Accidental findings of maxillary sinuses in dental patients on CBCT images. A retrospective study

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Background and objective: Maxillary sinus pathology is a common finding on routine CBCT scans of the maxilla. Hence the objective of this study is to define the frequency of accidental findings within maxillary sinuses on patients' CBCT images that are referred for various dento-alveolar reasons in the maxilla and to evaluate the relation of the age and gender with the maxillary sinus condition.

Methods: A total of 255 sequential CBCT scans from patients aged between 15-78 years, with a localized field of view (8.0cm x 5.0 cm) were retrospectively included in the analysis, resulting in an evaluation of 510 maxillary sinuses. The findings were categorized as healthy sinus, mucosal thickening, polypoid thickening and partial opacification.

Result: Out of 255 patients, 148 (58%) were males and 107 (42%) were females with a mean age of 50.23 (SD=19.08). Implant assessment was the major request 206 (80.8%) followed by exploration of impacted teeth 35 (13.7%). 52.2% of included cases showed sinuses with no pathology (NP). 47.8% showed accidental findings of wich mucosal thickening (MT) was the highest 104 (40.8%). The relationship between gender and maxillary sinus status was statistically non-significant (p=0.346). The relation of the age (≤50 and >50) and sinus status, however, was statistically significant (p=0.035)

Keywords: CBCT, Maxillary sinus, incidental pathologies, Accidental findings, mucosal thickening

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Introduction

The paranasal sinuses are four paired air-filled cavities of craniofacial complex composed of maxillary, frontal, sphenoidal, and ethmoidal air cells.[1] The maxillary sinus is the first and largest paranasal sinus to form; it locates in the body of the maxillary bone and drains into the lower and middle meatuses in the nasal cavity.[2,3] Acquaintance about the anatomy, the most frequent variations, and the normal or pathologic conditions of the maxillary sinus are of clinical significance to dental professionals because of their close proximity to teeth and associated structures.[3]

Computed tomography is considered the gold standard for sinus diagnosis, because of its ability to provide mul-tiple sections through the sinus at different planes and allow visualization of bone and soft tissues.[4] Visualization quality of the maxillary sinus and bony structures in CBCT appears to be similar to that offered by computed tomography. However, CBCT generates high-resolution isotropic volume data and therefore could offer benefits in evalu-ating the maxillary sinus thanks to the use of a lower radiation dose.[5-9]

Since the maxil-lary sinus is an anatomical structure that can be visual-ized by CBCT, the specialists performing such explorations must not only record the radiological findings for which CBCT is requested (dental implants, endodontics, periodontics, impactions, etc.) but should also evaluate the rest of the structures seen during the examination.[6]

Objective:

To define the frequency of accidental find-

ings in maxillary sinuses on the CBCT images of patients referred for different dento -alveolar reasons in the maxilla and to test the relation of the age and gender with the maxillary sinus condition.

Material and methods:

This retrospective study is based on an assessment of Cone Beam Computed tomography (CBCT) scans of (510 maxillary sinuses) from (255) patients obtained from a specialized oral and maxillofacial radiology clinic in Erbil city/Iraq, between 2021 and 2023. These scans were justified and taken for different reasons according to the referral criteria. Only patient age and sex were exposed while their names were anonymously maintained.

For the selection of relevant CBCT datasets, the following inclusion criteria were adopted: aged between 15-78 years and the CBCT images of patients in which a considerable volume of both maxillary sinuses was visible and could be evaluated.

The exclusion criteria consisted of CBCT images in which trauma had destroyed the maxilla, odontogenic lesions of the sinus, and cases in which the patients had undergone maxillary sinus lift procedures or implant placement on one or both sides.

CBCT scanning

A Newtom Giano CBCT scanner (Quantitative Radiology / Cefla Dental Group/ Italy) is used, operated with a full 360° rotation and exposure parameters controlled by SafeBeam™ technology ("AEC" Automatic Exposure Control), wi-Healthy Sinuses/ No pathology (15 years male) th a field of view (FOV) of 8.0cm x 5.0cm, using voxel size of 0.150mm.

