

# Prevalence of incidental maxillary sinus pathologies in dental patients on cone-beam computed tomographic images

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## Abstract

**Objectives:** The aim of the present study was to infer and to record the prevalence of incidental maxillary sinus pathologies in patients presenting with dental problems using the cone-beam computed tomography (CBCT) scans performed for maxillofacial diagnostic purposes. **Materials and Methods:** This retrospective study has evaluated 201 patients (402 maxillary sinuses consecutive CBCT) for various incidental maxillary sinus pathologies by two observers. Pathologic findings were categorized as mucosal thickening (MT), opacification (OPA), polypoidal-mucosal thickening (PT), others (antrolith and discontinuity of the sinus floor) and no pathologic findings. Correlations for pathologic findings and the factors of age and gender were calculated. **Results:** The prevalence for total incidental findings is 59.7%. The present study showed MT (35.1%) as most prevalent finding followed by OPA in (16.6%), PT in 7.2% and others in 0.7%. There was no statistically significant difference between gender and between the age groups. There was no statistically significant difference between different indications groups for CBCT scans. **Conclusions:** The incidental maxillary sinus abnormalities are highly prevalent in the asymptomatic dental patients; hence oral radiologists should be aware of these incidental findings and comprehensively evaluate the entire captured CBCT volume, which can help in early diagnosis, treatment and follow-up of the patient.

**Keywords:** Cone-beam computed tomography, maxillary sinus, pathology, polyps

## Introduction

Maxillary sinus pathologies are common in patients with dental pathologies (periapical lesions, cysts or tumors). Radiography is frequently used to diagnose diseases of the maxillary sinus. Maxillary sinus can be visualized on the panoramic radiograph, Water's view, computed tomography (CT), magnetic resonance imaging (MRI) and cone-beam computed tomography (CBCT). CT is considered as the "gold standard" for examination of the maxillary sinuses.<sup>[1,2]</sup> However, in dentistry CT machines have limitations, which includes their high cost and high radiation exposure.

CBCT addresses the limitation of CT and provides many dental advantages.<sup>[3]</sup> Over the last decade, CBCT was available for

maxillofacial radiographic imaging in western countries, but it is explored in our country since few years and numerous systems are now in use.<sup>[4]</sup> No other imaging modality in dentistry has made as great an impact on dental procedures in as short a time as CBCT.<sup>[5]</sup> Despite the major limitation of CBCT in differentiation soft-tissue, it easily identifies sinus opacification (OPA) and can provide valuable information on paranasal sinus inflammation without additional exposure.<sup>[3]</sup>

Imaging such as panoramic radiograph, CT and CBCT plays an important role in diagnosis, treatment and surgical planning in the maxillofacial region. The area of the maxillary sinus can be within the imaging field when the CT/CBCT is indicated for various reasons such as dental implant site assessment, periapical, bony and inflammatory pathologies, endodontic lesion, sinus augmentation, impacted and supernumerary teeth and orthodontics.<sup>[6]</sup> Hence, the incidental findings in frequently viewed in the area of the maxillary sinus by the maxillofacial radiologists. The increase in use of CBCT by dentists and maxillofacial surgeons opens up an opportunity for assessment of the prevalence of incidental findings of maxillary sinus, which would be relevant for further evaluation. These can be either incidental or of direct significance to the treatment.

The incidences of sinus abnormalities of the asymptomatic subjects varied between 10.9% and 69.1% in some reported studies.<sup>[7-11]</sup> In order to avoid unnecessary treatment or provide appropriate treatment and follow-up, the significance of incidental pathologic findings should be clarified.

The aim of the present study was to infer and to record the prevalence of incidental maxillary sinus pathologies in

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patients presenting with dental problems using CBCT scans performed for maxillofacial diagnostic purposes.

## Materials and Methods

Approval for this study was obtained from the Institutional Review Board. This study included 201 patients (402 maxillary sinus), which fulfilled the following inclusion and exclusion criteria.

### Inclusion criteria

This retrospective study included CBCT scans of bilateral maxillary sinus where individual factors of gender, age and indication for scanning had been recorded.

### Exclusion criteria

The CBCT scans with known cases of maxillary pathologies were excluded from the study.

