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Prevalence of Incidental Findings in Paranasal Sinuses Using CBCT

Niezamierzone rozpoznania zmian patologicznych w zatokach obocznych nosa w tomografii stożkowej

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article

Abstract

Background. There is little information about the use of cone-beam computed tomography (CBCT) in evaluation of paranasal sinuses.
Objectives. The aim of this study was to determine the CBCT findings of all paranasal sinuses in a defined group of Iranian patients.
Material and Methods. CBCT images of 220 patients were evaluated to detect the incidental findings in paranasal sinuses. After excluding images not meeting the inclusion criteria, 100 CBCT images taken for evaluation of dental implants, position of impacted teeth and their association with vital structures, orthodontic treatment, maxillofacial surgery, and TMJ examination were interpreted by two observers. Data was analyzed with χ^2 test.
Results. The most prevalent CBCT findings in the maxillary (68%), frontal (70%), and sphenoid (74%) sinuses was septation, whereas in the ethmoid sinus flat mucosal thickening found to be the most frequent one (28%). The prevalence of incomplete opacity was significantly higher in men than in women in the right maxillary sinus ($p = 0.019$). In the sphenoid sinus, septation was significantly higher in females than in males ($p = 0.032$). Incomplete opacity was significantly higher in patients > 30 than the younger in the right maxillary, frontal, and ethmoid sinuses ($p = 0.017$, $p = 0.018$, $p = 0.01$). In the frontal sinus, flat mucosal thickening was significantly higher in patients > 30 than younger ones ($p = 0.037$).
Conclusions. Septation was found as the most frequent incidental finding in three of four paranasal sinuses. Moreover, incomplete opacity was more common in older patients in the right maxillary, frontal, and ethmoid sinuses (**Dent. Med. Probl. 2014, 51, 4, 431–438**).

Key words: cone-beam computed tomography, paranasal sinus, prevalence.

Streszczenie

Wprowadzenie. Wiedza na temat zastosowania tomografii stożkowej w ocenie zatok obocznych nosa ciągle jest niepełna.
Cel pracy. Ocena zastosowania tomografii stożkowej w diagnostyce patologii wszystkich zatok obocznych nosa w określonych grupach pacjentów irańskich.
Materiał i metody. Analizowano 220 tomografii stożkowych w celu wykrycia przypadkowych patologii zatok obocznych nosa. Po wykluczeniu obrazów niespełniających kryteriów włączenia do badania 2 lekarzy analizowało 100 tomografii wykonanych w związku z leczeniem implantologicznym, diagnostyką zębów zatrzymanych, leczeniem ortodontycznym, chirurgią szczękowo-twarzową i badaniem stawów skroniowo-żuchwowych. Dane analizowano z zastosowaniem testu chi-kwadrat.
Wyniki. Najczęściej rozpoznawano zmiany w zatokach szczękowych (68%), czołowej (70%) i klinowej (74%), nato-

miast najczęściej diagnozowano pogrubienie błony śluzowej zatoki sitowej (28%). Występowanie niecałkowitego zacienienia było istotnie częstsze u mężczyzn w prawej zatoce szczękowej (p = 0,019). W zatoce klinowej przegrody występowały istotnie częściej u kobiet (p = 0,032). Niecałkowite zacienienie zatoki występowało znacząco częściej u osób powyżej 30 lat niż u osób młodszych w prawej zatoce szczękowej, czołowej i sitowej (p = 0,017, p = 0,018, p = 0,01). W zatoce czołowej pogrubienie błony śluzowej było istotnie częstsze u pacjentów powyżej 30 lat niż u osób młodszych (p = 0,037).

Wnioski. Przegrody w zatoce były w niezamierzony sposób najczęściej stwierdzane w 3 z 4 zatok obocznych nosa. Niecałkowite zacienienie zatoki było częstsze u pacjentów starszych niż młodszych w zatokach szczękowych, czołowej i sitowej (**Dent. Med. Probl. 2014, 51, 4, 431–438**).

