------|-------------------|--------------------|----------------|---------------|---------------|
| Tyndall & Matteson 1985 ⁴ | 1061 | 28 | 13 (46.4) | 15 (53.6) | 15-75 | 2.6 | 23 (82.1) | 5 (17.9) | Panoramic |
| Kaugars et al 1986 ⁹ | 784 | 8 | 1 (12.5) | 7 (87.5) | 32-69 | 1.0 | 4 (50.0) | 4 (50.0) | Panoramic |
| Carter et al 1999 ⁵ | 2734 | 40 | 20 (50.0) | 20 (50.0) | 17-83 | 1.5 | 32 (80.0) | 8 (20.0) | Panoramic |
| Hofmman et al 2001 ¹⁰ | 1084 | 20 | 9 (45.0) | 11 (55.0) | 7-87 | 1.8 | 16 (80.0) | 4 (20.0) | Panoramic |
| Orhan et al 2005 ¹¹ | 1006 | 19 | 7 (36.9) | 12 (63.1) | 11-90 | 1.9 | 12 (63.1) | 7 (36.9) | Panoramic |
| Orhan et al 2006 ¹² | 1049 | 17 | 9 (53.0) | 8 (47.0) | 7-16 | 1.62 | 10 (58.9) | 7 (41.1) | Panoramic |
| Yavuz et al 2009 ¹³ | 8107 | 83 | 42 (50.6) | 41 (49.4) | 10-75 | 1.03 | 56 (67.5) | 27 (32.5) | Panoramic |
| Orhan et al 2010 ¹⁴ | 1405 | 48 | 12 (25.0) | 36 (75.0) | 9-20 | 3.42 | 32 (68.8) | 16 (31.2) | Panoramic |
| Miloglu et al 2011 ⁸ | 514 | 41 | 16 (39.0) | 25 (61.0) | 15-62 | 8 | 31 (75.6) | 10 (24.4) | Cone beam CT |
| Ladeira et al 2013 ⁶ | 658 | 140 | — | — | 11-85 | 21.3 | 76 (54.3) | 64 (45.7) | Cone beam CT |
| Current series | 1563 | 98 | 33 (66.4) | 65 (33.6) | 8-60 | 6.2 | 64 (65.3) | 34 (34.7) | Panoramic |

Kaugars et al,⁹ Hofmman et al,¹⁰ Orhan et al,¹¹ and Miloglu et al,⁸ and was in disagreement with Orhan et al¹² and Yavuz et al.¹³ In the study by Carter et al, both sexes showed similar degrees of involvement.⁵

Pneumatization commences during maturation or post-natal growth. Since females' puberty takes place earlier than that of males, their pneumatizations are biologically more advanced than men of the same age. That is why PAT is more likely to be detectable or more common in women than men.¹⁴

The age range and the mean age of the patients in our study were 8-60 and 22.8 ± 9.7 years, respectively. These findings were close to previous reports by Tyndall and Matteson,⁴ Yavuz et al,¹³ and Miloglu et al.⁸ Pneumatization of the mastoid process is usually complete at the age of 5, whereas pneumatization of the maxillary zygomatic process does not begin until 9 years of age. It is unknown at what age air cells within the articular eminence begin to develop.¹⁴ It was demonstrated that the accessory air-filled cavities began pneumatization after puberty and achieve their maximum size after several years.¹¹ In contrast to this finding, Orhan et al reported 9 cases of PAT

before puberty with the age range of 7-11 years.¹² In our study, the youngest patient with PAT was 8 years old. This finding was in accordance with Hofmman et al,¹⁰ Orhan et al,¹² and Yavuz et al.¹³

In the present study, the ratio of unilateral PAT to bilateral PAT was 1.88 : 1, similar to previous reports.^{13,14} The most unilateral and bilateral presentation of PAT was reported by Tyndall and Matteson (82.1%)⁴ and Kaugars et al (50.0%),⁹ respectively. Ladeira et al did not identify any predisposing factors for unilateral or bilateral pneumatization.⁶

Regarding the types of pneumatization (unilocular and multilocular), there were no significant differences between the prevalences of these types in most of the previous studies,^{8,10-13} which was in agreement with ours. In contrast to our findings, Ladeira et al showed a much higher prevalence of the multilocular type (98.7%) on the basis of CBCT images. They concluded that this difference was related to the use of panoramic radiography, which had limitations in evaluating the prevalence and type of pneumatization.⁶

The clinical importance of pneumatization is that it facil-

itates the spread of various pathologic processes along the joint, such as inflammation, tumors, and fractures due to minimal bone resistance.^{6,8} Moreover, in patients needing surgical intervention of the articular eminence, it should be considered a complicating factor because of the higher likelihood of perforation following aggressive dissection or forceful flap retraction.^{4,6} Therefore, surgeons must be aware of this condition.

The differential diagnosis of PAT includes hemangioma, aneurismal bone cyst, giant cell tumor, eosinophilic granuloma, metastatic tumor, and fibrous dysplasia. Almost all of these entities are usually characterized by painful enlargement of the cheeks and seen radiographically as expansive and destructive lesions.^{4,12} Treatment of PAT is not necessary, and asymptomatic lesions should be kept under observation.⁶

In conclusion, among ten large case series, the prevalence of PAT in Iranian patients (6.2%) was higher than that of the other eight case series from other countries that used the same detection method of panoramic radiography.

References

1. Stoopler ET, Pinto A, Stanton DC, Mupparapu M, Sollecito TP. Extensive pneumatization of the temporal bone and articular eminence: an incidental finding in a patient with facial pain. Case report and review of literature. *Quintessence Int* 2003; 34: 211-4.
2. Deluke DM. Pneumatization of the articular eminence of the temporal bone. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1995; 79: 3-4.
3. Sözen E, Çelebi I, Uçal YO, Coşkun BU. Is there a relationship between subjective pulsatile tinnitus and petrous bone pneumatization? *J Craniofac Surg* 2013; 24: 461-3.
4. 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.
5. Carter LC, Haller AD, Calamel AD, Pfaffenbach AC. Zygomatic air cell defect (ZACD). Prevalence and characteristics in a dental clinic outpatient population. *Dentomaxillofac Radiol* 1999; 28: 116-22.
6. 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.
7. Hasnaini M, Ng SY. Extensive temporal bone pneumatization: incidental finding in a patient with TMJ dysfunction. *Dent Update* 2000; 27: 187-9.
8. Miloglu O, Yilmaz AB, Yildirim E, Akgül 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.
9. 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.
10. Hofmann T, Friedrich RE, Wedl JS, Schmelzle R. Pneumatization of the zygomatic arch on pantomography. *Mund Kiefer Gesichtschir* 2001; 5: 173-9.
11. 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.
12. Orhan K, Delilbasi C, Orhan AI. Radiographic evaluation of pneumatized articular eminence in a group of Turkish children. *Dentomaxillofac Radiol* 2006; 35: 365-70.
13. 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.
14. 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.
15. Roser SM, Rudin DE, Brady FA. Unusual bony lesion of the zygomatic arch. *J Oral Med* 1976; 31: 72-3.