The age of the patients included in the study ranged from 10-69 years, with a mean age of 32.09 years. The patient pool consisted of 91 females and 110 males. For statistical analysis, patients were separated into the six age groups: (1) 10-19; (2) 20-29; (3) 30-39; (4) 40-49 and (5) 50-59; (6) 60-69 years of age.

CBCT scans were obtained with Kodak 9300 consisting of an X-ray tube, a source collimator and an amorphous-silicon flat-panel detector. Images were reconstructed using a high spatial frequency reconstruction algorithm. CBCT scan was made using a KODAK 9300 unit (Carestream Health Inc., 150 Veronal Street, Rochester, NY 14608, USA). The exposure factors were field of view ranging from  $5 \times 5$  mm to  $17 \times 13.5$  mm, 80-90 kVp, 5 mA and Voxel size 90-500  $\mu$ . CBCT scans were performed with a rotation of  $360^\circ$  for data acquisition. The acquired data was reconstructed with a 0.2 mm slice interval and thickness.

All the CBCT scans were independently reviewed by two oral and maxillofacial radiologists with experience analyzing more than

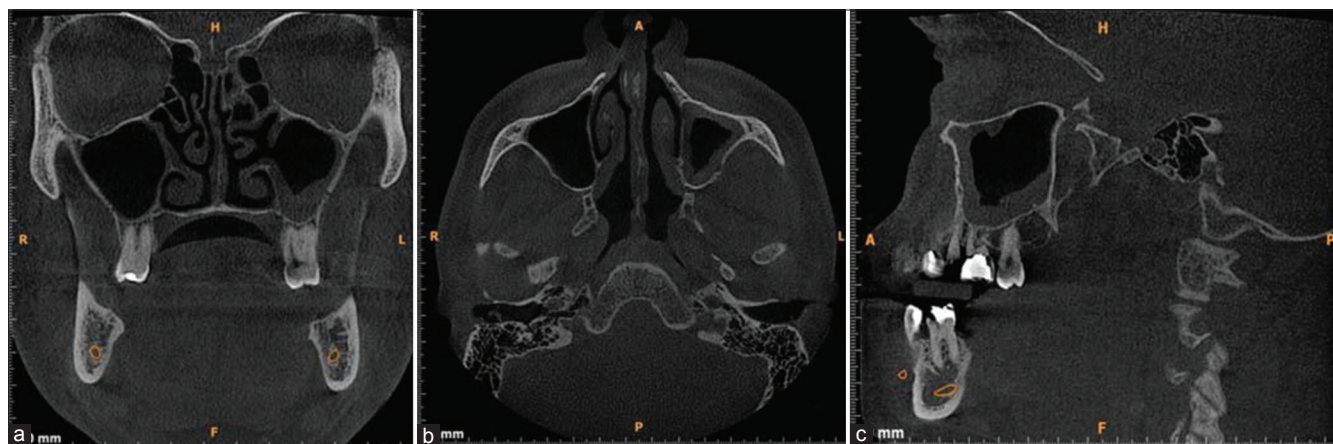
500 CBCT scans. CBCT images were viewed on a HP Compaq LE 1911, 19" VGA LCD display (Hewlett Packard Company, 3000 Hanover Street, 94304-1185, USA) at  $1280 \times 800$  resolutions. Observers were allowed to adjust brightness and contrast of the images and to zoom. Observers used the Digital Image Communication in Medicine software (National Electrical Manufacturers Association, Kodak Dental imaging software 3D module 2.4.10 copyright Carestream Health Inc., 2007) to evaluate the reconstructed image in three different planes. A training session was provided to radiographic observers to familiarize them with a set of CBCT images maxillary sinus pathologies considered in the study. For the detection of pathologic findings, the observers were instructed to evaluate the all the three planes (Axial, Coronal and Sagittal). All observations were carried out in a windowless room with dim lighting. When necessary, the window setting was adjusted to optimize the images for evaluation.

