

# Topographic Relationship Of Maxillary Sinus Floor With The Posterior Teeth Roots Using Panoramic Radiography And Cone Beam Computed Tomography (CBCT).

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## ABSTRACT

**Background:** The relation of maxillary posterior teeth roots to the maxillary sinus floor is important for diagnosing and planning of many surgical procedures. The anatomical proximity of the root apices of the maxillary posterior teeth to the maxillary sinus floor may favor the development of inflammatory, infectious and/or traumatic alterations in the maxillary sinus. **Objective:** To correlate the topographic relationship of the maxillary sinus floor to the posterior teeth roots using panoramic radiography and cone beam computed tomography (CBCT). **Methods:** Panoramic and CBCT images of 30 patients were analyzed. The relationship between the posterior teeth and the maxillary sinus and panoramic radiography signs associated with protrusion of root apices into the sinus were evaluated following Kwak et al. (2004) classification. **Results:** The OPG showed statistically significant ( $P>0.001$ ) longer root projection in the sinus cavity in comparison with the root protrusion into the sinus measured by using CBCT images. It was found that cbct was statistically more significant than OPG. Given the limitations of panoramic radiography being a 2D radiography. **Conclusion:** CBCT is reliable in assessment of topographic relationship of maxillary sinus floor with the posterior teeth in comparison with panoramic radiography CBCT is indicated to provide the information about the relation to the maxillary sinus floor when there is protrusion detected in panoramic images.

**Keywords:** CBCT, maxillary sinus; tooth apex.

## INTRODUCTION

Surgical removal of upper posterior teeth is a routine procedure in which complications occasionally arise. Oroantral communications might occur after dental extractions, given the anatomical proximity between the upper posterior dental roots and the maxillary sinus. This accident, which has always been a concern for dental practitioners, consists in the violation of the maxillary sinus floor and may or may not involve tearing of the Schneiderian membrane.<sup>[1]</sup>

In about half of the population, the sinus floor extends between adjacent teeth or individual roots, creating elevations in the antral surface, commonly referred to as 'hillocks'. The roots of the maxillary premolar, molar and occasionally canine teeth may project into the maxillary sinus.<sup>[2]</sup>

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Because of the implications this can have on surgical procedures, the exact assessment of the relationship between roots of maxillary premolars and molars and inferior wall of the maxillary sinus is essential.<sup>[3]</sup>

The anatomical and clinical significance of the maxillary sinus was first described by Nathaniel Highmore in 1651. Hence, the maxillary sinus is also called as Antrum of Highmore.<sup>[4]</sup> The close anatomic proximity of the root apices of the teeth to the maxillary sinuses make dental disease a potential source for spread of disease into the maxillary sinuses.<sup>[5]</sup> Therefore, it seems clear that a thorough assessment of maxillary sinus topography is paramount whenever dental implants, extractions, endodontic therapy and orthodontics are considered in the posterior maxilla.<sup>[6]</sup>

Tooth roots that protrude into the maxillary sinus can have various implications like:

1. Sinus expansion after extraction can greatly decrease the bone height available for implant placement
2. Oroantral fistulae or root displacement into the sinus cavity.

3. Endo-antral syndrome-the spread of pulpal disease beyond the confines of the dental supporting tissues into the maxillary sinus causing sinusitis.
4. Intrusion or bodily movement of teeth across the sinus floor by orthodontic treatment have been shown to cause moderate apical root resorption and a higher degree of tipping.
5. Sinusitis of odontogenic origin.<sup>[7]</sup>

The simplest way to assess the relationship between upper posterior roots and the maxillary sinus is through proper imaging of the area. The most commonly used approach is the panoramic radiography, which allows visualization of several anatomical features at low cost and with a relatively low radiation dose.<sup>[1]</sup> However its disadvantages include superposition of anatomic structures, horizontal and vertical magnification (10-33%), and a lack of cross sectional information which may jeopardize the analysis.<sup>[7]</sup>

