Dental Research Journal

Original Article

Prevalence of zygomatic air cell defect: Panoramic radiographic study of a selected Esfehanian population

Asieh Zamaninaser[1], Roghayeh Rashidipoor[1], Farzaneh Mosavat[1], Ahura Ahmadi[2]

[1]Torabinejad Dental Research Center and Department of Oral and Maxillofacial Radiology, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, [2]Community Medicine, Shahid Beheshti University of Medical Science, Tehran, Iran

Received: February 2012
Accepted: June 2012

Address for correspondence:
Dr. Farzaneh Mosavat, Torabinejad Dental Research Center and Department of Oral and Maxillofacial, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: F_mosavat@resident.mui.ac.ir

ABSTRACT

Background: The mastoid pneumatization begins on the 33rd week of embryonic life, and continuous up to 8-9 years of age. This air cells is important for surgical perspective. Inadvertent penetration through this anatomical feature during surgical procedures can be disastrous. Aim of this study is to determine the prevalence of zygomatic air cell defect (ZACD) in the Esfehanian population.
Materials and Methods: This was a cross-sectional study. 2600 panoramic radiographs of patients aged between 3 and 90 years were evaluated retrospectively to establish dominant laterality, type and grade amongst these patients. The SPSS 11.5 program was used for the statistical analysis. Mean and standard deviation were used for statistical methods in this study.
Results: ZACD was found in 94 cases, representing a prevalence of 3.6%. 59 cases occurred in females (62.8%) and 35 cases occurred in males (37.2%). Most cases were in their twenties. Unilateral ZACD was found in 70 patients (74.5%) with the half occurring on the right side. In 24 cases (25.5%) was bilateral. 70 of the cases (59.3%) were multilocular type, while 45 (38.1) and 3 (2.6%) were unilocular and trabecular type, respectively. 59 cases were grade 2 (62.8%) and 35 were grade 3 (37.2%).
Conclusions: The frequency of ZACD amongst Iranian population was more than previous studies. In addition younger population was involved in this group. So it is important for clinicians who are planning to perform temporomandibular joint surgery to assess radiographic imaging thoroughly before the surgery to avoid intraoperative complications.

Key Words: Panoramic radiography, temporomandibular joint, zygomatic air cell defect

INTRODUCTION

Pneumatization is the presence or development of air-filled cavities in a bone.[1] The mastoid pneumatization begins on the 33rd week of embryonic life, and continuous up to 8-9 years of age.[2] Pneumatic cellular expansion into the remainder of the temporal bone occurs until after birth, with the stimulation caused by the presence of air within the middle ear. The pneumatizing process then goes into a period of high activity, proceeding over several years.[3] In addition to the pneumatization, in the mastoid process, accessory air cells may develop in numerous location in the temporal bone, including the root of the zygomatic arch and its articular eminence.[1] A non-expansile, non-destructive cyst-like radiolucency in the zygomatic process of the temporal bone, which appears similar to the mastoid air cells and which does not extend further anteriorly than the zygomaticotemporal suture, entitled the zygomatic air cell defect (ZACD).[4] Three types of ZACD appearance based on their panoramic radiographic was further used: 1. Unilocular type; 2. Multilocular type; and 3. Trabecular type. A unilocular ZACD appears as radiolucency with well-defined borders, while the multilocular type demonstrates numerous small cavities within, which resemble

Access this article online

Website: www.drj.ir

mastoid air cells. The trabecular variety is basically a multilocular entity with internal bony striations.[4]

More than the epidemiological view, the recognition of these air cells is important for surgical perspective too. Inadvertent penetration through this anatomic feature during surgical procedures can be disastrous.[5]

The purpose of this study was to determine the prevalence and variations of ZACD in selected Iranian population.