Pathologic findings were categorized as mucosal thickening (MT) [Figure 1], polypoidal-mucosal thickening (PT) [Figure 2], OPA [Figure 3], others (antroliths, discontinuity of the sinus floor etc.) and no pathologic findings (NPF). MT was evaluated by measuring the distance between the air-mucosal interface and the inner bony margins of the sinus. The sinus pathology was considered when the MT was more than 3 mm.<sup>[12]</sup> Any dome shape radiopacity in the maxillary sinus was considered as PT (antral poly). Polyps and retention cysts are seen as smooth, outwardly convex soft-tissue masses at imaging (CT, MRI) and cannot be differentiated.<sup>[13]</sup> Hence, both were included in the polypoidal thickening.

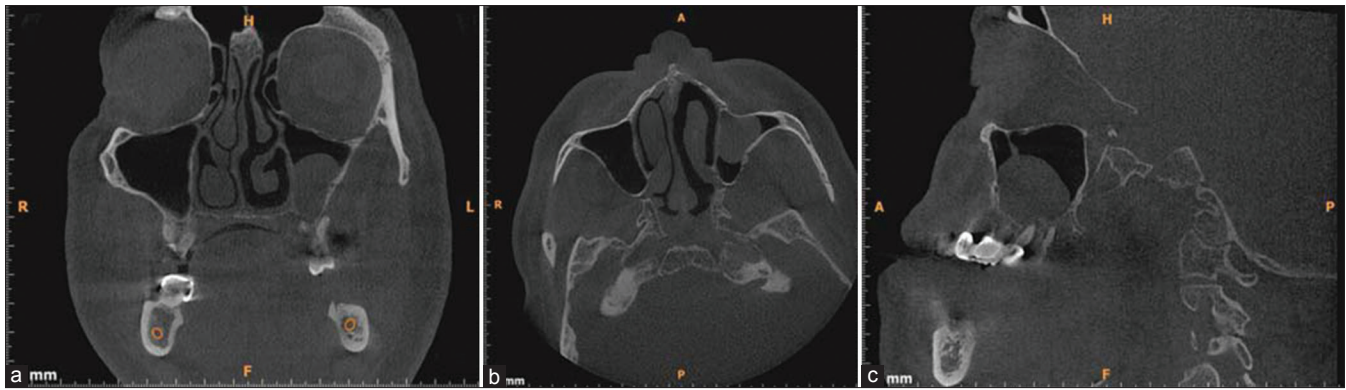
If there was disagreement regarding image assessment, the images were evaluated again and a consensus was reached by discussion.

### Statistical analysis

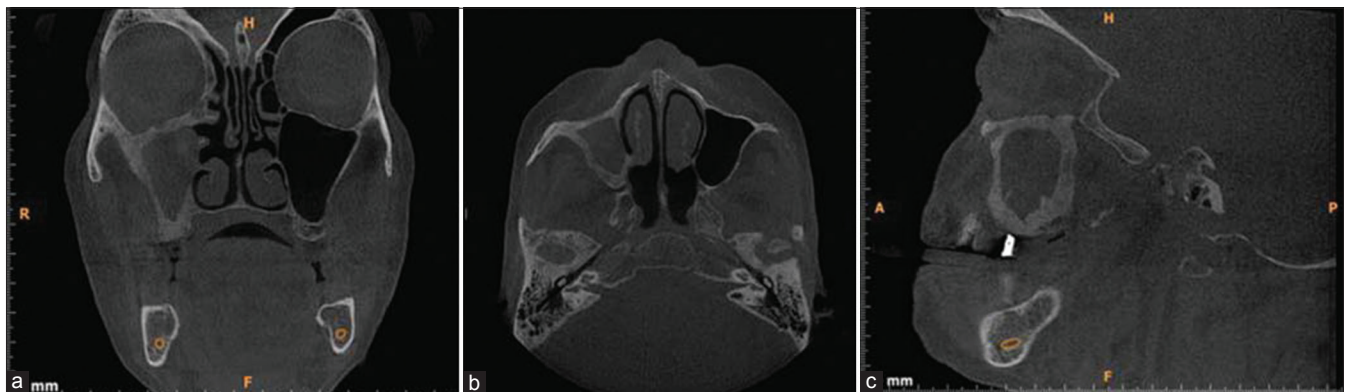
After data collection, data entry was done in excel and data analysis was performed with the help of SPSS Software Version 15 (IBM, New York, USA). Qualitative data was



