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Radiographic evaluation of the zygomatic air cell defect

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ABSTRACT

Purpose : The purpose of this study was to determine the prevalence, radiographic appearance, and characteristics of patients with zygomatic air cell defect (ZACD), and to give recommendations concerning radiographic evaluation and surgery.

Materials and Methods : Routine panoramic radiographs of 1,400 patients admitted to the Kyungpook National University Hospital Dental Clinic, were retrospectively examined for the clinical and radiographic features of ZACD.

Results : ZACD was found in 31 cases, representing a prevalence of 2.2%. Patients with ZACD had a mean age of 27.5 years and a range of 9-52 years. Most ZACD cases were in their thirties. ZACD showed a strong male predilection, 22 of the 31 subjects were males and 9 were females. Twenty-four cases of ZACD (77.4%) were unilateral, with the half occurring on the right side. In seven cases (22.6%), ZACD was bilateral. Twenty-six (68.4%) of the defects were of unilocular, while twelve (31.6%) of the defects were multilocular.

Conclusion : Knowledge of ZACD may be helpful in interpreting images, including panoramic radiographs, in planning surgical treatment of the TMJ and in understanding the spread of pathological processes into the joint. ***(Korean J Oral Maxillofac Radiol 2002; 32 : 207-11)***

KEY WORDS : zygomatic air cell defect; radiography; radiography, panoramic

Pneumatization refers to the presence or development of air-filled cavities in a bone. Pneumatization is originated from numerous locations in the skull, including the temporal bone as well as the major paranasal sinuses. Also accessory air cells may develop in numerous location in the temporal bone. The distribution of air cells in the temporal bone was reported by Tremble[1] in 1934. 10 locations within the temporal bone were identified where accessory air cells could be found, including the root of the zygomatic arch and its articular eminence.[1,2]

The zygomatic air cell defect (ZACD) has defined as an accessory air cells in the zygomatic process and articular eminence of the temporal bone which appears similar to the mastoid air cells and which does not extend further anteriorly than the zygomaticotemporal suture.[3,4] The ZACD appears as an asymptomatic radiolucent defect in the zygomatic process of the temporal bone without enlargement or cortical destruction of the zygoma in radiographs.[3]

There have been case reports on ZACD in the dental literatures.[3,5-7] In 1976, Roser et al.[5] reported a case of pneumatization of the root of the zygomatic arch that was observed incidentally on a panoramic radiograph obtained as part of an examination of the temporomandibular joint. Kulikowski and his associates[6] reported the discovery of an air cells in the zygomatic arch of a patient who was undergoing surgical removal of the articular eminence for the treatment of chronic severe condylar subluxation. They noted the paucity of reports in the literature illuminating the prevalence of this condition.

Tyndall and Matteson[3] reemphasized the occurrence of ZACD and presented three cases discovered in panoramic radiographs. Several authors[8-10] have suggested the importance of air cells as possible complicating factor during surgical procedure.

Panoramic radiograph is a useful technique to display the zygomatic air cell defect of temporal bone, since the posterior aspect of the zygomatic arch is usually displayed.[9,10] Computed tomography has been used for this purpose[11] but the cost makes its use difficult to justify. A few series have reported the prevalence of ZACD on panoramic radiographs in general populations.[4,9,10] Tyndall and Matteson[9] provided the first detailed data on prevalence and patient characteristics of pneu-

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matized articular eminence of the temporal bone in 1985. Of a series of 1,061 panoramic radiographs, pneumatization of the articular eminence was found in 28 cases (2.6%) with no gender predilection. Most recently, Carter and his associates[4] described ZACD in 40 patients (1.5%) out of 2,734 dental clinic outpatients.

The purpose of this study is to determine the prevalence, radiographic appearance and characteristics of the patients with ZACD and to give recommendations concerning radiographic evaluation and surgery.