The CBCT image datasets were exported from the acquisition computer with the native viewing software (NewTom NNT™ software) to a Dell laptop (Inspiron 17 7000 Series 2-in-1 – 7773, Dell Inc., TX, USA) 17.3-inch FHD, IPS Truelife LED-Backlit Touch Display with a screen resolution of 1920 x 1080 pixels, the luminance of 330cd/m2, and luminance contrast ratio of 1538:1. These parameters fulfilled the requirements for monitors used for clinical CBCT viewing.[10,11]

CBCT assessments

All CBCT scans were assessed by a single examiner, a specialist in oral and maxillofacial radiology, who has more than ten years of experience using (NewTom NNT™ software), to perform the necessary evaluations on multiplanar images. All assessments were made on the same laptop PC described above.

The findings were categorized as healthy or no pathology (NP); where no pathological findings exist (Figure 1A). Mucosal thickening (MT) was verified when the mucosa between the air mucosal surface and the inner bony margins of the sinus was slightly enlarged subjectively[12,13] (Figures 1B). Any outwardly dome-shaped mucosa was considered as polypoid thickening (PT)[12,13] (Figure 1C). Partial opacification (PO) was evaluated in cases that showed mucosal thickening or radiopacity of about half or more of the sinus[12,13] (Figure 1D). In this study, cases for complete opacification (where the whole sinus is radiopaque)[12,13], were not detected.

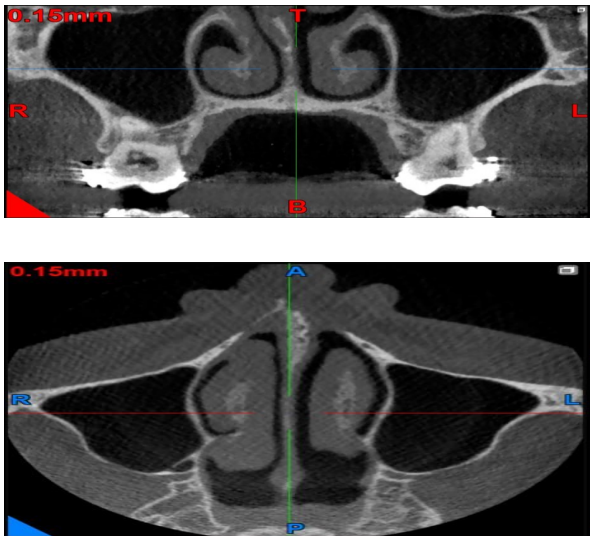
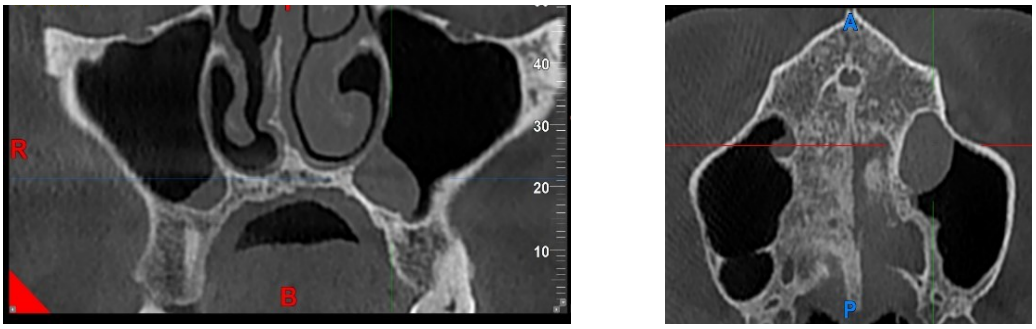
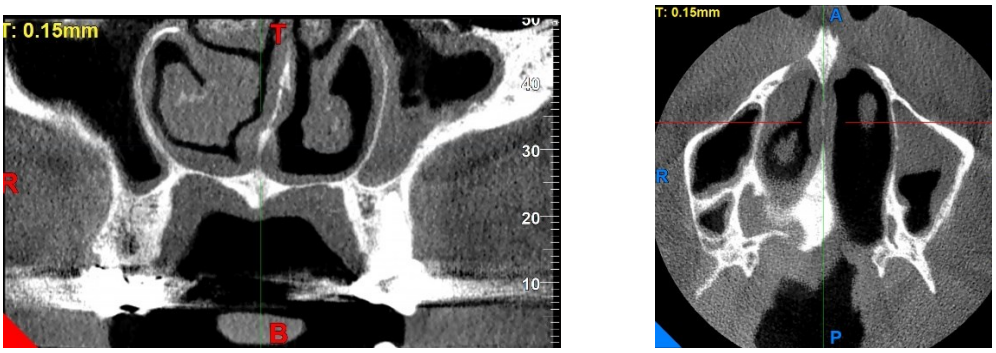