Słowa kluczowe: tomografia stożkowa, zatoka oboczna nosa, częstość.

The advent of cone-beam computed tomography (CBCT) represented a great improvement in the field of craniofacial imaging [1]. The use of CBCT to obtain multi-planar views from oral and maxillofacial regions (OMF) was pioneered by Arai in the late 1990s [2]. The main advantages of CBCT imaging are accessibility, easy handling and the possibility of acquiring a real-size data set with multi-planar cross sectional, and three-dimensional views based on a single scan with a low radiation dose [3, 4]. In addition, according to Patel, the most clinically useful aspect of CBCT imaging is the highly sophisticated software that allows large volume of collected data to be broken down and processed or reconstructed into a format that closely resembles what is produced by other imaging modalities [5]. In contrast, there are some limitations for CBCT such as lack of a soft tissue window, lack of precise Hounsfield units, higher imaging noise, low contrast range (dependent on the type of X-ray detector), and truncation artifacts [3, 6]. De Vos [3] demonstrated that there are 380 papers on CBCT imaging of the OMF regions of which 86 were related to clinical application of this method. Gracco et al. [1] studied the prevalence of incidental findings of maxillary sinus in Italian orthodontic patients retrospectively, and Cağlayan et al. [6] accomplished a study regarding incidental findings in the maxillofacial region by means of CBCT. However, there is little information about the use of CBCT in evaluation of paranasal sinuses especially for ethmoid, frontal and sphenoid sinuses.

An incidental finding is one that is unrelated to the present illness and is discovered unintentionally such as mucosal thickening, septation, discontinuity of sinus wall, complete/incomplete opacity, foreign body in sinus, sinus hypoplasia, expansion of the maxillary sinus, expansion of sinus wall, et al. [6–9].

As studies about incidental findings in paranasal sinuses are scarce, with the exception of maxillary sinus, we have conducted this study to determine the CBCT findings in all paranasal sinuses in a defined group of Iranian patients.

Material and Methods

CBCT images of 220 patients referred to the Department of Oral and Maxillofacial Radiology, Hamadan Dental School, Hamadan, Iran, were evaluated retrospectively from June 2011 to September 2013 to detect the incidental findings in the paranasal sinuses. CBCTs, which had been taken for the following reasons, were included in the study: dental implants, position of impacted teeth and their association with vital structures, orthodontic treatment, maxillofacial surgery, evaluation of TMJ. After excluding cases with a history of trauma, facial deformity, those referred for paranasal sinus evaluation, history of surgery, images with field of view (FOV)# 6, and those without adequate quality for evaluation of sinuses the remaining images were chosen. In our study most of CBCTs were taken for dental implant treatment, so a great number of samples were omitted due to smaller FOV, and 100 cases remained finally. All images were obtained by using a NewTom® 3G volume scanner (Verona, Italy) under the following conditions: 12 inch FOV, 110 kV, 2.00 mA, 5.4-S exposure, and 0.5 mm slice thickness. The resulting images were elaborated by using NNT NewTom 3G software to obtain the multi-planar views from paranasal sinuses.

Two experienced oral and maxillofacial radiologists interpreted the CBCT images separately. The diagnostic criteria were considered according to the literature [1, 7, 8] and in case of disagreement, a consensus was made after a discussion between the observers. All scans were displayed by using the same computer (17-inch Samsung monitor, SyncMaster 740 N®, Samsung Co, Korea) with the screen resolution set at 1280 × 1024 pixels and color set to 320 bit depth.

The reliability and degree of agreement among observers were also determined by Cohen's Kappa coefficient. In this study the values obtained for intra-examiner reliability were over 0.86 with 95% confidence interval (CI). The Kappa coefficient for inter-examiner reliability was 0.92 with 95% CI.

The χ^2 test and the SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA) were used to analyze the significance of differences between groups. P-value less than 0.05 was considered statistically significant.

