Oral Radiology (2020) 36:80–84
https://doi.org/10.1007/s11282-019-00382-5

ORIGINAL ARTICLE

What are the risk factors for maxillary sinus pathologies? A CBCT study

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Received: 12 February 2019 / Accepted: 20 March 2019 / Published online: 29 March 2019

Abstract

Objective Some anatomic variations may interfere with proper airflow in the maxillary sinus and predispose to maxillary sinus pathologies. It was also reported that as a result of the transport of microorganisms from infected periapical tissues, maxillary sinus pathologies can develop. The objective of this study was to determine the potential relationships of maxillary sinus septa, concha bullosa, nasal septal deviation, and teeth with periapical lesion to maxillary sinus pathologies.

Methods 200 cone beam computed tomography scans obtained at Necmettin Erbakan University, Faculty of Dentistry from 2013 to 2018 were retrospectively reviewed for the presence of maxillary sinus septa, concha bullosa, nasal septal deviation, teeth with periapical lesions, and maxillary sinus pathologies. When maxillary sinus mucosal thickening exceeded 2 mm, it was considered as a pathological condition. Logistic regression analysis was used to determine the risk factors for maxillary sinus pathologies. $p < 0.05$ considered statistically significant.

Results 185 (46.2%) of the 400 maxillary sinuses showed maxillary sinus pathologies. Maxillary sinus septa, concha bullosa, and nasal septal deviation were not found to be as a risk factor for the maxillary sinus pathologies ($p > 0.05$). At least one apical lesion adjacent to the maxillary sinus increased the maxillary sinus pathology by 5.24 times on the right (OR 5.24, $p < 0.001$) and by 4.67 times on the left side (OR 4.67, $p < 0.001$).

Conclusion To prevent maxillary sinus pathologies, it is important for the teeth adjacent to the maxillary sinus to be healthy.

Keywords Maxillary sinus pathology · Anatomic variation · Periapical lesion · CBCT

Introduction

A normal sinus will not be observed on a radiograph if there is not an increase in mucosal thickness or an irritation by an allergic or infectious agent [1]. Mild maxillary sinus mucosal thickening is a normal finding in asymptomatic individuals [2]. In fact, maxillary sinusitis has been reported in most cases to be when mucosal thickening exceeds 2 mm [3]. Based on this, when maxillary sinus mucosal thickening exceeds 2 mm, it is suggested to be considered as a pathological condition [1, 4].

Inflammation of maxillary sinuses (or maxillary sinusitis) may occur as a result of viral, bacterial and fungal agents. Approximately 10–12% of cases of maxillary sinusitis are reported to be caused by odontogenic infections in the roots of posterior teeth that are adjacent to the maxillary sinus space. As a result of the transport of microorganisms from infected periapical tissues, acute or chronic sinusitis can develop [1]. It has been reported that apical periodontitis [5], periodontal diseases [6], implant therapy [7] and tooth extraction [8] increase the risk of maxillary sinusitis. Apical and marginal periodontitis are the 83% of all dental causes of maxillary sinusitis [5].

Concha bullosa is the pneumatisation of the middle turbinate [9]. It is believed that osteomeatal obstructions predispose to sinus diseases [10]. Although it remains controversial, a deviated nasal septum or concha bullosa may be potential contributors to sinus disease by narrowing the osteomeatal unit and blocking proper airflow [9]. The aim of this study was to find out the potential relationships of maxillary sinus septa, concha bullosa, nasal septal deviation, and teeth with periapical lesions to maxillary sinus pathologies.

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Methods

Sample and study design

Two hundred patients' cone beam computed tomography (CBCT) records were examined retrospectively. Patients which underwent CBCT examination with reasons of implant surgery and third molar surgery were included in the study. 124 patients were female and 76 were male. The patients were aged between 16 and 68 years and the mean age was 32.93 ± 14.14 years. The study protocol was approved by The Ethics Committee in Research of the Necmettin Erbakan University, Faculty of Dentistry (no. 2019/01). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Individuals with evidence of bone disease and relevant drug consumption, congenital disorders and syndromic conditions, trauma, history of surgery and pathologies in the maxillofacial region were not included in the study. To assure that the examination is precise, images with small FOV (field of view) and with no diagnostic competence.

