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CBCT ASSESSMENT OF PNEUMATIZATION OF THE ARTICULAR TUBERCLE AND THE ROOF OF THE GLENOID FOSSA: A RETROSPECTIVE STUDY

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ABSTRACT

Objectives: To determine the prevalence of the pneumatization of the articular tubercle (PAT) and glenoid fossa (PGF) concerning the sex, laterality and locularity in a sample of Egyptian population using CBCT images.

Subjects and methods: 210 CBCT scans (74 males and 136 females) were assessed retrospectively by an oral and maxillofacial radiologist. The presence of pneumatization was identified bilaterally on a serial of reformatted sagittal cuts at the articular tubercle and the roof of the glenoid fossa. Age and sex for all patients were recorded as well as the type and laterality for the pneumatization cases.

Results: 19.1 % of the scans exhibited PAT and 35.24% exhibited PGF. Of the scans found with PAT, 50% were unilateral (20% on the right and 30% on the left) and 50% were bilateral. Moreover, 15 of the PAT cases were unilocular and 28 were multilocular with 3 cases showing different locularity between sides. For PGF, 41.9% of the PGF cases were unilateral (13.5% on the right and 28.4% on the left) and 58.1% were bilateral. Only 16 of the PGF cases were unilocular, while 61 were multilocular with 3 cases also showing different locularity between sides. There was no significant difference between both sexes regarding the PAT or PGF prevalence, laterality or locularity.

Conclusion: In the studied sample, the prevalence of PAT and PGF was 19.1 and 35.24% respectively. The prevalence was not linked to sex or laterality or locularity.

KEY WORDS: CBCT, articular tubercle, glenoid fossa, pneumatization

INTRODUCTION

Skeletal pneumatization, frequently found in the skull, is described as the development of air-filled spaces within a specific bone [1–3]. Pneumatization of the articular tubercle (PAT) has been initially defined as an asymptomatic radiolucent defect, similar to the mastoid air cells, in the zygomatic process of temporal bone and articular tubercle, but it does not extend beyond the zygomatico-temporal suture

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and is not associated with any bony enlargement or cortical destruction[4]. Ten different areas of the temporal bone, a part of the temporomandibular joint (TMJ) complex, have been reported with pneumatization, as the zygomatic arch, glenoid fossa, and articular tubercle [5,6].

Although considered as a normal anatomic variation, detection of pneumatization in the articular tubercle (PAT) and glenoid fossa (PGF) is critical as they signify regions of weak resistance and facilitate the spread of numerous pathologies into the TMJ complex as tumor, fracture or inflammation [7]. Consequently, this rapid spread of inflammation as otitis and mastoiditis reaching the TMJ region and causing joint ankylosis could lead, at a young age, to detrimental effects on the mandibular development and growth, such as malocclusion, facial asymmetry, and mandibular retrusion [8]. Moreover, PAT and PGF can also increase the complications risk of TMJ surgeries, as unintentional penetration of the pneumatization may occur causing dural tear and leakage of the cerebrospinal fluid [9]. At the same direction, the skull fractures may extend through these defects causing an air release into the glenoid fossa [7]. Thus, the identification of such defects is mandatory to choose the required preoperative precautions and the ideal surgical procedures in order to minimize many detrimental complications [10].

Different imaging modalities have been used for evaluating the pneumatization of the articular tubercle (PAT) and glenoid fossa (PGF) in previous studies. Panoramic radiographs were considered the early technique of choice for evaluation of these defects because of its wide availability, lower cost and radiation dose when compared to CBCT [6]. However, CBCT, the optimal modality of maxillofacial radiographic imaging, exceeds the diagnostic accuracy of panoramic radiographs in evaluation of temporal air spaces, as CBCT is not subjected to anatomical superimposition and also regions as the medial portion of the articular eminence can only be visible on CBCT images [7,11].