Results

The mean age of 100 patients was 27.57 ± 11.05, ranging from 12 to 73. There were 40 (40%) males and 60 (60%) females. The mean age of males and females was 30.58 ± 11.93 and 21.57 ± 9.97, respectively. Table 1 shows the list of detected incidental findings in this study.

The prevalence of incidental findings in all paranasal sinuses are listed in Table 2 in terms of sex. In the left maxillary sinus, there was no significant difference between the male and female patients in terms of incidental findings ($p > 0.05$). On the other hand, in the right maxillary sinus a significant difference between men and women was found in terms of incomplete opacity ($p = 0.019$).

Moreover, there was no significant difference between male and female patients with respect to the incidental findings of the frontal sinus.

In the ethmoid sinus, there was no significant difference between male and female patients in relation to its CBCT findings as well.

However, a significant difference between men and women was found in the sphenoid sinus in terms of septation ($p = 0.032$).

The frequency of all incidental findings (Fig. 1–5) was also calculated in terms of the patients' age and summarized in Table 3.

Table 1. CBCT findings with definitions

Tabela 1. Zastosowania tomografii stożkowej

Finding	Definition
Mucosal thickening	mucosal thickening was considered present when the thickness of the sinus mucosa was ≥ 1 mm as measured from the floor of the sinus to the highest border of the mucosa [1]
Flat mucosal thickening	thickened mucosa is readily detectable in the radiograph as a noncorticated band noticeably more radiopaque than the air filled sinus, paralleling the boney wall of the sinus [7]
Polypoid mucosal thickening	the thickened mucous membrane of a chronically inflammed sinus frequently forms into regular folds called polyps. Polyposis of the sinus mucosa may develop in an isolated area in a number of areas throughout the sinus [7]
Complete/Incomplete opacity	thickening of sinus mucosa and accumulation of secretions that accompany sinusitis reduce the air content of the sinus and causes it to become increasingly radiopaque [7]
Discontinuity of sinus wall, perforation, fistule	As the malignant neoplasms of the paranasal sinuses enlarge, it may destroy sinus walls and in general cause irregular radiolucent areas in the surrounding bone [7]
Foreign body, tooth in sinus	tooth roots may be fractured due to various forms of trauma, including iatrogenic causes. They may be displaced into the sinus during extraction or subsequent attempts to retrieve them [7]
Siuns Hypoplasia/sinus expansion	in hypoplasia the radiographic images of the affected sinus may appear more radiopaque than normal, because of the relatively large amount of surrounding maxillary bone [7]
Expansion of the maxillary sinus	the sinus walls become thin [7]
Air-fluid level	an air-fluid level results from accumulation of secretions. Since the radiopacities of transudates, exudates, blood and pathologically altered mucosa are similar; the differentation among them relies on their shape and distribution. When present, fluid appears radiopaque and occupies the inferior aspect of the sinus.The border between the radiopaque fluid and the relatively radiolucent antrum is horizontal and straight or with a meniscus [7]
Septation	they are thin folds of cortical bone that projecting a few millimeters away from the floor and wall of sinus, which may extend across the sinus as well [7]
Bony nodule	the floor of the maxillary sinus occasionally shows small radiopaque projections, which are nodules of the bone [7]
Neurovascular canal	thin radiolucent lines of uniform width are found within the image of maxillary sinus. These are the shadows of neurovascular canals or grooves in the lateral sinus walls that accommodate the posterior superior alveolar branches, and accompany superior alveolar nerves [2]

Table 2. Prevalence of incidental findings in the paranasal sinuses using CBCT according to sex

Tabela 2. Płeć a częstotliwość przypadkowych patologii zatok obocznych nosa z użyciem tomografii stożkowej