Figure 1A: Healthy Sinuses/ No pathology 15 years male

B-Bilateral mucosal thickening (78 years female



C- Mucous retention pseudocyst at the floor of left sinus (43 years male)



C- Partial opacification of the left sinus (67 years female)
Figure 1: Example of different findings of maxillary antra in this study
A-Healthy Sinuses/ No pathology, B- Bilateral mucosal thickening, C- Polypoid thickening at the floor of left sinus D- Partial opacification of the left sinus

Ethical aspects
The study protocol was approved by Ethics and Scientific Committee at the College of Dentistry/ Hawler Medical University (HMU.D.74/2023).

Statistical analysis:
The data were analyzed with IBM® SPSS 22 for Windows. The primary reason for the referral and their frequencies were mentioned. Frequencies were used to describe the findings at right, left and both maxillary sinuses whereas accidental findings could be seen in one or both sinuses as well. Frequency tables were presented for the findings in both genders. The chi-square test was used to analyze the relationship between sinus status with age and gender. Statistical significance was set at $P < 0.05$.

Result

Out of 255 patients, 148 (58%) were males and 107 (42%) were females with a mean age of 50.23 (SD=19.08).

It is clear that implant assessment was the major request 206 (80.8%) (Table 1). The second most common referral reason was for exploration of impacted teeth 35 (13.7%). The referral reasons for the category "Others", which had a frequency of 8 (3.1%), were for assessment of periapical area and suspected fracture of teeth that were unclear on 2D radiographs (Table 1).

More than half of included cases in this study showed healthy sinuses or no pathology (NP), 133 (52.2%). 104 (40.8%) patients had unilateral mucosal thickening (MT) of maxillary sinus, and half of these 52 (20.4%) were bilateral (Table 2).

The frequency of cases that the diagnosis was confirmed in a minimum of one side of maxillary sinuses was 255 (100%), but this number declined to 186 (72.9%) when the imposed diagnosis was made to show identical status in each case (Table 2).

Frequencies of maxillary sinus findings based on gender and age are presented in Table 3. The table also presents a comparison between males and females and the age as well, where the cutoff age was set as ≤50 and >50, based on the mean age of 50.23 (SD=19.08). When the genders were compared for the different statuses of the sinuses, the data were statistically non-significant (p=0.346). The comparison of the age was statistically significant (p=0.035).

Table 1: Frequencies of the reasons that the patients referred to CBCT of the maxilla

Referral reason	Frequency	(%)
Implant	206	80.8
Impaction	35	13.7
Endodontics	4	1.6
Periodontics	2	0.8
Others	8	3.1
Total	255	100.0

Table 2: Frequencies of maxillary sinus findings on CBCT images of patients

Maxillary sinus findings	No. (%) right side	No. (%) left side	No. (%) Both sides 1* (Minimum one side diseased)	No. (%) Both sides 2** (Identical status on both sides)
No pathology (NP)	162 (63.5%)	163 (63.9)	133 (52.2)	133 (52.2)
Mucosal thickening (MT)	81 (31.8)	85 (33.3)	104 (40.8)	52 (20.4)
Polypoid thickening (PT)	10 (3.9)	4 (1.6)	14 (5.5)	0 (0)
Partial opacification (PO)	2 (0.8)	3 (1.2)	4 (1.6)	1 (0.4)
Total	255 (100)	255 (100)	255 (100)	(72.9)

*Number and frequency for both sides when a minimum of one side or both sides have a diagnosis of disease other than normal (ex. One side has mucosal thickening or one side has mucous retention cyst).
**Number and frequency for both sides when both sides have the same diagnosis based on the identical status of both sides (ex. Both sides are healthy or both sides show mucosal thickening).