Radiographic assessment

CBCT images were for any presence of maxillary sinus septa, concha bullosa, nasal septal deviation, teeth with periapical lesions adjacent to the maxillary sinus, and maxillary sinus pathologies (maxillary sinus mucosal thickening > 2 mm) [1, 4] on sagittal, coronal and axial sections. Mucosal thickness was measured as the highest thickness from the sinus floor [11]. The determination of periapical lesions depended on the circumstance that the lamina dura was invisible and periapical radiolucency around the root apex indicating bone destruction was distinguishable [12]. Premolar and molar teeth in the right and left maxillary posterior region were assessed in the study. Concha bullosa was defined as pneumatization of any size within the middle conchae. Careful radiological examination on axial and coronal slices should be performed to exclude 'pseudopneumatisation' of the concha, which results from the contact of the lateral edge of the concha with the internal wall of the maxillary sinus. Nasal septal deviation was defined as a deviation that is more than 4 mm from the midline [9] (Fig. 1).

CBCT images were acquired in a sitting position using a Morita 3D Accuitomo 170 device (J Morita MFG Corp., Kyoto, Japan) which operated at 90 kVp and 5 mA, 17.5 s rotation time, voxel 0.25 mm, 100 mm FOV according to the protocol recommended by the manufacturer. All of the observations were made by one observer with the use of the i-Dixel software Ver. 2.0 (manufactured by J Morita, MFG Corp.) 2.66 GHz Intel Xeon PC with 3.25 Gb RAM, Windows XP Professional operating system and a 27-inch flat panel color display with a resolution of 2.560×1.600 pixels (Dell U2711HTM).

Statistical analysis

All statistical performed using SPSS software v.21 (IBM Corp., Armonk, NY, USA). Mean and standard deviations were calculated with descriptive statistics and the Pearson's chi-square test was used for categorical variables. Mann–Whitney *U* test was applied to find out the relationship between age and maxillary sinus pathologies. The risk factors for maxillary sinus pathologies were investigated by binary logistic regression analysis. Statistical significance was assumed for $p < 0.05$.

Results

In this study 400 maxillary sinus from 200 patients were evaluated. The frequency of maxillary sinus pathology was 46.2% (185/400). There was no statistically significant relationship between age, gender and maxillary sinus pathology ($p > 0.05$).

The frequency of maxillary sinus septa was 19.5% (78/400), concha bullosa 41.7% (167/400), nasal septal deviation 60.5% (121/200), teeth with apical lesion (at least one tooth) 35.2% (141/400).

The chi-square test showed that there was a statistically significant relationship between the presence of an apical lesion (at least one tooth) and maxillary sinus pathology ($p < 0.001$). There was no relationship between maxillary sinus pathology and other studied parameters (maxillary sinus septa, concha bullosa and nasal septal deviation) ($p > 0.05$) (Table 1). The logistic regression analysis showed that presence of apical lesion (at least one tooth) was a risk factor for the maxillary sinus pathologies on the right (OR 5.213) and left side (OR 4.777) ($p < 0.001$) (Table 2).

Discussion

Although it was first introduced in 1998 [13], CBCT has become popular for diagnosis and treatment planning in dentistry [14]. Compared to computed tomography (CT) [15, 16] which is considered gold standard for displaying paranasal sinuses, CBCT is preferred for the patient because of lower radiation dose [17], higher resolution and lower scanning duration [1]. It features a three-dimensional cross-sectional imaging which eliminates distortion and superposition