Pathological finding	Female (n = 60) N (%)	Male (n = 40) N (%)	Total N (%)	p value
left maxillary sinus				
Flat mucosal thickening	11 (18.3)	10 (25.0)	21 (21.0)	0.423
Polypoid mucosal thickening	11 (18.3)	6 (15.0)	17 (17.0)	0.664
Complete opacity	1 (1.7)	0 (0.0)	1 (1.0)	0.412
Incomplete opacity	3 (5.0)	4 (10.0)	7 (7.0)	0.337
Discontinuity of sinus wall	1 (1.7)	0 (0.0)	1 (1.0)	0.412
Sinus hypoplasia	2 (3.3)	0 (0.0)	2 (2.0)	0.243
Sinus expansion	1 (1.7)	0 (0.0)	1 (1.0)	0.412
Air fluid level	0 (0.0)	1 (2.5)	1 (1.0)	0.218
Septation	23 (38.3)	11 (27.5)	34 (34.0)	0.263
Bony nodule	6 (10.0)	5 (12.5)	11 (11.0)	0.695
Neurovascular canal	16 (26.7)	5 (12.5)	21 (21.0)	0.088
right maxillary sinus				
Flat mucosal thickening	10 (16.7)	11 (27.5)	21 (21.0)	0.193
Polypoid mucosal thickening	18 (30.0)	10 (25.0)	28 (28.0)	0.585
Complete opacity	1 (1.7)	0 (0.0)	1 (1.0)	0.412
Incomplete opacity	3 (5.0)	8 (20.0)	11 (11.0)	0.019
Foreign body, tooth in sinus	2 (3.3)	0 (0.0)	2 (2.0)	0.243
Sinus hypoplasia	0 (0.0)	2 (5.0)	2 (2.0)	0.080
Septation	23 (38.3)	11 (27.5)	34 (34.0)	0.263
Bony nodule	6 (10.0)	4 (10.0)	10 (10.0)	1.000
Neurovascular canal	7 (11.7)	3 (7.5)	10 (10.0)	0.496
frontal sinus				
Flat mucosal thickening	0 (0.0)	2 (5.0)	2 (2.0)	0.080
Polypoid mucosal thickening	2 (3.3)	1 (2.5)	3 (3.0)	0.811
Complete opacity	9 (15.0)	2 (5.0)	11 (11.0)	0.117
Incomplete opacity	2 (3.3)	3 (7.5)	5 (5.0)	0.349
Septation	44 (73.3)	26 (65.0)	70 (70.0)	0.373
Bony nodule	6 (10.0)	1 (2.5)	7 (7.0)	0.150
ethmoid sinus				
Flat mucosal thickening	17 (28.3)	11 (27.5)	28 (28.0)	0.928
Polypoid mucosal thickening	4 (6.7)	4 (10.0)	8 (8.0)	0.547
Incomplete opacity	1 (1.7)	2 (5.0)	3 (3.0)	0.338
Septation	2 (3.3)	0 (0.0)	2 (2.0)	0.243
sphenoid sinus				
Flat mucosal thickening	3 (5.0)	0 (0.0)	3 (3.0)	0.151
Polypoid mucosal thickening	4 (6.7)	2 (5.0)	6 (6.0)	0.731
Complete opacity	0 (0.0)	1 (2.5)	1 (1.0)	0.218
Incomplete opacity	2 (3.3)	1 (2.5)	3 (3.0)	0.811
Septation	49 (81.7)	25 (62.0)	74 (74.0)	0.032
Bony nodule	1 (1.7)	2 (5.0)	3 (3.0)	0.338

n – number of findings.

Table 3. Prevalence of incidental findings in the paranasal sinuses using CBCT according to age

Tabela 3. Wiek a występowanie przypadkowych patologii zatok obocznych nosa z użyciem tomografii stożkowej