Table 3: Frequencies and comparison of maxillary sinus findings based on gender and age

	No. of healthy sinuses (No pathology)	No. of unhealthy sinuses			*P value*
		Mucosal thickening	Polypoid thickening	Partial opacification	
Sex					
Male	74	63	10	1	0.346
Female	59	41	4	3	
Age					
≤50	58	39	11	2	0.035
>50	75	65	3	2	

Discussion:

The data for this retrospective study were collected from a private dental imaging clinic; based on localized CBCT scans for the maxilla that allowed the visualization of a significant volume of the maxillary sinuses, beyond the area of interest. It is obvious that patient protection was taken in consideration in the majority of the cases, before the examination by applying the justification criteria and during the examination by applying the optimization criteria. This protocol, however, is promising as it followed the selection criteria for CBCT scans that is implemented internationally.[14-18]

The present study was performed on CBCT scans from 255 patients (510 maxillary sinuses) and patients ages 15-78 years, with a mean age of 50.23 (SD=19.08). Of these; 148 (58%) were males and 107 (42%) were females. The studies in this field used different sample sizes. The sample size in the present study is greater than most of the studies performed in this field. For instance, a study by Raghav et al.[19] 201 patients (402 maxillary sinuses) were used. In recent studies, 200 CBCT images (400 maxillary sinuses) were used by Sanaullah et al.[13], and 140 (280 maxillary sinuses) were used by Salari et al.[20]

Referral reasons were well documented and presented in the present study. It benefits the reader with referral criteria and justification of the localized CBCT examinations done in this area. Looking at (Table 1) Implant assessment was the greatest among the CBCT requests 206 cases (80.8%) similar to the recent systematic review by Ata-Ali et al.[6] and other studies.[19,21,22] This is typical due to the growing popularity of implant dentistry, however, indicating that there was also a growing demand for cross-sectional imaging within the dental practice environment; that could produce geometrically accurate images with a high level of detail and acceptable levels of radiation dose. Consequently, implant dentistry was the propeller for the invention of CBCT, and the most frequent indication for dento-alveolar CBCT.[24-27] On the other hand, a study by Ritter et al.[23] found that trauma and implant surgery were the main indications for CBCT. As the included age for the present study was started at 15 years, assessments for impacted teeth and localization were the second most frequent requests 35 cases (13.7%) [27,28]. Raghav et al.[19] on the contrary found endodontics as a second major reason for CBCT requests although the age included in their study started from 10 years. Interestingly, the study by Chandran et al.[22] found "prosthetic rehabilitation" as a second reason for advising CBCT without giving information about the justification and meaning of prosthetic rehabilitation. In the present study, fewer cases were referred for endodontic and periodontic assessments 4 (1.6%) and 2 (0.8%) respectively. This was

similar to the findings of the study conducted by Raghav et al.[19] regarding periodontics. Finally, the category "Others" was set for less frequent referral reasons other than those mentioned above. Interestingly, the frequency of these referrals was 8 (3.1%) which comprises of assessment of periapical areas and suspected dental or dentoalveolar fractures where the 2D radiographs provided limited or vague information.

The present study showed about 52.2% incidence of cases with no pathology (NP) (Table 2) which is close to the survey by Manji et al.[29] (54.9%), but more than the findings of the studies by Ragav et al.[19] (40.3%), Kihara et al.[21] (42%) and Chandran et al.[22] (42%). The NP category in the present study was far less than the findings in the study conducted by Sanaullah et al.[13] (65%).