MATERIALS AND METHODS

Panoramic radiographs of 2600 patients, who were referred to one of the oral and maxillofacial radiology centers' of Isfahan city, were evaluated retrospectively during the period of August 2010 to October 2011. Cases in which the zygomatic arch were not adequately seen for technical or anatomic reasons and had previous history of maxillofacial fractures or had maxillofacial anomalies were excluded from the study. Digital radiographs were obtained with Orthopantomograph Op200 D panoramic digital radiographic machine operating at 57 to 85 Kvp, 2 to 16 mA, 8 to 17.6 s using Kodak Dryview laser imaging film and Kodak Dryview 5800 laser imager printer (made in USA). Analysis of all 2600 panoramic radiographs was performed by an oral and maxillofacial radiologist under optimum viewing conditions. Age and sex of all the patients were recorded. Diagnosis of ZACD was done if clear, well-defined uni or multilocular or trabecular radiolucency of the zygomatic arch or articular eminence posterior to the zygomaticotemporal suture was recognized. Furthermore, ZACD were classified based on: 1. Age and gender; 2. Laterality: Unilateral or bilateral; 3. Appearance: Unilocular, multilocular or trabecular; and 4. Grade: 2, 3. The mastoid and zygomatic arch pneumatization degree were classified according to panoramic finding:

1. Grade 0: The air cells are limited to the mastoid process;
2. Grade 1: The air cells extended between the mastoid process and the deepest point of the glenoid fossa;
3. Grade 2: The air cells extended from the deepest point of the glenoid fossa to the crest of the articular eminence; and
4. Grade 3: The air cells extended beyond the crest of the articular eminence.

The SPSS 11.5 Program was used for the statistical analysis. The statistics methods used were mean and standard deviation.

RESULTS

Out of the 2600 panoramic radiographs investigated, ZACD was discovered in 94 patients, accounting for prevalence of 3.6%. Patients' ages ranged from 3 to 90 years and the overall mean age was 33.2 years. Participants in this study were 1017 (39.1%) male and 1583 (60.9%) female patients. The mean age of male patients was 34.4 years with age ranging from 3 to 90 years, while the mean age of female patients was 32.4 ranging from 4 to 82 years [Figure 1]. The ages of the patients with ZACD ranged from 6 to 81 years (mean age: 27.4). Out of 94 ZACDs, 35 (37.2%) were male patients and 59 (62.8%) were found in females, 70 (74.5%) occurred unilaterally and 24 (25.5%) bilaterally. 70 (59.3%) of ZACDs presented with multilocular type, 45 (38.1%) with unilocular type and 3 (*2.6%) with trabecular appearance. 59 (62.8%) cases of ZACD was located between the deepest point of the glenoid fossa to the crest of the articular eminence (grade 2) and in 35 (37.2%) cases of ZACD extended beyond the crest of the articular eminence (grade 3). The variation of ZACDs with gender, appearance, laterality and grade is summarized in Table 1. The youngest patient with ZACD was a 6-year-old girl and the oldest one was a 81-year-old male. Age distribution of the ZACD patients based on age in decades is presented in Table 2 and Figure 2. Most of the ZACD cases were in the 3rd and after the second decade. Then the incidence decreased in other decades.

DISCUSSION

The mastoid air cells and paranasal sinuses (PNSs)

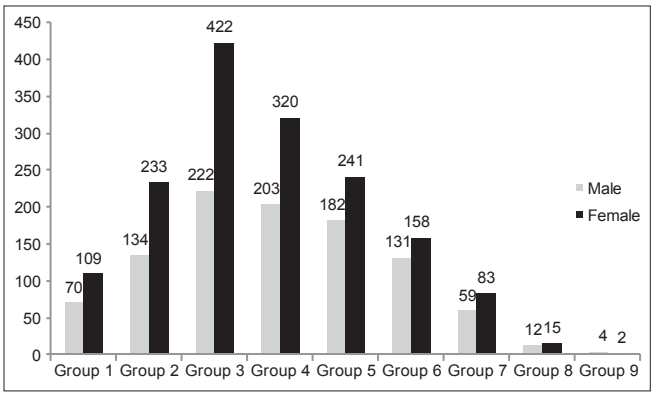

Figure 1: Age distribution of 2600 patients by decade

Table 1: Gender, appearance, laterality and grade of the zygomatic air cell defect patients