Using panoramic radiographs, the prevalence of PAT in the literature was recorded in the range of 1 and 6.2% [3, 12-14]. On the other hand, CBCT provides consistent and precise assessment of the features, exact extension of pneumatization and its relationship to the surrounding structures [15]. Accordingly, using CBCT, PAT was assessed in various populations. In the literature, the Turkish population showed a prevalence of 2.54% in one study [16] and 8% in another one [6]. For Indians, a study identified the PAT in 40.3% of their sample[17] and another recorded a much higher prevalence of 76.7% [15], while, in a study on Iranians, PAT represented a prevalence of 15.6% [18]. Furthermore, PAT and PGF were both evaluated using CBCT in many studies: A study on a sample of Turkish population found that 65.8% had PAT, while 11.7% had PGF [1], while, other study evaluated another sample of the same population and recorded that only 14.7% of their patients had PAT while 47.1% had PGF [10]. For Iranians, a study revealed that 21.3% of their sample presented with PAT and only 5.9% with PRGF [19], while, another study compared the prevalence of PAT using panoramic and CBCT images on Indians, they recorded that the prevalence found by using panoramic radiography is 1.96% and by using CBCT is 12.5% [20].

Since the cranial morphology is frequently representing a wide range of discrepancy among modern human populations, [21] and there is absence of published researches on our Egyptian population, the purpose of the present study was to determine the prevalence of the pneumatization of the articular tubercle (PAT) and glenoid fossa (PGF) concerning the age, sex, laterality and locularity in a sample of Egyptian population using CBCT.

MATERIALS AND METHODS

Following institutional ethical clearance, a retrospective cross-sectional study was planned where the CBCT scans of 210 patients (74 males and 136 females) with age ranging from 5 to 65 years were evaluated. The study sample was recruited from the CBCT scans database of the Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University, where the patients had been referred for CBCT examination for various diagnostic purposes.

CBCT scans were acquired by Planmeca ProMax 3D Mid scanner (Planmeca, Helsinki, Finland) either for craniofacial or maxillary jaw fields of view (FOV). All scans have been taken with the following parameters: 90 kVp, 8 mA, 13.5 -13.75 sec, voxel size 400μ.The acquired images, next to Digital Imaging and Communications in Medicine (DICOM) files export, were processed and analyzed with the Romexis Viewer 4.5.0.R (Planmeca, Helsinki, Finland) on a personal computer (Dell Latitude e6320, Dell Inc., TX, USA) running Microsoft Windows 10 (Microsoft Corp, Redmond, WA, USA) in darkened quiet room.

CBCT scans in which the articular tubercle or the glenoid fossa could not be adequately demonstrated because of anatomical or technical causes and scans with patients having a history of maxillofacial fracture were excluded from the study. On the axial cut, using the software cross hair, the long axis of the condyle was traced, and oblique planar reformatted sagittal and coronal cuts were generated perpendicular and parallel to the long axis of the condyle, respectively.

On a serial of reformatted sagittal cuts, as described by Tyndall and Matteson[4], the pneumatization of the articular tubercle (PAT) was identified as a radiolucent defect in the zygomatic process of the temporal bone similar in appearance to the mastoid air cells, extending anteriorly to the articular eminence but not beyond the zygomatico-temporal suture, with no expansion or cortical destruction of the zygoma. However, if a radiolucent defect with the same above-mentioned criteria was located on the roof of the glenoid fossa above the condyle, it was defined as PGF.

The defects were also classified according to their type as unilocular or multilocular: Unilocular pneumatization was recorded if a single radiolucent oval defect with well-defined borders (figure 1A& C), whereas multilocular pneumatization was recorded if multiple radiolucent small cavities were found (figure 1B& D). The age and gender were recorded for all patients and, for the cases of PAT or PGF, laterality and type were also noted. All scans were assessed bilaterally, so, 420 sites were finally evaluated.

