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Incidental findings of maxillary sinuses in Cone Beam Computed Tomography (CBCT)

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ABSTRACT

Background- The paranasal sinuses are paired sets of air-filled cavities of the craniofacial complex composed of maxillary, frontal, sphenoidal, and ethmoidal air cells. Amongst these, maxillary sinuses, also, called maxillary antra or, Antra of Highmore, are of clinical significance to dental professionals because of their proximity to the teeth and associated structures.

Aim - To evaluate the prevalence of abnormalities of the maxillary sinus using cone-beam computed tomography [CBCT] of the maxilla in dental patients.

Material and methods- In this retrospective study, CBCT scans of 150 dental patients who were advised CBCT scans for a purpose other than the sinus evaluation were included. CBCT was used to assess incidental maxillary sinus pathologies and the data was tabulated. Statistical analysis was done using descriptive statistics.

Results- Seventy-two patients had pathological changes [44.9%], 38 [25.3%] had mucosal thickening, 11[7.4%] had mucous retention cyst, 6 [4.1%] had complete while another 4 [2.7%] had complete opacification, 3 [2%] had cystic lesions and discontinuity of wall and 1 [0.7%] had a benign odontogenic and fibro-osseous lesion, discontinuity of wall each.

Conclusions- Incidental findings of abnormalities in the maxillary sinus were a common finding in the present study using CBCT scans of maxilla. Dental professionals reviewing CBCT scans should be cautious and aware of maxillary sinus anatomy and pathologies when interpreting a CBCT scan of the maxilla which can help in early detection of undetected diseases.

Keywords:
Cone-beam computed tomography, incidental findings, maxillary sinus, pathology

Introduction

Since its introduction in the 1990s, cone beam computed tomography [CBCT] has become an important dental imaging tool used in the detection, prevention, and screening of disease. Nowadays it is a widely and readily available investigative imaging tool.[1] Dental implant site assessment, maxillofacial trauma, impacted teeth, and orthodontics are frequent indications for CBCT wherein the maxillary sinus can be imaged completely within the field of view. This frequently confronts the operator with incidental findings in the area of the maxillary sinus.[2] An "incidental finding" is a term applied in radiology to describe the unexpected discovery of a hidden entity during an imaging test that is unrelated to the indication for the test. [2]

Pathologies of maxillary sinuses can be intrinsic which is characterized by lesions originating primarily from within the sinus walls, and extrinsic in which the lesion originates outside the sinuses which can either impinge on or infiltrate the sinuses. Intrinsic pathologies of the maxillary sinus includes diseases such as mucosal thickening, polypoidal mucosal thickening, partial opacification with fluid accumulation, complete opacification, retention cysts, while

extrinsic pathologies includes root stumps, impacted teeth, antroliths, exostosis, oro-antral fistulas and a plethora of odontogenic benign and malignant diseases. [3-6]

Material and methods

The present cross-sectional retrospective study comprises 150 consecutive records of CBCT scans undertaken at the department of Oral Medicine and Radiology. Approval from the Institutional Ethical Committee was taken before the start of the study.
CBCT data of patients who were referred for diagnosis and treatment planning such as implant planning, maxillofacial surgeries including trauma, cyst & tumors, impacted teeth, orthodontic evaluation, endodontic evaluation were included for the analysis. Only those CBCT scans which showed the bilateral maxillary sinuses completely were included in the study. Age, gender, and indication for radiographic examination were recorded. CBCT data of patients who were referred primarily for maxillary sinus symptoms or suspected diseases of sinus were excluded. Patients under 15 years old were excluded because of their incomplete sinus development. Images of low-resolution quality or the presence of metallic/motion artifacts in the scan were also excluded from the study sample.
All CBCT scans included in the study were obtained using Dentium Rainbow CT unit, having standard resolution mode made of voxel size of 0.3 mm using Rainbow CT Scanner [made in Korea] using 70-110 kVp, 7-10 mA, 10-20 secs, and FOV of 10 x 16 cm. An experienced oral radiologist analyzed the CBCT scans in an ambient environment and ideal conditions and any abnormalities seen were noted. Coronal & sagittal sections were prepared with 1 mm thickness at an interval of 0.5 mm. A software program, Dentium 3D imaging software (rainbow viewer) was used to reconstruct the images and perform the measurements. The data obtained were tabulated and subjected to statistical analysis using descriptive statistics.

Results

The CBCT scans of 150 patients were included in the sample, 68 [45.3%] of which were female and 82 [54.7%] male. Their ages ranged from 15-75 years [mean = 36.36; SD = 15.7]. The CBCT examination had been undertaken for diagnostic purposes, such as implant planning [54.7%], endodontic [0.7%], surgical planning [34%] and orthodontic diagnosis [10.6%]. [Table 1]

Table1: Reasons for which CBCT was advised.