Materials and Methods

Routine panoramic radiographs of 1,400 patients who were visited the Dental clinics of Kyungpook National University Hospital from January 1, 1998 toSeptember 30, 1999 were examined retrospectively. 1,400 patients (742 females, 658 males) were divided into 7 groups by decade. Each group was composed of 200 patients. Cases in which the zygomatic arch was not adequately displayed for anatomical or technical reasons were excluded from the sample and did not constitute part of the 1,400 patient sample. All patients had no severe bone disease including tumor, cyst or fracture. Selection criteria for the acquisition of panoramic radiographs on pediatric, adult patients included caries, pain, missing or supernumerary teeth, mixed dentition analysis, periodontal disease, third molar extraction, extensive restorative dental procedures, prosthodontic evaluation, facial asymmetry, orthodontic evaluation and TMJ problems.

Radiographs were obtained with an Orthophos CD (Siemens Corp., Germany) using a Ortho CP-G Plus film (AGFA Co., Belgium)/Lanex regular screen (Kodak Co., USA). Exposed films were processed according to manufacture's recommendations using automatic film processor, Kodak RPX-OMAT (Kodak Co., USA). Radiographs were examined in transmitted light from a standard viewing box by an oral and maxillofacial radiologist.

Patients were recorded as having ZACD only if unequivocal pneumatization of the root of zygomatic arch or articular eminence posterior to the zygomaticotemporal suture as a well-defined uni- or multilocular radiolucency could be viewed on the radiograph. The age, sex of the patients who had ZACD and its location, radiographic appearance were also recorded. The radiographic appearance was classified into two types, unilocular and multilocular. Unilocular ZACD was defined as single oval radiolucent defect with well-defined border and multilocular ZACD as numerous small radiolucent defects similar to the mastoid air cells.

Results

The average age of the 1,400 patients in the study was 35.2 years and an overall range was 2-91 years. There were 658 (47%) males and 742 (53%) females in the study population. The mean age of the males was 33.2 years (range: 3-85 years), while that for the females was 37.0 years (range: 2-91 years) (Table 1). ZACD was found in 31 cases, representing a prevalence of 2.2%. Patients with ZACD had a mean age of 27.5 years and a range of 9-52 years. 22 patients (71%) of them were males with a mean age of 29 years (range: 9-52 years). The females were 9 patients (29%), who had a mean age of 23.9 years (range: 9-34 years). There was a 1 : 2.4 female-to-male ratio (Table 2).

Most of the cases were in the 3rd decade. After the third decade the incidence decreased. ZACD did not manifest until

Table 1. Group of patients evaluated for zygomatic air cell defect (ZACD)

Age (years)	Number	Gender		Average Age (yrs)		
		M	F	M	F	Total
-9	200	118	82	6.7	7.0	6.8
10-19	200	102	98	15.8	15.1	15.5
20-29	200	95	105	24.3	24.1	24.2
30-39	200	86	114	34.1	34.1	34.1
40-49	200	85	115	44.4	44.1	44.2
50-59	200	86	114	54.3	54.5	54.4
60-	200	86	114	66.8	67.3	67.1
Total	1400	658	742	33.2	37.0	35.2

Table 2. Patients with ZACD

Number	Prevalence	Gender		Average Age (yrs)			Age Range(yrs)		
		M	F	M	F	total	M	F	total
31	2.2%	22	9	29	23.9	27.5	9-52	9-34	9-52

Table 3. Age distribution of 31 patients with ZACD by decade

Age	Number	%	Gender	
			M	F
-9	2	6.4	1	1
10-19	7	22.6	6	1
20-29	10	32.3	5	5
30-39	6	19.4	4	2
40-49	5	16.1	5	0
50-59	1	3.2	1	0
60-	0	0.0	0	0
Total	31	100	22	9

Table 4. Chief complaints of patients with ZACD

Chief complaints	Cases (%)
TMJ problems	10 (32.3)
Orthodontic evaluation	7 (22.6)
Tooth fracture & trauma	4 (12.9)
Third molar extraction	3 (9.7)
Routine dental radiographs	3 (9.7)
Caries treatment	2 (6.4)
Pain	1 (3.2)
Swelling	1 (3.2)
Total	31 (100)

Table 5. Involvement side in ZACD

	Right	Left
Unilateral (24)	12	12
Bilateral (7)	7	7
Total	19	19

*Total patients: 31, Total defects: 38

Table 6. Radiographic appearance on 38 cases of ZACD

	Unilocular	Multilocular
Unilateral (24)	17	7
Bilateral (7)	9	5
Total (%)	26 (68.4%)	12 (31.6%)

*Total patients: 31, Total defects: 38

9 years and also did not appear over 60 years (Table 3).