Image analysis procedures were performed by an oral and maxillofacial radiologist of more than 18 years of experience. To avoid any bias, the observer was blinded of the patient's sex and age during image analysis procedures which were concealed by a colleague who did not participate in the study. In order to test the intra-observer reliability of the analysis procedure, 90 scans were re-evaluated by the same observer after 2 weeks interval under the same optimum viewing conditions. Data were collected, revised and entered to the statistical package for social science (SPSS) version 20 (Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, New York: IBM Corp.). Quantitative data were presented in the form of mean, standard deviations and ranges while qualitative data were presented in the form of numbers and percentages. The comparison between groups regarding qualitative data were done by using Chi-square test. Kappa test was used to assess the intra-observer agreement. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant at the level of < 0.05. (k values: 0-0.2= poor, 0.21-0.4=Fair, 0.41-0.6=moderate, 0.61-0.8=substantial 0.81-1= almost perfect).

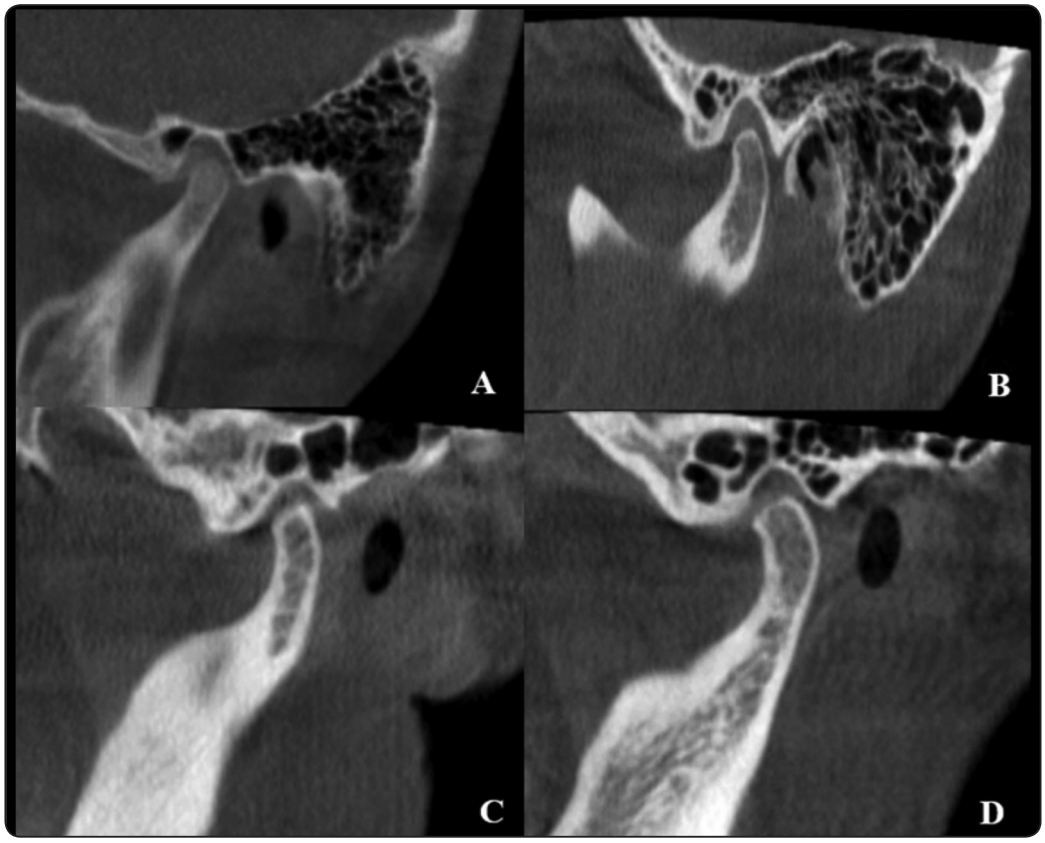

Fig. (1): Different CBCT reformatted sagittal cuts showing variable forms of articular tubercle and pterygoid fossa pneumatization (PAT & PGF). A- Unilocular PAT B- Multilocular PAT C- Unilocular PGF D- Multilocular PAT& PGF

RESULTS

The sample size for the study consisted of CBCT scans of 210 patients 136 females (64.8% of the sample) and 74 males (35.2% of the sample) providing 420 regions of interest bilaterally. The age of the patients ranged from 5 to 65, with a mean age of 26.77 ± 13.23. An almost perfect intra-observer agreement was found between the two assessment sessions of the dually assessed 90 scans confirming the consistency and reliability of the evaluation procedures (K= 0.89-1).