Pathological finding	12–29 yr (n = 68) N (%)	30–73 yr (n = 32) N (%)	Total N (%)	p value
left maxillary sinus				
Flat mucosal thickening	14 (20.6)	7 (21.9)	21 (21.0)	0.883
Polypoid mucosal thickening	10 (14.7)	7 (21.9)	17 (17.0)	0.373
Complete opacity	0 (0.0)	1 (3.1)	1 (1.0)	0.143
Incomplete opacity	3 (4.4)	4 (12.5)	7 (7.0)	0.139
Discontinuity of sinus wall	0 (0.0)	1 (3.1)	1 (1.0)	0.143
Sinus hypoplasia	2 (2.9)	0 (0.0)	2 (2.0)	0.327
Sinus expansion	0 (0.0)	1 (3.1)	1 (1.0)	0.143
Air fluid level	1 (1.5)	0 (0.0)	1 (1.0)	0.491
Septation	25 (36.8)	9 (28.1)	34 (34.0)	0.395
Bony nodule	9 (13.2)	2 (6.2)	11 (11.0)	0.298
Neurovascular canal	14 (20.6)	7 (21.9)	21 (21.0)	0.883
right maxillary sinus				
Flat mucosal thickening	14 (20.6)	7 (21.9)	21 (21.0)	0.883
Polypoid mucosal thickening	18 (26.5)	10 (31.3)	28 (28.0)	0.620
Complete opacity	1 (1.5)	0 (0.0)	1 (1.0)	0.491
Incomplete opacity	4 (5.9)	7 (21.9)	11 (11.0)	0.017
Foreign body, tooth in sinus	2 (2.9)	0 (0.0)	2 (2.0)	0.327
Sinus hypoplasia	1 (1.5)	1 (3.1)	2 (2.0)	0.581
Septation	25 (36.8)	9 (28.1)	34 (34.0)	0.395
Bony nodule	8 (11.8)	2 (6.3)	10 (10.0)	0.391
Neurovascular canal	7 (10.3)	3 (9.4)	10 (10.0)	0.886
frontal sinus				
Flat mucosal thickening	0 (0.00)	2 (6.3)	2 (2.0)	0.037
Polypoid mucosal thickening	2 (2.9)	1 (3.1)	3 (3.0)	0.960
Complete opacity	8 (11.8)	3 (9.4)	11 (11.0)	0.722
Incomplete opacity	1 (1.5)	4 (12.5)	5 (5.0)	0.018
Septation	50 (73.5)	20 (62.5)	70 (70.0)	0.262
Bony nodule	5 (7.4)	2 (6.3)	7 (7.0)	0.840
ethmoid sinus				
Flat mucosal thickening	19 (27.9)	9 (28.1)	28 (28.0)	0.985
Polypoid mucosal thickening	4 (5.9)	4 (12.5)	8 (8.0)	0.255
Incomplete opacity	0 (0.0)	3 (9.4)	3 (3.0)	0.010
Septation	2 (2.9)	0 (0.0)	2 (2.0)	0.327
sphenoid sinus				
Flat mucosal thickening	2 (2.9)	1 (3.1)	3 (3.0)	0.960
Polypoid mucosal thickening	4 (5.9)	2 (6.3)	6 (6.0)	0.942
Complete opacity	1 (1.5)	0 (0.0)	1 (1.0)	0.491
Incomplete opacity	2 (2.9)	1 (3.1)	3 (3.0)	0.960
Septation	54 (79.4)	20 (62.5)	74 (74.0)	0.072
Bony nodule	3 (4.4)	0 (0.0)	3 (3.0)	0.228

n – number of findings.

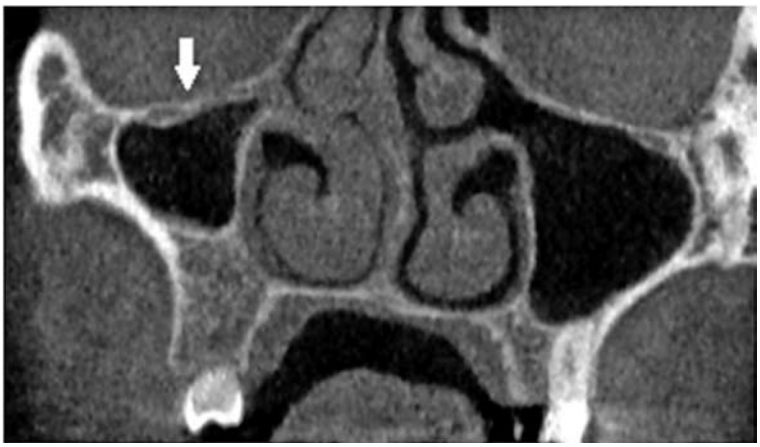

Fig. 1. Hypoplasia of the right maxillary sinus (CBCT, coronal view)