The chief complaint of patients with ZACD was TMJ problem, orthodontic evaluation, tooth fracture and trauma, third molar extraction, routine dental radiographs, caries, pain, and swelling (in descending order) (Table 4).

Twenty-four cases of ZACD (77.4%) were unilateral, with half on the right side. In seven cases (22.6%), the ZACD was bilateral (Table 5). Twenty-six (68.4%) of the defects were of unilocular type. Twelve of the defects (31.6%) were of multilocular type (Table 6).

Discussion

The cause of ZACD is unknown but may be similar to that of pneumatization of the mastoid process. Pneumatization begins with the formation of small osseous cavities created by normal periosteal activity.[12] The air cells of the temporal bone develop as outpouchings of the antrum, epitympanum, tympanic cavity, and eustachian tube. Primitive bone marrow in these cavities dedifferentiates into a loose mesenchymal connective tissue. Epithelium arising from the lining of the middle ear and its extensions invaginates into this connective tissue, producing a mucous membrane which then undergoes atrophy, leaving a thin residual lining membrane attached to the periosteum. Continued subepithelial bone resorption further expands the air cells.[13,14] The air cells would invade bone only after the marrow has been converted into a loose mesenchymal tissue. The presence of middle ear infections in infancy causes the embryonic subepithelial connective tissue to fibrose; this prevents its condensation and thinning and impedes the progress of the advancing fingers of evaginating pneumatic cells. Therefore, any process such as otitis media in infants and children would limit pneumatization.[14,15]

Pneumatization of the mastoid of temporal bone is initiated in infancy and completed in early childhood, it can be divided into three stages: infantile (birth to 2 years), transitional (2-5 years) and adult or fully developed (at and after six years).[13,16] In the infantile stage, air cells begin to appear in the mastoid antrum. In the transitional stage, the squamomastoid undergoes gradual enlargement with migration of air cells towards the periphery. When a patient reaches the age of 6, pneumatization of the mastoid process is almost complete, but air cells may continue to develop and do become more distinct by virtue of continued calcification of their walls even after the patient reaches adulthood.[5,16,17]

The primary regions of pneumatization of the temporal bone consist of the middle ear, squamomastoid (mastoid), perilabyrinthine, petrous apex, and accessory. The accessory regions include the squamous, the zygomaticooccipital, and the styloid.[12,18] The tegmental or periantral air cell may extend into the zygomatic arch, producing the ZACD.[12,18]

A few series have reported the prevalence of ZACD in general populations. Tyndall and Matteson[9] found 28 cases (2.6 %) of 1061 panoramic radiographs with a mean age of 32.5 years and an age range of 15-74 years. No gender predilection was found and five cases were bilateral. But no details concerning the mean age, age range or gender distribution within the overall sample population were given. They obtained the sample of cases from a group of mostly adult patients. Kaugars and associates[10] described pneumatization in the articular eminence in eight (1%) out of 784 panoramic radiographs reviewed. A mean age of 8 cases was 45.9 years with age range of 32 -69 years. 7 patients of them were female and one was male. The overall sample had the three subpopulations (children, adolescents and adults). All cases were found in adults. Four cases were unilateral and four were bilateral. Carter and his associates[4] reported 40 cases (1.5%) with ZACD in 2,734 dental clinic outpatients. Patients with ZACD had a mean age of

49.6 years and a range of 17-83 years. 32 cases were unilateral and there was no gender predilection.

In the present study, ZACD was found in 31 cases (2.2%) with a mean age of 27.5 years and an age range of 9-52 years. There was a preponderance in male patients (male : female = 2.4 : 1). 24 cases of them were unilateral. In case of unilateral involvement, half of them involved the right side.