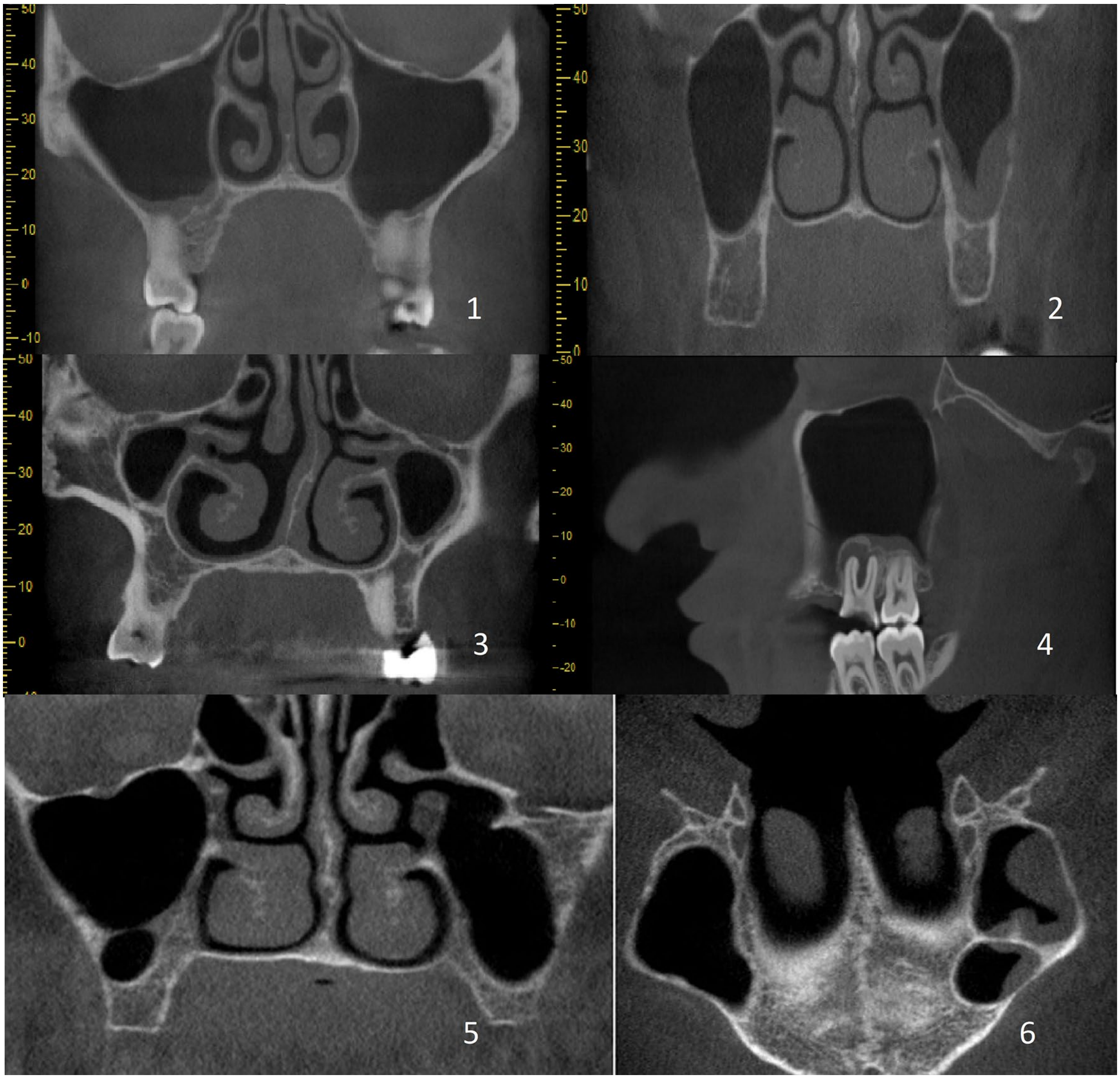

Fig. 1 (1) Concha bullosa on coronal CBCT slice (2) maxillary sinus mucosal hypertrophy on coronal CBCT slice (3) nasal septal deviation on coronal CBCT slice (4) a posterior molar tooth adjacent to the maxillary sinus on sagittal CBCT slice (5) maxillary sinus septa on coronal CBCT slice and (6) axial CBCT slice

Table 1 Distribution of maxillary sinus pathologies according to studied parameters

Parameter	Presence of maxillary sinus pathology, *n*	Absence of maxillary Sinus pathology, *n*	%	*p* values
Right maxillary sinus				
Maxillary sinus septa	14	20	41.1	0.573
Concha bullosa	42	39	51.8	0.248
Nasal septal deviation	56	65	46.2	0.527
Presence of teeth with apical lesion	49	19	72	< 0.001*
Left maxillary sinus				
Maxillary sinus septa	19	25	43.1	0.733
Concha bullosa	42	44	48.8	0.567
Nasal septal deviation	56	65	46.2	0.519
Presence of teeth with apical lesion	50	23	68.4	< 0.001*

*The significance level is $p < 0.001$

Table 2 Results of regression analysis for studied risk factors

Parameter	OR, 95% CI	*p* value
Right maxillary sinus		
Sex	0.687 (0.365–1.292)	0.244
Maxillary sinus septa	1.220 (0.546–2.727)	0.628
Concha bullosa	0.599 (0.320–1.121)	0.109
Nasal septal deviation	1.073 (0.579–1.988)	0.824
Presence of teeth with apical lesion	5.213 (2.720–9.990)	< 0.001*
Left maxillary sinus		
Sex	0.593 (0.319–1.102)	0.099
Maxillary sinus septa	1.354 (0.650–2.818)	0.418
Concha bullosa	0.681 (0.369–1.258)	0.220
Nasal septal deviation	0.874 (0.471–1.621)	0.668
Presence of teeth with apical lesion	4.777 (2.530–9.019)	< 0.001*