Gender	Average age	Appearence			Location			Grade	
		Multilocular	Unilocular	Trabecular	Unilateral (*n*=70)		Bilateral (*n*=24)	2 (*n*=59)	3 (*n*=35)
					Right	Left			
Male (*n*=35)	27.7	29	12	1	15	13	17	19	16
Female (*n*=59)	27.2	41	33	2	20	22	7	40	19
Total (*n*=94)	27.4	70	45	3	35	35	24	59	35

Table 2: Age distribution, laterality and grade of 94 patients with zygomatic air cell defects by decade

Age group (years)	Number	Mean age	Unilateral		Bilateral	Grade	
			Left	Right		2	3
1-9 (group 1)	5	7.0	2	0	3	5	0
10-19 (group 2)	28	14.0	12	6	10	13	15
20-29 (group 3)	29	24.7	9	13	7	18	11
30-39 (group 4)	14	34.2	8	6	0	13	1
40-49 (group 5)	8	45.6	2	3	3	5	3
50-59 (group 6)	7	54.0	2	4	1	4	3
60-69 (group 7)	2	62.0	0	2	0	1	1
70-79 (group 8)	0	81.0	0	0	0	0	0
80-90 (group 9)	1		0	1	0	0	1

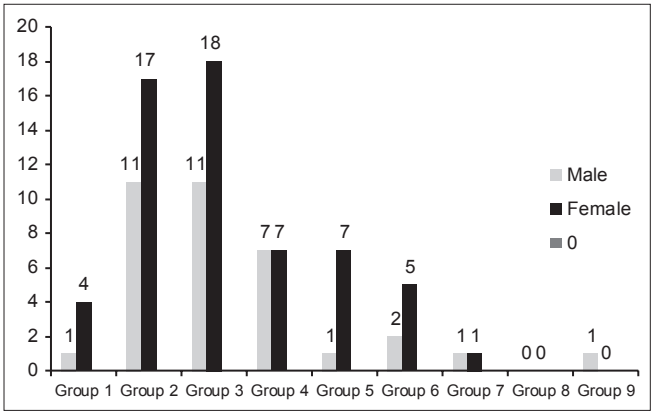

Figure 2: Age distribution of ZACD patients by decade

are the best characterized structures for aeration in humans, and both structures develop by gradual pneumatization of solid tissue.[6] There have been two theories proposed concerning mastoid pneumatization; the hereditary theory holds that genetic influences directly affect the extent of temporal bone pneumatization.[2] The environmental theory holds that the condition of middle ear determines good temporal pneumatization.[7] Bone air cells in modern humans have been proposed (e.g., reception of sound, resonance, insulation, air reservoir action), many functional implications of the development of temporal acoustic dissipation, protection from external violence, and minimization of the skull mass.[8] The primary regions of pneumatization of the temporal bone consist of the middle ear, squamomastoid, perilabyrinthine, petrous apex, and accessory. The accessory regions include the squamous, the zygomaticooccipital, and the styloid. The tegmental or periantral air cell may extend into the zygomatic arch, producing the ZACD.[9] ZACDs are important because air spaces are the potential pathways for the spread of pathological processes, cranial sepsis and infection.[4,10] In addition, tumors of the mastoid process and ear may extend into the TMJ while otitis or mastoiditis may involve the TMJ and can even result in ankylosis.[11-13] Al-Faleh *et al.* stated that ZACD may render the temporal component of the TMJ more fragile and the roof of the glenoid fossa would be extensively weakened by pneumatization. Therefore, a severe traumatic injury may cause impingement of the head of the condyle on the middle cranial fossa.[14] ZACD requires no treatment but it may be a contraindication for performing eminectomy or eminoplasty.[10] So it is necessary for surgeons to be more cautious when dealing with mandibular condyle and articular eminence surgery because inadvertent penetration through the defect can lead to dural tear and cerebrospinal fluid leakage.[4,5,10] Panoramic radiography seems to be proper option for evaluation of ZACD, since the posterior part of zygomatic arch is usually displayed. Furthermore low cost and radiation dose compared with CT made it the initial method to check for this defect.[10,15]