Generally, it was found that 19.1 % of the patients in this study exhibited PAT (n = 40) and 35.24% exhibited PGF (n = 74). Of the CBCT scans found with PAT, 20 PAT were unilateral (50%) and 20 cases (50%) were found with bilateral PAT. Moreover, 8 (20%) of the unilateral PAT cases were observed on the right side and 12 (30%) on the left side. In addition, 15 of the PAT cases were unilocular and 28 were multilocular with 3 cases showing different locularity between both sides. For PGF, 31 of the PGF cases (41.9%) were unilateral and 43 (58.1%) were bilateral. Of the unilateral PGF cases, 10 (13.5%) were on the right side and 21(28.4%) were on the left side. Only 16 of the PGF cases were unilocular, while 61 were multilocular with 3 cases also showing different locularity between both sides (Table 1).

There was no significant difference between both sexes in PAT or PGF prevalence, laterality or locularity. Of the 40 scans with PAT, 20 (50%) were female and 20 (50%) were male patients (p = 0.659), compared to 44 (59.5%) female and 30 (40.5%) male PGF patients (p = 0.230) (table 2).

TABLE (1) Descriptive Statistics

		No. = 210
Sex	Females	136 (64.8%)
	Males	74 (35.2%)
Age	Mean ± SD	26.77 ± 13.23
	Range	5 - 65
PAT	Positive	40 (19.1%)
Side	Right	8 (20.0%)
	Left	12 (30.0%)
	Bilateral	20 (50.0%)
Unilocular	Right	7 (46.7%)
	Left	4 (26.7%)
	Bilateral	4 (26.7%)
Multilocular	Right	4 (14.3%)
	Left	13 (46.4%)
	Bilateral	11 (39.3%)
PGF	Positive	74 (35.24%)
Side	Right	10 (13.5%)
	Left	21 (28.4%)
	Bilateral	43 (58.1%)
Uni	Right	0 (0.0%)
	Left	11 (68.8%)
	Bilateral	5 (31.3%)
Multi	Right	13 (21.3%)
	Left	14 (23.0%)
	Bilateral	34 (55.7%)

Of the patients with PAT in this study (n = 40), 2 were aged between 0 and 10 years, 22 were between 10 and 19 years, 9 were between 20 and 29 years, 5 were between 30 and 39 years, only one patient was between 40 and 49, and another one was between 50 and 59 years old. Of the 74 cases with PGF, 2 were aged had less than 10 years, 33 were aged between 10 and 19, 24 were aged between 20 and 29, 10 were aged between 30 and 39, only one patient was aged between 40 and 49, and 4 patients were between 50 and 59 years old (Table 3).

TABLE (3) Age distribution of the pneumatized articular tubercle and glenoid fossa cases

AGE (years)	PAT		PGF	
	No.	%	No.	%
<10	2	1.0%	2	1.0%
10 - <20	22	10.5%	33	15.7%
20 - <30	9	4.3%	24	11.4%
30 - <40	5	2.4%	10	4.8%
40 - <50	1	0.5%	1	0.5%
50 - <60	1	0.5%	4	1.9%
60 - <70	0	0.0%	0	0.0%

TABLE (2) Comparison of both sexes considering PAT and PGF prevalence, laterality and locularity

Defect		Females		Males		Test value*	P-value	Sig.
		No.	%	No.	%			
PAT								
Side	Right	5	25.0%	3	15.0%	0.833	0.659	NS
	Left	5	25.0%	7	35.0%			
	Bilateral	10	50.0%	10	50.0%			
Unilocular	Right	4	44.4%	3	50.0%	0.565	0.754	NS
	Left	3	33.3%	1	16.7%			
	Bilateral	2	22.2%	2	33.3%			
Multilocular	Right	3	23.1%	1	6.7%	1.649	0.439	NS
	Left	5	38.5%	8	53.3%			
	Bilateral	5	38.5%	6	40.0%			
PGF								
Side	Right	7	15.9%	3	10.0%	2.937	0.230	NS
	Left	15	34.1%	6	20.0%			
	Bilateral	22	50.0%	21	70.0%			
Unilocular	Right	0	0.0%	0	0.0%	0.873	0.350	NS
	Left	9	75.0%	2	50.0%			
	Bilateral	3	25.0%	2	50.0%			
Multilocular	Right	10	28.6%	3	11.5%	3.784	0.151	NS
	Left	9	25.7%	5	19.2%			
	Bilateral	16	45.7%	18	69.2%			