*The significance level is $p < 0.001$

situations [18]. The aim of this study was to find out the potential relationships of maxillary sinus septa, concha bullosa, nasal septal deviation, and teeth with periapical lesions to maxillary sinus pathologies using CBCT. On the CBCT image, it was observed that at least one apical lesion associated with the right maxillary sinus was found to increase maxillary sinus pathology by 5.213 times on the right side and by 4.777 times on the left side. Previous studies have reported ORs of 3.5 [3], 16.4 [19], and 9.75 [16] for mucosal thickening in the presence of teeth with periapical lesions. It was believed that bacteria and toxins in apical lesions can infiltrate the maxillary sinuses directly or via the numerous vascular anastomoses, the porous alveolar bone marrow, and lymphatic system, thereby infecting the sinus mucosa [1].

On the other hand, the severity of the periapical lesion, although unevaluated in our study, may affect the intensity of mucosal thickening. Lu et al. [1] reported that the prevalence of maxillary sinus mucosal thickening was 41.5% in patients without apical periodontitis, more than 70% in patients with mild and moderate apical periodontitis, and 100% for those with severe apical periodontitis. We found that the OR values stated in our study were different than the ones stated in literature [3, 16, 19]. This may be due to differences in the periapical lesion severities of the teeth included in the study.

In their study, Pommer et al. [20] described an ideal sinus mucosal thickness to be 0.09 ± 0.05 mm on average. On the other hand, Aimetti et al. [21] described the mean sinus mucosal thickness to be 0.97 ± 0.36 mm. In another study, it was emphasized that sinus mucosa could only be seen when it was 2 mm or more. It was also stated that a thickness above 2mm should be considered pathological [22]. For this reason, in our study, cases where sinus floor mucosa thickness was 2 mm or more were accepted as pathological.

The reported prevalence of mucosal thickening of the maxillary sinus ranged from 12% [3] to 60.5% [16]. In this study, the rate of mucosal thickening exceeding 2 mm which is accepted to be pathological was found to be 46.2%. This variation could be attributed to the differences in race or age as well as the different diagnostic techniques and criteria used [1].

This study showed that the frequency of nasal septal deviation was 60.5%. Although this percentage seemed to be quite high, according to the literature nasal septal deviation ranged from 14.1 to 80%. The exact reason remains controversial but trauma at birth or early life, traffic accidents, and violence seems to be possible causes [23]. Geographical differences may be seen [24]. Perfectly straight nasal septum is quite rare and therefore, small amount of deviation is acceptable. Obstruction of the nasal cavity and respiratory difficulties may be seen with the increase of deviation. The present study showed that there was no relationship between maxillary sinus pathology and nasal septal deviation. In a conflicting study, Hatipoglu et al. [25] reported that there was a relationship between these two parameters. The difference of the results can be explained with the criteria differences in the description of the septal deviation. In this study, nasal septal deviation was defined as a deviation more than 4 mm from the midline. The current study revealed that the prevalence of maxillary sinus septa was 19.5%. According to the literature, the prevalence of this variation ranged from 16 to 58% [26]. It was found that there was no relationship between maxillary sinus pathology and maxillary sinus septa. To the best of our knowledge, this was the only study investigating the relationship between these two parameters. Therefore, more research is required.

In this study, the prevalence of concha bullosa was 41.7%, which is relatively higher than other studies. In the literature, the prevalence of this variation ranged from 13 to 67.5% [9, 23]. This wide range may be due to the different criteria defining concha bullosa. Moreover, misinterpretation of the images may be the result in higher frequency. Careful radiological examination on axial and coronal slices should be performed to exclude 'pseudopneumatisation' of the concha, which results from the contact of the lateral edge of the concha with the internal wall of the maxillary sinus. Concha bullosa causes the obstruction of the middle meatus and complicates the nasal airflow and mucociliary transport [26]. Although it is a common variation in the nasal cavity, relationship between concha bullosa and maxillary sinus pathology. As a limitation, this was a retrospective radiological study and no clinical examination was performed related to the symptoms of rhinosinusitis of the patients. In future studies, in addition to the radiological analysis, clinical examination is recommended to validate this result.

In conclusion; within the limitations, it was observed that periapical lesions anatomically associated with maxillary sinuses are a risk factor for sinus mucosal thickening. The treatment of infected teeth has vital importance to prevent the maxillary sinus pathologies. This was a cross-sectional radiological study and longitudinal clinical studies are needed to make a definitive conclusion about maxillary sinus pathologies.

Funding None.

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