The present study revealed demonstrable similarities in the prevalence and involvement of ZACD to the previous studies.[4,9,10] All of the series including this study showed low prevalence. Two possible reasons for ZACD's being seen less often are 1) The number of ZACD may be small as there is a wide variability in the extent of accessory air cell of temporal bone 2) In panoramic radiograph, radiographic visualization of ZACD is more difficult because there are superimposition of adjacent anatomic structures. High-resolution CT can give a better visualization in the evaluation of bony structure allowing exact delineation of temporal air spaces,[11,12] but it is not justified because of cost and inconvenience. In 1999, Groell and Fleischmann[11] examined high-resolution CT of the base of the skull in 100 patients to assess the relationship between the pneumatic spaces of the temporal bone and the TMJ. They found 17 patients showing extension of pneumatization to articular eminence or zygomatic process of temporal bone. The prevalence for ZACD was higher than that in panoramic radiograph. Generally, unilateral involvement of ZACD was predominant. In this finding, bilateral involvement is only in 7 cases (22.6%). Tyndall and Matteson (17.9%),[9] Carter and his associates (20%)[4] demonstrated that ZACD was bilateral in approximately one-fifth of cases.

Compared with previous study, there were some differences found in our results. The mean age in the present study (27.5 years) was relatively lower than that found by Kaugars et al.,[10] Carter and associates.[4] While the number of sample by age was equal in the present study, there was disproportion in age distribution of the overall population in other studies. It has mentioned that there is no gender predilection in ZACD,[4,9,10] but 71% of the ZACD cases in present study were males.

In this study, the youngest patient with ZACD was 9 years of age. Review of the literature demonstrated that the youngest patient reported to date was 15 years.[4] 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[2] pointed out that the accessory air cells begin to pneumatize after puberty and achieve full size after several years as with mastoid air cells proper. 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. The cases of ZACD were found in a broad range of patient ages but it did not appear over 60 years. No longitudinal data have been collected to determine if these defects change in size with time.

In the present study, most of the chief complaints was TMJ problems. This is accounted for by the fact that the patients with TMJ problems were the largest in number out of overall population. No study have been investigated to determine whether there is a relationship between ZACD and TMJ disorder, so further study would be recommended in oder to find out their relationship.

Examination of the radiographic appearance of the ZACD cases revealed two patterns: unilocular and multilocular. Unilocular ZACD appeared as an oval radiolucent defect with well-defined border and multilocular ZACD demonstrated numerous small cavities within the defect and resembled the mastoid air cells.[9] 26 (68.4%) of the defects were of the unilocular type and 12 (31.6%) were of multilocular type. In fact, distinction between the two radiographic types was difficult because adjacent anatomic structures were superimposed over ZACD. So some would argue that this classification wasunnecessarily confusing and not justified.[4,10]

The differential diagnosis of radiolucencies within the zygomatic arch include ZACD, aneurysmal bone cyst, hemangioma, giant cell tumor, eosinophilic granuloma, fibrous dysplasia, and metastatic tumor.[3,9,10] Only the ZACD occurs in the zygomatic arch with any frequency and presents as an asymptomatic, nonexpansile, nondestructive radiolucency detected incidentally on radiograph. All of the other entities in the differential diagnosis including osseous hemangioma is a rare lesion in zygoma and would be characterized by enlarging and painful cheek, bony expansion with cortical destruction and frequently mixed density lesions.[19-21]

The clinical significance of ZACD is that they represent sites of minimal resistance and thus facilitate the spread of various pathologic processes into the TMJ such as tumors, inflammation or fractures[22-26] and that they may be possible complicating factors during TMJ surgery.[8] While the ZACD requires no treatment, one caveat is in order. Inadvertent violation of an air cell during eminectomy, producing communication with the infratemporal or middle cranial fossa poses the genuine danger of intracranial infection and/or hemorrhage.[6] This points out the need for thorough pre-operative imaging evaluation.

In conclusion, knowledgement of the ZACD may be helpful

in the interpretation of imaging studies, including panoramic radiographs, in the planning of surgical treatment of TMJ and in understanding the spread of pathological processes into the joint.

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