The overall prevalence of ZACD in this study was 3.6% which showed higher prevalence compared to previous studies that reported almost similar prevalence of 1.5%, 1.82%, 1.88%, 1.85%, 1%, and 1.3%.[4,5,10,11,16,17] Our result supports those of Tyndall and Matteson[18] and Park *et al.*[9] [Table 3]. Only the recent investigation by Miloglu *et al.*,[15] studying 515 CBCT images revealed the prevalence to be 8%. The cause of this vast difference is perhaps that CBCT is not subject to superimposition and hence

Table 3: Prevalence of zygomatic air cell defect cases in previous studies

Author and year	Sample size (no)	ZACD (%)	Age range of ZACD (years)	% Male (no)	% Female (no)	Review source
Tyndall and Matteson, 1985[18]	1061	2.6	15-74	46.4 (13)	53.6 (15)	Panoramic
Kaugar *et al.*, 1986[16]	784	1	32-69	12.5 (1)	87.5 (7)	Panoramic
Carter *et al.*, 1999[4]	2734	1.5	17-83	50 (20)	50 (20)	Panoramic
Hofmann *et al.*, 2001[11]	1084	1.85	7-87	45 (9)	55 (11)	Panoramic
Hee Park *et al.*, 2002[9]	1400	2.2	9-52	71 (22)	29 (9)	Panoramic
Orhan *et al.*, 2005[10]	1006	1.88	11-90	36.6 (7)	63.1 (12)	Panoramic
Yavuz *et al.*, 2009[17]	8107	1.03	10-75	50.6 (42)	49.4 (41)	Panoramic
Patil *et al.*, 2011[5]	7755	1.82	19-75	64.5 (91)	35.5 (50)	Panoramic
Miloglu *et al.*, 2011[15]	514	8	15-62	39 (16)	61 (25)	CBCT
Present series, 2011	2600	3.6	4-81	37.2 (35)	62.8 (59)	Panoramic

ZACD: Zygomatic air cell defect

it exceeds the diagnostic accuracy of panoramic radiographs in the evaluation of temporal air spaces. In the present research, ZACDs were nearly twice as common in females than in males (F:M: 1.6:1), which is in accordance with Orhan *et al.*[10] and Miloglu *et al.*[15] (1.7:1 and 1.5:1, respectively). Unlike these studies, in Park *et al.*[9] and Patil's[5] study female-to-male ratios were reveres (1:2.4 and 1:1.82, respectively). The present study and the study by Orhan *et al.*[10] and Miloglu *et al.*[15] had more female subjects, which could probably explain the greater occurrence of ZACD in female, whereas in the study by Park *et al.*,[9] although male subjects were less, a higher male occurrence of ZACD was found. However, the difference between females and males was not statistically significant ($P > 0.05$) and this was consistent in previous studies. The mean age of patients with ZACD have been reported by authors previously: 49.6, 36.6, 43.3, 45.9, 30.0 and 32.5.[4,10,11,16,18] The mean age of patients was 27.5 in our study similar to that reported by Park *et al.*[9] and was lower compared to previous studies. It is perhaps for that the greatest amounts of patients were in the third decade in the present study.