The accidental findings of maxillary sinuses in the present study encompassed about 47.8% (Table 2). These accidental findings are composed of mucosal thickening (MT), polypoid thickening (PT), and partial opacification (PO). The result of the present study is close to the study conducted by Pazera et al.[30] (46.8%). This incidence is higher than the studies by Cha et al.[31] (24.6%) and Lin and Spanger[32] (27.5%). There were other studies with the incidence of pathology within the antra being way higher than the present study (around 56-65%).[19-23] The highest incidence of pathological findings of the maxillary sinuses were found in the study conducted by Rege et al.[33] (68.2%). Taking each side of the maxillary sinuses separately (Table 2), apart from PT which showed a massive difference between right and left maxillary sinuses (10 on the right side and 4 on the left side), the incidences and percentages of the other categories were very close. Overall, the findings of the right side (36.5%) were vaguely more than the left side (36.1%). The study conducted by Raghav et al.[19] also showed the pathological findings associated with the right side (51.7) to be more than the left side (48.3%). To register the findings for each patient or scan, and for comparison with the other studies, two types of pooled results were suggested (Table 2); No. and (%) of both sides when a minimum of one side or both sides showed the findings and No. and (%) of both sides when both sides showed identical findings for each case. Thus, the merged results provided different outcomes as shown in Table 2. The frequency of cases that the diagnosis is confirmed in a minimum of one side of maxillary sinuses was 255 (100%), but this number declined to 186 (72.9%) when the imposed diagnosis was made to show identical status in each case. Apart from NP which was the same 133 (52.2%), the accidental pathological findings were different. There were cases where accidental findings were confirmed on both antra for the same patient. Among these, MT was the highest (40.8%) in one maxillary sinus, and exactly half of these (20.4%) were cases in which both sinuses showed MT for the same patient or scan. PT repeated on one side, but never presented on both antra. PO was found on one side 4 (1.6%), while in only one case it presented on both sides 1 (0.4%).

In the present study, MT showed the highest incidence (40.8%), very close to the results of the study conducted by Gracco et al.[5] (40.1%). Other studies in this field, however, MT was the most diagnosed incidental finding, the percentage was less than the present study; Sanaullah et al.[13] (35.1%) and Raghav et al.[19] (35%). The overall prevalence of MT in a study by Rege et al.[33] was found to be (66%).

In the present study, PT was found to be the second most repeated finding (5.5%). This result was far less than other studies, Raghav et al.[19] (7.2%), Lim and Spanger[32] (8%), Kihara et al.[21] (15%) and Rege et al.[33] (10.1%). Interestingly, the study conducted by Chandran et al.[22] PT was the most common finding in the study (36.7%).

In the present study, cases for partial opacification (PO) of the sinus were the least findings (1.6%) which was near the results of the studies by Chandran et al.[22] (2%) and Lim and Spanger[32] (2.3%). A study conducted by Shiki et al.[35] reported (0%) incidence of PO. Finally, complete opacification and other miscellaneous findings such as foreign bodies and antroliths were (0%) in the present study.

In the present study, the incidence of acci-

dental findings within maxillary sinuses were higher in males than females apart from PO that shows otherwise. This was in concurrence with the findings of other studies.[19,23,33] The frequency of males was higher than females 148 (58%) and 107 (42%); respectively, and this may explain the variations. Despite differences between gender, the comparison revealed statistically non-significant result (p= 0.346) in concordance with the study done by Raghav et al. [19]

The frequencies of maxillary sinus findings based on age showed confused results (Table 3). The findings were varied and showed more MT in the age group >50, equal findings for PO, but far fewer incidences of PT in comparison to the age group ≤50. Nonetheless, the frequencies of healthy sinuses were higher in older ages. This was in agreement with the study conducted by Raghav et al.[19] argued that patients in their third decades showed more pathology in the form of MT in comparison to other groups, but in contrast to the study by Ritter et al.[23] It is clear that this divergence of the frequencies of the findings within the antra based on the age, resulted in statistically significant difference (p=0.035).

Finally, it is important to mention that several studies have reported excessive variability in the prevalence of incidental findings in the maxillary sinuses of asymptomatic subjects when 3D images were used[33]. Direct comparison, however, of the present study with other studies was inappropriate. The rationale for the differences in abnormality rates may be due to several factors, such as sample size, the different ages, the aim of the study, the applied classification system in different studies and the influence of climate among different geographical area.[13,19,22,31].

Conflicts of interest

The author reported no conflict of interest.

Conclusion:

According to the present study results, the most common referral reasons for CBCT examination were for implant assessment. Mucosal thickening was the highest among the pathologic findings in the maxillary sinus. There was no significant relationship between gender and maxillary sinus status but there was a statistically significant relationship between age and findings. CBCT can help in the early detection and evaluation of accidental pathologies within maxillary antra in asymptomatic patients. The findings of the present study recommend a thorough interpretation of the whole volume CBCT scans, by an oral radiologist, to ensure a proper diagnosis as it might have an impact on the patient's medical status and advice the referred practitioner about the findings which may affect the treatment plan accordingly. Finally, referral of the patient to a specialist if necessary.

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