Reason CBCT was advised	No. of patients	Percentage (%)
Endodontic	1	0.7
Implant	82	54.7
Orthodontic	16	10.6
Surgery	51	34.0
Total	150	100.0

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The age range of the patients included in the study was from 15-70 years. The patients were arbitrarily grouped according to the following age groups: [1] 15-30; [2] 31-45; [3] 46-60; and [4] 60-75 years. Maximum numbers [68(45.3%)] of patients were in the age group of 15-30 years while minimum numbers [14(9.4%)] of patients were in the age group of 61-75 years [Table 2]

Table 2: Age wise distribution of patients

Age wise distribution (years)	Number of patients	Percentage (%)
15-30	68	45.3
31-45	39	26.0
46-60	29	19.3
61-75	14	9.4
Total	150	100.0

The overall prevalence of incidental abnormal findings was found to be 44.9% with the prevalence of mucosal thickening being 25.3%, mucous retention cyst 7.4%, complete opacification 4.1%, partial opacification with fluid accumulation 2.7%, cystic lesion 2%, discontinuity of wall of maxillary sinus 1.3 %, congenitally absent maxillary sinus 0.7 %, fibro-osseous lesion with 0.7% and benign odontogenic tumor 0.7 %. [Table 3]

Incidental abnormalities	Number of patients	Percentage (%)
Mucosal thickening	38	25.3
Mucous retention cyst	11	7.4
Complete opacification	6	4.1
Partial opacification	4	2.7
Cystic lesion	3	2
Discontinuation of maxillary wall	2	1.3
Congenital absence of maxillary sinus	1	0.7
Fibro-osseous lesion	1	0.7
Benign odontogenic tumor	1	0.7
No Abnormality Detected	83	55.8
Total	150	100

Table 3: Incidental abnormalities detected in maxillary sinus on CBCT

Out of 68 patients in the age group of 15-30 years, 30 patients showed positive findings i.e presence of incidental finding in the maxillary sinus. Similarly, out of 39 patients in the age group 31-45 years, 21 showed positive finding, out of 29 patients between age group of 46-60 years showed positive finding, and out of 14 patients in the age group of 61-75 years, four patients showed positive findings. In terms of the highest prevalence of incidental findings in the maxillary sinus, the age group of 31-45 years had the highest prevalence of 53.8% followed by 44.2% in age group of 15-30 years. The findings were suggestive that incidental findings of the maxillary sinus were more common in patient less than 60 years of age. The age group of 61-75 years showed a 28.6% prevalence of incidental findings which was the lowest in comparison to other age groups. [Table 4]

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Table 4: Age-wise distribution of incidental findings in the maxillary sinus

Age group		Incidental findings in Maxillary sinus		Total
		Absent	Present	
15 to 30 years	No. of patients	38 (55.8%)	30(44.2%)	68
	Percentage	45.8%	44.8%	45.3%
31 to 45 years	No. of patients	18 (46.2%)	21(53.8%)	39
	Percentage	21.7%	31.3%	26.0%
46 to 60 years	No. of patients	17(58.6%)	12(41.4%)	29
	Percentage	20.5%	17.9%	19.3%
61 to 75 years	No. of patients	10(71.4%)	4(28.6%)	14
	Percentage	12.0%	6.0%	9.3%
	Total	83 (55.3%)	67 (44.7%)	150
	Percentage (%)	100.0%	100.0%	100.0%

The sex distribution of the study sample is shown in Table 5 wherein the prevalence of sinus pathologies was found to be more common in the male patients though the overall prevalence did not differ significantly between the male and female patients [p-value=0.098]. Out of 150 patients, 68 [45.3%] were female and 82 [54.7] were male. 23 [34.3%] female patients and 44 [65.7%] male patients had shown incidental findings in the maxillary sinus.

Table 5: Gender-wise distribution of the study sample

Gender		Abnormalities in maxillary sinus		Total
		Absent	Present	
Female	Count	45	23	68
	Percentage	54.2%	34.3%	45.3%
Male	Count	38	44	82
	Percentage	45.8%	65.7%	54.7%
Total	Count	83	67	150
	Percentage	100.0%	100.0%	100.0%

Discussion

Cone-beam computed tomography (CBCT) is a modern computer-based imaging technology providing three-dimensional details of the region of interest. With its introduction in dentistry roughly 2 decades ago, the use of CBCT imaging in clinical dentistry and related research has increased exponentially with various studies published in this discipline. [7-11] However, an interpretation of CBCT images requires familiarity with the anatomy of the area of interest, an understanding of the spatial relationships of the image volume, a sound knowledge of the possible diseases, anatomical variations, and abnormalities that affect the maxillofacial area and, finally, competence when formulating a differential diagnosis. [12-14]

In this study, 150 CBCT scans were evaluated retrospectively for incidental findings of abnormalities in the maxillary sinus. The present study showed a 44.9% incidence of maxillary sinus pathologies, which is nearly similar to Pazera et al.[15] study [46.8%] ; lower than the studies by Hahnel et al.[16] [63%], Bolger et al[17] [82.2%], Kumar et al. [58%][18], Nayyar et