**Figure 1:** Cone-beam computed tomography scan showing mucosal thickening in maxillary sinus. (a) Coronal section (b) axial section (c) sagittal section



**Figure 2:** Cone-beam computed tomography scan showing polypoidal mucosal thickening in maxillary sinus. (a) Coronal section (b) axial section (c) sagittal section



**Figure 3:** Cone-beam computed tomography scan showing opacification in maxillary sinus. (a) Coronal section (b) axial section (c) sagittal section

presented with the help of frequency and percentage table. The Chi-square test was used to compare groups.  $P < 0.05$  was taken as significant level. The inter-observer agreement among different observers was assessed by Kappa statistics based on the following criteria: kappa value of, 0.40 was considered to indicate poor agreement, 0.40-0.59 fair agreement, 0.60-0.74 good agreement and 0.75-1.00 excellent agreement.

## Results

A total of 110 patients (55.3%) were male and 91 patients (44.7%) were female. The number of patients who had incidental pathologic findings in at least one sinus or both was 153 (76.1%) [Table 1]. 48 (26.2%) of the 201 investigated patient scans showed no pathologic signs within either left or right maxillary sinus [Table 1].

The prevalence for the sum of incidental findings is 59.7%. Maxillary sinus scans showed MT in 141 (35.1%), OPA in 67 (16.6%), PT in 29 (7.2%), others in 3 (0.7%) and no findings in 162 (40.2%) [Table 2]. The pathologies associated with the right side (51.7%) of sinus were slightly more than the left side (48.3%) [Table 2]. From 110 male patients, 87 (79%) had at least some pathology in either of the sinuses, whereas only

66 (72.5%) of the 91 investigated scans of female patients showed pathologic signs in either sinus [Table 1]. There was no statistically significant difference between the gender, side and between the age groups. There was no statistically significant difference between different indications groups for CBCT Scans. Patient in the 3<sup>rd</sup> and 5<sup>th</sup> decade in our study showed the slightly higher prevalence of pathologic findings in the maxillary sinus, but that was not statistically significant [Table 3].

Most of the scans were indicated for dental implant (24.3%) site assessment and endodontic purpose (23.1%) [Table 4]. Other indications were bone lesions, impacted 3<sup>rd</sup> molars and canines, orthodontic treatment planning, periodontal bone loss, bony and inflammatory pathologies. The inter-observer agreement for CBCT scans was excellent for all types of maxillary sinus pathologies abnormalities (kappa is 0.97 for MT, kappa is 0.84 for PT, kappa is 0.96 for OPA, kappa value is 1 for others and NPF).

## Discussion

In this study, 201 (402 maxillary sinus) CBCT datasets were retrospectively evaluated for pathologies in the maxillary sinus. The present study showed 59.7% incidence of

maxillary sinus pathologies, which is slightly higher than some previous studies.<sup>[14-16]</sup> A study by Cho and Jung<sup>[14]</sup> found a 37.7% incidence of maxillary sinus OPA. In orthodontics patients, Pazera *et al.*<sup>[15]</sup> reported 46.8% incidental maxillary sinus pathologies. The study carried out by Ritter *et al.*<sup>[16]</sup> using CBCT showed a prevalence of incidental findings in the maxillary sinus is 56.3%. Rege *et al.*<sup>[17]</sup> found a 68.2% prevalence of mucosal pathologies, which is higher than our study. This can be due to the difference in the indication of CBCT scans, which were included in the study.

We found a higher frequency of pathologic findings in males, which are in concordance with other studies,<sup>[16-18]</sup> but the difference is not statistically significant in our study.<sup>[9,11]</sup> In the present study, patients in the third decade showed more

**Table 1: Prevalence of incidental pathologic findings in males and females**

Prevalence of pathologic findings	Males	Females
With pathologic findings	87	66
Without pathologic findings	23	25
Total	110	91

**Table 2: Frequency of incidental pathologic findings in maxillary sinus**

Pathologic findings	Total no. sinus (%)	Right sinus	Left sinus
Mucosal thickening	141 (35.1)	76	65
Polypoid mucosal thickening	29 (7.2)	13	16
Opacification	67 (16.6)	34	33
Other findings	3 (0.7)	1	2
No findings	162 (40.1)	76	86