In our study most of the ZACD cases were in the second and third decades, while total number of patients in the second decade wasn't higher compared to the other decades. Although the third decade's group had the highest number of patients, the number of patients with ZACDs in second and third decade were almost equal. The mean age of ZACD cases in the second decade were 14.0 years. We also reported 6 cases of ZACD in the first decade with a mean age of 7.0 years. This is a noticeable point, which has been mentioned less in previous studies. Previous reports stated that ZACDs are hardly found in the latter half of second decade as the accessory air cells start the process of pneumatization only after puberty and achieve complete dimension several years after the mastoid cell.[4] In Tyndall and Matteson,[18] Kaugar *et al.*,[16] Carter *et al.*,[4] Patil *et al.*[5] and Miloglu *et al.*[15] studies, all cases were found in adults, while Hoffman *et al.*,[11] Park *et al.*,[9] Orhan *et al.*,[10] and Yavuz *et al.*[17] detected cases of ZACD in patient aged 7, 9, 11 and 10, respectively. In our study, the youngest patient with ZACD was 6 years. Although it is unknown at what age accessory air cells begin to develop, pneumatization of the mastoid process is almost completed by 6 years. Hollingshead pointed out that the accessory air cells begin to pneumatize after puberty and achieve full size after several years as with mastoid air cell proper.[19] The failure to detect before the second half of the second decade of life might be due to the fact that the process of pneumatization does not become extensive enough to be radiographically evident.[9] However, further studies in children should be done, using high resolution CT and CBCT, which allows exact delineation of temporal air spaces to removal, a contradiction of this case.

In present study, the oldest patient with ZACD was an 81-year-old male. Although Park *et al.*[9] suggested that the chances of detecting ZACD decreases after the age of 60 years, we found two–cases in 7th decade and 1 in 9th decade, as all other studies had been scheduled. So it does not seem there are any corresponding between age and ZACD existence. Most of the previous studies revealed that ZACD frequently occur unilaterally (unilateral to bilateral ratio was 2.5:1).[15] In parallel with other studies, in the present investigation this ratio was

2.9:1 that nearly the same results of Miloglu *et al.*[15] (3:1). This study exhibited equal representation of ZACDs on the left and right side which is in accordance with Park *et al.*[9] and opposing to that Patil *et al.*[5] and Carter *et al.*[4] where high proportion of ZACDs was noted on right side and Hafmann *et al.*[11] that high proportion of ZACDs were found on left side. A review of the previously published reports illustrates a variation with respect to locality of ZACD. In the present study, we found 70 (59.3%) multilocular, 45 (38.1%) unilocular and 3 (2.6%) trabecular appearance. Tyndall and Matteson[18] reported 15 multilocular and 17 unilocular ZACD cases, Patil *et al.*[5] found 96 multilocular and 45 unilocular ZACD cases and Miloglu *et al.*[15] detected 24 multilocular and 17 unilocular cases in their studies. We have noted the grading system for air cell pneumatization of temporal bone. Grade 0 and 1 could not be examined in panoramic radiography, since the posterior aspect of glenoid fossa is usually superimposed by adjacent structures. So we just reported grades 2 and 3. Observably, the highest incidence of air cells in the right and left temporal component was that of grade 2 (59 cases) followed by grade 3 (35 cases). So the incidence of air cell defect which extends anterior to the crest of the articular eminence was infrequent finding compared to the one which does not pass the crest.

ZACD must be differentiated from some diseases that are involved in zygomatic process of temporal bone, including aneurismal bone cyst, central hemangioma, central giant cell tumor, eosinophilic granuloma, fibrous dysplasia and metastatic tumors. Unlike ZACD, these lesions incite symptoms like pain, swelling over the zygoma, facial asymmetry and present with radiographic evidence of cortical expansion.[3,9,18,20]

CONCLUSION

In conclusion, this study established the prevalence of ZACDs amongst Iranians is higher than other population studies. Also in present study, younger people are more involved compared to the other studies. Due to the fragile and formidable nature of these defect, clinicians who are planning to perform temporomandibular joint surgery should be extra cautious when dealing with these entities especially in young people in this population.