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al.[19],Ritter et al.[20] [56.3%] and Rege et al.[21] [68.2%] and higher than the prevalence in the studies by Vallo et al.[22][19%] ,Cha et al. [23][24.6%] and Lim and Spanger[24] [27.5%] .
We found a higher frequency of pathologic findings in males, which is consistent with the studies by Raghav et al.[25], Dobele et al.[26], Ritter et al.[20] and Vallo et al. [22] who also found a higher prevalence of pathologic findings in the male patients which was statistically significant. In the present study, patients in the second decade showed more prevalence of maxillary sinus abnormalities when compared with other age groups which was in agreement with the study done by Malik et al. [27] but it is inconsistent with the study by Ritter et al.[20] who found maximum pathologies were present above 60 years of age. Kumar et al.[18] and Raghav et al.[25]found maximum pathologies in patients in third decade of life.
In the present study, the most prevalent finding was mucosal thickening [25.3 %] which is in accordance with the studies conducted by Pazera et al.[15] [23.7%]; Raghav et al.[25] [35.1%] and Carmeli et al.[28][36.1%]. Dobele et al. [26], Kihara et al.[29] and Shiki et al. [30] also found mucosal thickening as the most prevalent finding in their studies but the prevalence was significantly higher [48.5%, 43% and 49% respectively] than the present study. Contrary to the findings of the aforementioned studies, Vallo et al.[22] [12%] and Lim and Spanger[24] [16.8%] found less prevalence of mucosal thickening in their studies. Highest prevalence of mucosal thickening was found in the study conducted by Rege et al. [21] [66%]. [Figure 1]

Figure 1. showing mucosal thickening with all the walls on right maxillary sinus

The second most common finding was mucous retention cyst [7.4%] which is in consistent with the studies done by Raghav et al. [25] [7.2%] and Lim and Spangera[24] [8%]. Kihara et al. [29] [15%] and Rege et al [21] [10.1%] also reported mucous retention cyst as the second most common finding. [Figure 2.]

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Figure 2. Axial view showing mucous retention cyst on left maxillary sinus

Complete opacification was found to be 4.1 % in the present study which was slightly higher than the studies reported by Dobele et al. [26] [2.9%], Kihara et al. [29] [2%] and Lim and Spangera[24] [2.7%]. Rege et al. [21] [7.8%], Raghav et al. [25] [16.6%] and Shiki et al. [30] [18%] found higher prevalence of complete opacification in their studies. [Figure 3]

Figure 3. Axial view showing complete opacification bilaterally

In the present study, prevalence of partial opacification with liquid accumulation was 2.7% which was in accordance with the study conducted by Lim and Spangera[24] [2.3%]. Shiki et al. [30] did not find a single case of partial opacification in their study. [Figure 4]

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Figure 4. Axial view showing partial opacification

Prevalence of extrinsic diseases in the present study appeared to be 3.4% which included three cystic lesions and one each case of fibro-osseous and benign odontogenic tumor [Fig.5] and one case of congenitally absence of maxillary sinus bilaterally [0.7%]. [Fig.6] Various previous researchers did not report the prevalence of extrinsic lesions in their studies.

Figure 5. Coronal view showing soft tissue density lesion (odontogenic tumor) encroaching into the right maxillary sinus

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Figure 6. Coronal view showing complete absence of maxillary sinus bilaterally

Other radiographic modalities have also been used in past for evaluating maxillary sinus pathologies such as orthopantomogram, Multi-slice CT, and MRI. These modalities have shown a wide range of incidence from 10.9% to 69.1%. [31-34] In general, MRI has shown abilities to demonstrate higher levels of incidental sinus abnormalities than Multi-slice CT. [35,36] Several studies using MRI found the prevalence of incidental findings in the maxillary sinus in a range of 26-50%. [32,35-38] Nam and Lee[32] and Min *et al*.[33] using Multi-slice CT reported incidence of 36.3% and 38% for the asymptomatic Korean population respectively. Studies based on the panoramic imaging have also found 24 % and 36.7 % prevalence of incidental finding in maxillary sinus respectively. [22, 39]

Conclusion

With the increased availability of CBCT in recent times, its use in various maxillofacial studies including detection of incidental maxillary sinus pathologies has also increased. As the maxillary sinus is surrounded by vital structures all around, detection of any incidental maxillary sinus pathologies can also help in early diagnosis and treatment and better management of the progression of disease preventing involvement of other vital organs and structures. It is also advisable to develop a clinical and radiographic guideline for maxillary sinus evaluation so that nothing is overlooked thus improving the communication and collaboration between general dentists, maxillofacial surgeons, oral radiologists, and otolaryngologists in providing successful oral rehabilitation and improving quality of life of the patients.

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