**Table 3: Prevalence of incidental maxillary sinus pathologic findings in different age group**

Age group	Pathologic findings	No. findings
10-19	14	9
20-29	49	16
30-39	36	8
40-49	39	8
50-59	8	4
60-69	7	3
Total	153	48

**Table 4: Prevalence of incidental pathologic findings in maxillary sinus with different indication**

Prevalence of pathologic findings	Implant	Orthodontics	Exodontia	Periodontics	Endodontics	Bone lesion/pathology
No. of sinus with pathologic findings	61	32	43	8	57	39
No. of sinus without pathologic findings	37	28	29	6	36	26
Total	98	60	72	14	93	65

pathologies in the maxillary sinus when compared with other groups, which is in contrast to the Ritter *et al.*<sup>[16]</sup> findings in which most pathologic findings are seen by patients more than 60 years.

In our study, the most prevalent finding was MT (35.1%) followed by OPA (16.6%) and PT (7.2%), which is in concordance, with the Ritter *et al.*<sup>[16]</sup> These results are in contrast to some other studies<sup>[17,19-21]</sup> which reported the incidence of mucous retention cyst as second most common pathology ranging from 1.4% to 10.1% respectively. The OPA found in our study population is slightly less than the study done by Ritter *et al.*<sup>[16]</sup> The variations in the results of our study can be attributed to the different imaging modality,<sup>[8-11,14]</sup> population addressed in the study,<sup>[15,22]</sup> variation in sample size<sup>[16,17]</sup> and the definition of abnormality, which is considered.<sup>[18,23-26]</sup>

There is some controversy over the significance of abnormal sinus images and their relationship to clinical disease in previous studies.<sup>[27,28]</sup> Different imaging modalities had been used for detection of maxillary sinus pathologies in previous studies showed a wide range of incidence from 10.9% up to 69.1% with the majority between 30% and 50%.<sup>[8-11,14]</sup> In general, MRI seems to demonstrate higher levels of incidental sinus abnormalities than CT scans as it is better sensitivity detecting soft-tissue pathologies.<sup>[28,29]</sup> Studies<sup>[10,29-32]</sup> based on MRI found the prevalence in a range of 26-50%. Nam and Lee<sup>[10]</sup> and Min *et al.*<sup>[11]</sup> in their study have reported incidences of 36.3% and 38% for the asymptomatic Korean population using CT. Studies based on the panoramic imaging found the prevalence of mucosal changes in the maxillary sinus of 12% for MT and 7% for PT in 5,021 individuals.<sup>[18]</sup> Recently, CBCT is used in many studies as a feasible option for detecting incidental maxillary sinus pathologies including our study. CBCT as a new 3D imaging modality could be of clinical value not only in screening, but also in planning paranasal surgery and implant planning. Some of the studies reported on the useful application of CBCT for intraoperative imaging of the paranasal sinus.<sup>[29]</sup> CBCT is more cost-and radiation-effective than the conventional CT and maxillary sinus pathologies can be evaluated easily on the CBCT images.

It can be inferred from the high frequency of incidental maxillary sinus pathologies in asymptomatic patients that a certain degree of sinus OPA is normal. The reason is unclear, but the proximity of dental structures to paranasal sinuses might be related to the high incidence. The association between the periapical pathology and type of maxillary sinus abnormality is still not proven.<sup>[17]</sup> The detection of incidental maxillary sinus pathologies can also help in early diagnosis

and treatment and the patient can be further followed-up for the development and progress of the disease.

The limitations of the present study are that differentiation was not done between polypoidal thickening and mucous retention cyst. Furthermore, the nature of fluid cannot be identified as they (i.e., blood or pus) appear radiologically identical.

In spite of the limitation, the present study indicates CBCT scans can help in early detection and evaluation of pathologies in asymptomatic patients.

## Conclusion

Based on the above study, it can be concluded that incidental maxillary sinus abnormalities are highly prevalent in the asymptomatic dental patients, hence Oral radiologists should be aware of these incidental findings and comprehensively evaluate the entire captured CBCT volume, which can help in early diagnosis, treatment and follow-up of the patient.

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