REFERENCES

1. Romannes GJ. Cunningham's textbook of anatomy. 11th ed. New York: Oxford University Press; 1972.
2. Görür K, Ozcan CO, Talas D. The computed tomographical and tympanometrical evaluation of mastoid pneumatization and attic blockage in patients with chronic otitis media with effusion. Int J Pediatr Otorhinolaryngol 2006;70:481-5.
3. Som PM, Curtin HD. Temporal bone: Embryology and Anatomy. In: Head and neck imaging. St Louis: Mosby; 2003. p. 1061-2.
4. Carter LC, Haller AD, Calamel AD, Pfaffenbach AC. Zygomatic air cell defect (ZACD). Prevalence and characteristic in a dental clinic outpatient population. Dentomaxillofac Radiol 1999;28:116-22.
5. Patil K, Mahima VG, Malleshi SN, Srikanth HS. Prevalence of zygomatic air cell defect in adults-A retrospective panoramic radiographic analysis. Eur J Radiol 2011;81:957-9.
6. Kim J, Song SW, Cho JH, Chang KH, Jun B. Comparative study of the pneumatization of the mastoid air cells and paranasal sinuses using three-dimensional reconstruction of computed tomography scans. Surg Radiol Anat 2010;32:593-9.
7. Pata YS, Akbas Y, Unal M, Duce MN, Akbas T, Micozkadioglu D. The relationship between presbycusis and mastoid pneumatization. Yonsei Med J 2004;45:68-72.
8. Balzeau A, Herve GD. Cranial base morphology and temporal bone pneumatization in Asian Homo erectus. J Hum Evol 2006;51:350-9.
9. Park YH, Lee SK, Park BH, Son HS, Choi M, Choi KS. Radiographic evaluation of the zygomatic air cell defect. Oral and Maxillofac Radiol 2002;32:207-11.
10. Orhan K, Delilbasi C, Cebeci I, Paksoy C. Prevalence and variations of pneumatized articular eminence: A study from Turkey. Oral Surge Oral Med Oral Patol Oral Radiol Endod 2005;99:349-54.
11. Hofmann T, Friedrich RE, Wedl JS, Schmelzle R. Pneumatization of the zygomatic arch on pantomography. Mund Kiefer Gesichtschir 2001;5:173-9.
12. Faerber TH, Ennis Rl, Allen GA. Tamporomandibular joint ankylosis following mastoiditis: Report a case. J Oral Maxillofac Surg 1990;48:866-70.
13. Dingle AF. Fistula between the external auditory canal and the temporomandibular joint: A rare complication of otitis externa. J Laryngol Otol 1992;106:994-5.
14. Al-Faleh W, Ekram M. A tomographic study of air cell pneumatization of the temporal components of the TMJ in patients with temporomandibular joint disorders. about10p. Available from: http://iadr.confex.com/iadr/saudi06/preliminaryprogram/abstract_87138.htm. [Last accessed on 2011 Oct 12].
15. 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.
16. 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.
17. Yavuz MS, Aras MH, Gungor H, Buyukkurt MC. Prevalence of the pneumatized articular eminence in the temporal bone.

J Craniomaxillofac Surg 2009;37:137-9.
18. Tyndall DA, Matteson RS. Radiographic appearance and population distribution of the pneumatized articular eminence of the temporal bone. J Oral Maxillofac Surg 1985;43:493-7.
19. Hollinshead WH. Anatomy for surgeons: Head and neck. 2nd ed. New York: Harper and Row; 1968. p. 190-4.
20. 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.

How to cite this article: Zamaninaser A, Rashidipoor R, Mosavat F, Ahmadi A. Prevalence of zygomatic air cell defect: Panoramic radiographic study of a selected Esfehanian population. Dent Res J 2012;9:S63-8.

Source of Support: This report is based on a thesis which was submitted to the School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran, in partial fulfillment of the requirements for the MSc degree in Radiology. The study was approved by the Medical Ethics and Research Office at the Isfahan University of Medical Sciences and financially supported by this University. **Conflict of Interest:** None declared.