: Chi-square test

DISCUSSION

Being totally asymptomatic, diagnosis of the pneumatization of the articular tubercle (PAT) and/or the glenoid fossa (PGF) on the radiographic images has been previously considered as a secondary accidental finding. Nowadays, the prevalence studies, especially those using three-dimensional imaging modalities as CT and CBCT, are considered the gold standard for assessment of the skull pneumatized air spaces since they provide valuable data for better understanding of the nature and diverse features of these infrequent defects [6]. Diagnosis of the articular tubercle and glenoid fossa pneumatization is vital since their presence may predispose to the spread of different pathological and inflammatory processes along the Temporomandibular joint, as well as many complications of any surgical intervention of the region, consequently, dictate cautious surgical precautions [1].

Furthermore, it is also significant to identify PAT and PGF as it may share many features with some pathological lesions that may occur in these regions as aneurysmal bone cyst, vascular malformations, eosinophilic granuloma, metastatic lesions, and early stages of fibrous dysplasia. To be highlighted, all these conditions could demonstrate some clinical symptoms and radiographic bone destruction in contrast to asymptomatic pneumatization that appear radiographically as non-expansile, and non-destructive well-defined defects [4].

In this the study, 210 CBCT scans of 136 females and 74 males were evaluated bilaterally, the age of the patients ranged from 5 to 65, with a mean age of 26.77 ± 13.23. It was found that only 19.1 % (40 scans) and 35.24% (74 scans) of the study patients showed PAT and PGF respectively. Of the scans with PAT, 20 scans (50%) belonged to females and the other 20 scans (50%) were for males (1:1 ratio). However, for the scans with PGF, a higher female's prevalence of 59.5% (44 scans) was found while 40.5% (30 scans) went to males (1.5:1 ratio). This was explained in many previous researches on the basis that pneumatization usually starts during maturation or post-natal growth. Since females' puberty occurs earlier than males, their pneumatization is biologically more pronounced and detectable than men of the same age range [2,3].

Comparing our prevalence results with earlier studies on various populations, the first study to use CBCT for the same purpose was performed by Miloglu et al on a sample of Turkish population, using 514 CBCT scans, the age range of their patients with PAT was 4-85 years with an average of 33.4 years. PAT prevalence was found in only 8% of their cases of whom 61% were females and 39% were males (1.6:1ratio). However, the authors highlighted that the PAT prevalence is higher than previously recorded with conventional radiographic images and thus the CBCT scans are highly recommended before any regional surgical procedures [6]. On the other hand, Dellibasi et al performed a retrospective study on 825 patients of the same Turkish population, aged between 18 and 91 years, using reformatted panoramic CBCT images, but they found a very low prevalence of 2.54% patients with PAT, and a different sex distribution of the defect with 47.6% occurred in females and 52.4% occurred in males [16]. Once more, another study on 111 CBCT scans of Turkish patients aged 17-81 years recorded a different prevalence of 65.8% and 11.7% of PAT and PGF respectively, the percentage of PAT was higher for females (73.6%) than males (51.3%) [1]. Again, in a study by Salli et al on 1000 CBCT images of Turkish patients aged 16 years and older, they observed that only 14.7% of the patients had PAT and 47.1% had PGF. Of the patients with PAT, 49.7% were females and 50.3% were male patients, compared to 52.2% females and 48% male PGF patients [10].