Ryc. 1. Niedorozwój prawej zatoki szczękowej (CBCT, przekrój koronowy)

Fig. 2. Mucosal thickening in the ethmoid sinus (CBCT, axial view)

Ryc. 2. Zgrubienie błony śluzowej w zatoce sitowej (CBCT, przekrój osiowy)

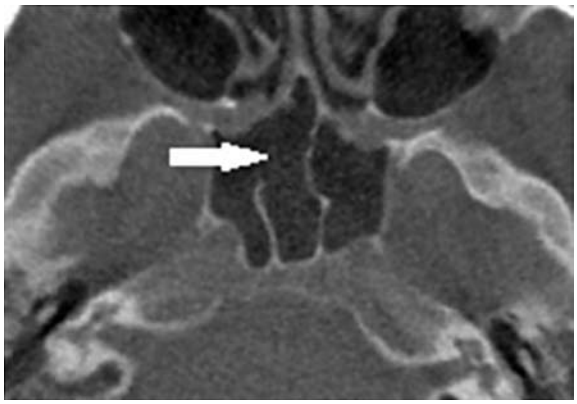

Fig. 3. Septation in the sphenoid sinus (CBCT, axial view)

Ryc. 3. Przegrody w zatoce klinowej (CBCT, przekrój osiowy)

Fig. 4. Partial opacification of frontal sinus (CBCT, coronal view)

Ryc. 4. Częściowe zacienienie zatoki czołowej (CBCT, przekrój koronowy)

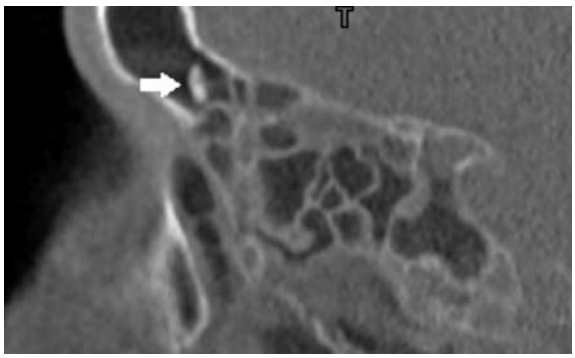

Fig. 5. Bony nodule in the frontal sinus (CBCT, sagittal view)

Ryc. 5. Guzek kostny w zatoce czołowej (CBCT, przekrój strzałkowy)

Significant difference between patients < 30 years and patients > 30 years was noticed in relation to incomplete opacity in the right maxillary sinuses ($p = 0.017$).

There were also significant differences between patients < 30 years and > 30 years with re-

spect to flat mucosal thickening and incomplete opacity in the frontal sinus ($p = 0.037$, $p = 0.018$).

Meanwhile, significant difference was found between patients < 30 years and > 30 years in the ethmoid sinus in terms of incomplete opacity ($p = 0.010$).

Discussion

In our study, the most frequent CBCT finding in the maxillary sinuses (left and right) was septation (68%), followed by polypoid mucosal thickening (45%), and flat mucosal thickening (42%). Septation was the most common finding in both sexes, followed by flat mucosal thickening in males and polypoid mucosal thickening in females.

In the left maxillary sinus, septation had the highest frequency followed by flat mucosal thickening. It is noteworthy that discontinuity of sinus wall, sinus expansion, and sinus hypoplasia were not found in the male patients. In addition, there were no significant differences in the above-mentioned variables between both sexes.

In the right maxillary sinus, septation was the most frequent finding, followed by polypoid mucosal thickening, flat mucosal thickening and incomplete opacity. In contrast to the left maxillary sinus, sinus expansion, discontinuity of the sinus wall, and air fluid level were not found in this sinus. In addition, complete opacity and sinus hypoplasia were not detected in male and female patients, respectively. The prevalence of incomplete opacity was also significantly higher in men than in women in the right maxillary sinus.

Our study showed that in the right and left maxillary sinuses together, septation was the most frequent finding in patients younger and older than 30 years of age.

Rege et al. [10] evaluated the occurrence of maxillary sinus abnormality using CBCT, and reported that mucosal thickening was the most prevalent abnormality (66%), followed by retention cyst (10%), and opacification (7.8%). In another study, Ritter et al. [11] showed that mucosal thickening was the most frequent pathology in the maxillary sinus. On the other hand, Ritter et al. [11] demonstrated that male patients and patients over 60 years of age had a significantly more pathologies in the maxillary sinus than females and younger patients. In Smith's study [12], mucosal thickening was found in 19.4% of patients.

Age has been considered as an influencing factor for sinus abnormalities in several studies [13, 14]. In agreement with these studies, Gracco [1] concluded that age is a significant predictor of mucosal thickening, in a way that subjects aged 41–60 years showed a 40.1% higher odds-ratio than those aged 12–18 years. However, Lesserson et al. [15] and Tatil et al. [16] reported that no correlation was found between age and sinus abnormalities.

According to Tatil et al. [16] and Cho et al. [17], sex does not seem to make any difference in sinus abnormalities. In contrast, Gracco [1] demonstrated that gender was a significant predictor of pseudocysts in the maxillary sinus, with males showing a 196.3% higher relative risk for this pathology. The same findings were also reported by Havas et al. [18].

In our study, septation was the most common CBCT finding in the frontal sinus followed by complete opacity, bony nodule and incomplete opacity. Septation also had the highest percentage in both sexes and in patients > 30 years and < 30 years. Flat mucosal thickening was not found in females and patients younger than 30. In addition, incomplete opacity and flat mucosal thickening were significantly higher in patients > 30 years than patients < 30 years.

In the ethmoid sinus, flat mucosal thickening was the most predominant finding followed by polypoid mucosal thickening in both sexes and age groups. Incomplete opacity was not found in younger patients, and septation was not detected in older ones. In addition, incomplete opacity was significantly higher in patients > 30 years compared to the younger.

In the sphenoid sinus, septation was the most frequent finding. Complete opacity and bony nodule were not detected in patients older than 30, and flat mucosal thickening was not found in male patients. In addition, septation was significantly higher in females than males.

In a recent study, Beaini et al. [19] concluded that CBCT could be a useful method in the evaluation of frontal sinus. Cho et al. [17], according to a CBCT-based study, reported that 41.8% of patients had opacification in at least one paranasal sinus. The ethmoid (28.4%) and maxillary (27.8%) sinuses were among the most frequently involved ones.

Unfortunately, limited information is available about CBCT findings in paranasal sinuses, especially regarding frontal, ethmoid, and sphenoid ones. Therefore, we could not compare our results with other studies.

As a conclusion, septation was found as the most frequent incidental finding in three of four paranasal sinuses. Moreover, incomplete opacity was more common in older patients in the right maxillary, frontal, and ethmoid sinuses. However, further studies are needed to determine whether our findings can be generalized to a nationally representative sample.

References

[1] Gracco A., Incerti Parenti S., Ioele C., Alessandri Bonetti G., Stellini E.: Prevalence of incidental maxillary sinus findings in Italian orthodontic patients: a retrospective cone-beam computed tomography study. Korean. J. Orthod. 2012, 42, 329–334.

[2] Arai Y., Tammisalo E., Iwai K., Hashimoto K., Shinoda K.: Development of a compact computed tomographic apparatus for dental use. Dentomaxillofac. Radiol. 1999, 28, 245–248.

[3] De Vos W., Casselman J., Swennen G.R.: Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: a systematic review of the literature. Int. J. Oral Maxillofac. Surg. 2009, 38, 609–625.