Three studies performed on Iranian patients recorded again a wide difference of prevalence: Khojastepour et al evaluated 327 CBCT images of

patients aged 7-65 years and identified a very high prevalence of PAT in 76.7% of their patients of whom 55.4% were males and 44.6% were females (males to females' ratio 1.1:1 ratio) [15]. However, Shokri et al studied 377 CBCT images of patients with a wider age range between 8 and 73 years but the prevalence of PAT was found only 15.6% (45.7% male, 54.3% female) [18]. Of their 239 assessed patients aged 18-81 years, Mosavat and Ahmadi resulted that 21.3% presented with PAT (female-to-male ratio of PAT was 1.1:1) and 5.9% with PGF [19].

Moreover, Ladeira et al assessed PGF and PAT on CBCT scans of 658 Caucasian Brazilian patients. They recorded very close prevalence values of PGF and PAT to the current study which were 38.3% and 21.3% of their patients respectively [12]. Prevalence of pneumatization in a study of a limited sample of 62 Indians was found to be 40.3% (61.3% males and 38.7% females) with a female to male ratio 1:2 [17]. Another study was performed on 200 Indian CBCT scans, PAT was found in 25 CBCT scans with a much lower overall prevalence of 12.5% (68% were males and 32% were females) [20]. The great variability of the PAT and PGF prevalence results may be attributed to the difference in sample size, distribution and composition as well as to the racial variation of the studied patients [1,15,19].

It is worth mentioned that by using Computed tomography (CT) images a much lower prevalence of PAT was recorded compared to the aforementioned CBCT prevalence results in two published studies that detected PAT in 12 % of their Austrian patients [7] and 9.55% in a sample of Iranians [5]. This can be explained on the basis that CBCT had thinner slice thickness and smaller isotopic voxel sizes as compared to CT images.

In the present study, upon comparing both sexes in PAT or PGF prevalence, no statistically significant difference was found. This finding was consistent with almost all of the previous studies that showed no significant difference between males and females in the prevalence of PAT [5,6,10,12,13,17-20]. These findings are expected since this phenomenon is not reported to be sex linked [15]. On the other hand, a study found a correlation between sex and the prevalence of PAT, with females being more predisposed than males on CBCT scans but no such correlation was found for PGF [1].

In the present study, of the 40 CBCT scans found with PAT, 20 PAT were unilateral (50%) (8 on the right side and 12 on the left side) and 20 cases (50%) were found with bilateral PAT(1:1ratio) with no statistically significant difference between unilateral and bilateral types or right and left sides . For PGF, 31 of the PGF cases (41.9%) were unilateral (10 on the right side and 21 on the left side) and 43 (58.1%) were bilateral. Again, the comparison between both types and sides were non- statistically significant.

Many of the previous studies have shown that unilateral PAT are more prevalent than the bilateral PAT by means of CBCT and CT [1,5,10,12]. Furthermore, Miloglu et al found unilateral PAT in 75.6% of their cases while bilateral PAT were detected only in 24.4% cases [6]. Also, Shokri et al found that unilateral lesions were significantly more frequent than bilateral lesions [18]. Additionally, Mosavat and Ahmadi found that unilateral PAT and PRGF were more prevalent than bilateral cases and were found in 68.6% and 57.1% of their patients, respectively [19]. On the other hand, two studies found that the prevalence of bilateral PAT cases were higher than unilateral ones [1,15]. To clarify, these previous researches pointed out that there is no predisposing factor for the occurrence of unilateral or bilateral pneumatization [1,2,12].

Of the PGF cases, Salli et al [10] recorded that 67.7% were bilateral as well as Ladeira et al [12] that revealed 57.5% bilateral PGF. On the other hand, Ilgüy et al [1] showed that unilateral PGF was more common than bilateral PGF. In the literature, no obvious reason has been identified that may influence the likelihood of unilateral or bilateral PGF [1].

In the present study, unilateral PAT and PGF cases were observed on the left side more than the right side, however, the comparison between both sides was not statistically significant. This result is consistent with the results of many researches [10,12,22]. On the opposite side, in a study conducted by Orhan et al, the proportion of unilateral PAT cases on the right side was higher than the left side [23]. However, in many other researches, there were no statistically significant differences in terms of pneumatization between the right and left sides [2,3,13,15,25]. Again, no mechanism has been proposed in the literature to explain the cause why pneumatizations may occur on any side in terms of laterality [10].