[4] Shokri A., Mortazavi H., Salemi F., Javadian A., Bakhtiari H., Matlabi H.: Diagnosis of simulated external root resorption using conventional intraoral film radiography, CCD, PSP, and CBCT: a comparison study. Biomed. J. 2013, 36, 18–22.

[5] Patel S., Dawood A., Ford T.P., Whaites E.: The potential applications of cone beam computed tomography in the management of endodontic problems. Int. Endod. J. 2007, 40, 818–830.

[6] Cağlayan F., Tozoğlu U.: Incidental findings in the maxillofacial region detected by cone beam CT. Diagn. Interv. Radiol. 2012, 18, 159–163.

[7] White C.S., Pharoah M.J.: Oral radiology principles and interpretation. 6th ed. Philadelphia: Mosby-Year Book Inc. 2009, 368–390.

[8] Beaumont C., Zafiropoulos G.G., Rohmann K., Tatakis D.N.: Prevalence of maxillary sinus disease and abnormalities in patients scheduled for sinus lift procedures. J. Periodontol. 2005, 76, 461–467.

[9] Uzun L., Aslan G., Mahmutyazicioglu K., Yazgan H., Savranlar A.: Is pneumatization of middle turbinates compensatory or congenital? Dentomaxillofac. Radiol. 2012, 41, 564–570.

[10] Rege I.C., Sousa T.O., Leles C.R., Mendonça E.F.: Occurrence of maxillary sinus abnormalities detected by cone beam CT in asymptomatic patients. BMC. Oral Health. 2012, 12, 30.

[11] Ritter L., Lutz J., Neugebauer J., Scheer M., Dreiseidler T., Zinser M.J.: Prevalence of pathologic findings in the maxillary sinus in cone-beam computerized tomography. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. 2011, 111, 634–640.

[12] Smith K.D., Edwards P.C., Saini T.S., Norton N.S.: The prevalence of concha bullosa and nasal septal deviation and their relationship to maxillary sinusitis by volumetric tomography. Int. J. Dent. 2010, 2010. pii: 404982.doi: 10.1155/2010/404982.

[13] Diament M.J., Senac M.O. Jr., Gilsanz V., Baker S., Gillespie T., Larsson S.: Prevalence of incidental paranasal sinuses opacification in pediatric patients: a CT study. J. Comput. Assist. Tomogr. 1987, 11, 426–431.

[14] van der Veken P.J., Clement P.A., Buisseret T., Desprechins B., Kaufman L., Derde M.P.: CT-scan study of the incidence of sinus involvement and nasal anatomic variations in 196 children. Rhinol. 1990, 28, 177–184.

[15] Lesserson J.A., Kieserman S.P., Finn D.G.: The radiographic incidence of chronic sinus disease in the pediatric population. Laryngoscope 1994, 104,159–166.

[16] Tatli M.M., San I., Karaoglanoglu M.: Paranasal sinus computed tomographic findings of children with chronic cough. Int. J. Pediatr. Otorhinolaryngol. 2001, 60, 213–217.

[17] Cho B.H., Jung Y.H.: Prevalence of incidental paranasal sinus opacification in dental paediatric patients. Korean. J. Oral Maxillofac. Radiol. 2008, 38, 219–223.

[18] Havas T.E., Motbey J.A., Gullane P.J.: Prevalence of incidental abnormalities on computed tomographic scans of the paranasal sinuses. Arch. Otolaryngol. Head Neck Surg. 1988, 114, 856–859.

[19] Beaini T.L., Miamoto Dias P.E., Duailib Neto E.F., Chilvarquer I., Haltenhoff Melani R.: Superimposition of frontal sinus 3D volumes. J. Forensic Odontostomatol. 2013, 31, Suppl 1., 144.

[20] Güldner C., Pistorius S.M., Diogo I., Bien S., Sesterhenn A., Werner J.A.: Analysis of pneumatization and neurovascular structures of the sphenoid sinus using cone-beam tomography (CBT). Acta. Radiol. 2012, 53, 214–219.

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