Besides, in terms of the type of pneumatization, 15 of the PAT cases (37.5%) were unilocular and 28 were multilocular (70%) with 3 cases showing different locularity between both sides. Furthermore, 16 of the PGF cases (21.6 %) were unilocular, while 61 were multilocular (82.4%) with 3 cases also showing different locularity between both sides.

Similarly, many researches [1,6,15,20] revealed a higher prevalence of the PAT multilocular type at variable ratios of 58.5%, 76, 86.1% and 93% of their cases respectively. Additionally, more studies [2,10,12] reported a higher incidence of the multilocular type (75%, 85.7% and 98.7%, respectively). Moreover, Shokri et al found that the multilocular PATs were significantly higher than unilocular lesions (84.7% vs. 15.3%) [18]. However, in contrast to our findings, various researchers found an almost equal distribution of unilocular and multilocular types [2,3,6,13,14,23,24]. On the other hand, Jangam et al showed contradictory where most of their detected PAT were unilocular [17].

The higher incidence of multilocular type in this study and other comparable aforementioned studies might be related to the use of multiplanar CBCT images that no doubt provides more clear visualization of the air cells in TMJ region, allowing better spatial resolution with detection of finer details of the anatomical structure as thin septae within the radiolucency in case of multilocular variety and thus allow for more correct classification of the type of PAT and PGF [15,19,20]. It is also noteworthy to mention that similar to the results of the current study, two studies [10,12] found that 95.5% and 99.8% of the PGF cases were multilocular respectively, while, on the other side, another research [1] found more unilocular PGF than the multilocular type (75 % versus 25%), however, all these studies employed CBCT for PGF assessment. The age of the patients in the present study ranged from 5 to 65, with a mean age of 26.77 ± 13.23. PAT & PGF were noted in all age decades except for the seventh one, but the highest number of both defects were noted in the second decade of life (22 PAT & 33 PGF). Moreover, the youngest age where PAT and PGF were detected was 8 years old. This may highlight that the pneumatization of accessory air cells might begin before puberty, but become more pronounced and detectable reaching its full size later in life. This antagonized the general opinion that previously hypothesized that the accessory air cell pneumatization starts after puberty and reach its complete size after several years [7]. Several studies [24,15,13,23] similar to the present study detected cases of PAT in young individuals aged 7, 9, 10 and 11 years and therefore, at the first decade or before the second half of the second decade of life. Other studies [17,20] found that the maximum number of pneumatization was found at the third decade of life.

The process of temporal bone pneumatization is contradictory in the literature as some authors suggested that it is typically complete by 10 years of age in females and 15 years in males [9]. One more study proposes that mastoid air cells have formed completely by the age of 10, but the maturation stage only ends at 15–20 years old [27]. Others suggested that 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 then, pneumatization ceases throughout adulthood [17]. Another study admitted that it is unknown at which age air cells within the articular tubercle begin to develop [2].

To summarize, there is a wide variability reported in the literature considering the temporal bone pneumatization prevalence, laterality, locularity and age distribution. This may be governed by racial, genetic or environmental factors [28]. The prevalence of PAT and PGF should be assessed individually in every population [19] then, studies on each population should be collected and used as population specific data. Although no treatment is necessary for PAT or PGF, the clinical significance of their detection is important in patients undergoing surgical interventions or suffering from pathological lesions of the region as they represent areas of minimal resistance that might complicate the surgical procedures or facilitate the spread of various pathologies. CBCT scans provide a powerful diagnostic aid that should be regularly used for diagnostic and preoperative assessment purposes of the temporal air spaces.

CONCLUSION

Prevalence of pneumatized articular tubercle was 19.1 while the prevalence of pneumatized glenoid fossa was 35.24%.in the studied sample. The prevalence was not linked to sex or laterality or locularity or age. CBCT provide a perfect imaging modality for evaluation of these temporal air spaces.

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