Cone beam computed Tomography (CBCT) is a recent technology initially developed for angiography in 1982 and subsequently applied to maxillofacial imaging.<sup>[8]</sup>

It has become very easy with CBCT, to determine the exact relationship between the roots of the maxillary posterior teeth and the maxillary sinus. Serial cross sectional views can be made in the axial, sagittal, and coronal planes. In addition, tomographic section in a curved plane corresponding to dental arch can be made in CBCT which is not possible with the CT.<sup>[9]</sup> However the disadvantage for CBCT includes radiation dose and cost in contrast to panoramic radiography. Many studies have been performed on the vertical relationship between the root apex and the maxillary sinus floor using many modalities. The purpose of this study is to correlate the topographic relationship of the maxillary sinus floor to the maxillary posterior teeth roots as imaged by pairs of panoramic imaging radiographs (OPG) and CBCT images.

## MATERIALS AND METHODS

The study material consisted of panoramic and conebeam computed tomographic (CBCT) images of 30 patients between ages of 20-65 years reporting to the Department of Oral Medicine & Radiology, DivyaJyoti College of Dental Sciences & Research, Modinagar, (U.P.).

Radiographs were obtained using OPG: Kodak 8000 Digital (73kV, 12mA, 13.9sec) .CBCT: CS 9300 3D Imaging System Software.

The objective of the study was to correlate the topographic relationship of the maxillary sinus floor to the posterior teeth roots using panoramic radiography and cone beam computed tomography (CBCT) [Figure 1]. Inclusion Criteria included – (a)Patient in the age range of 20-65 years.(b) Only

teeth whose root apices will be clearly imaged in both radiographic techniques. Exclusion Criteria were (a) Displacement of the root due to pathology, such as cyst or tumor. (b)Pregnant patient ( c)Any known maxillary sinus pathology. The protocol for the study was approved by the Research Ethical Committee of DJ College of Dental Sciences & Research.

All measurements and analyzes were performed by two oral and maxillofacial radiologists, with experience in interpreting CBCT exams. When there was disagreement between the two examiners, a third radiologist was called in to give an opinion. Each imaging technique (panoramic radiography and CBCT) was assessed as a separate subset in a random sequence. The panoramic radiography was the first, and the examiners were blinded about the patient data [Figure 2]. Posteriorly, the examiners evaluated the CBCT images in a different sequence from the first imaging modality evaluated [Figure 3 and 4]. The examiners were also blinded about the patient data. The classification followed in the present study is a condensed classification proposed by Kwak et al. (2004) classification:

0: the root is not in contact with the cortical borders of the sinus.

1: an inferiorly curving sinus floor, the root is in contact with the cortical borders of the sinus.

2: an inferiorly curving sinus floor, the root is projecting laterally on the sinus cavity but its apex is outside the sinus boundaries.

3: an inferiorly curving sinus floor, the root apex is projecting on the sinus cavity.

4: a superiorly curving sinus floor enveloping part or all of the tooth root.

### Statistical analysis

Statistical analyses were performed with the Statistical

Package for the Social Sciences SPSS® Inc., Chicago, IL). The various lengths of projection of the roots superior to the sinus floor in the 2 imaging techniques will be compared by paired t tests and Pearson's correlation coefficient and regression coefficient. A P value < 0.05 will be considered statistically significant. The frequency and percentages were calculated for the individual parameters and intergroup comparison was done using the Chi Square analysis.

## RESULTS

Out of 30 patients 08 were female patient and 22 were male patient. A total 180 teeth were assessed in these patients. Their age ranged from 18-45 years. Positional relationship between the floor of the maxillary sinus and maxillary second premolar [Table 1 & Graph 1], first [Table 2 & Graph 2] and

second molars were classified into 5 categories(Kwak et al. (2004) classification). In the present study, cases in which CBCT showed roots with score 0 are 27.8% whereas 11.8% have same score on opg, 35.6% showed roots with score 1 on CBCT whereas 20.6% have same score on opg. 6.1% showed roots with score 3 on CBCT whereas 7.8% have same score on opg. Roots which showed score 4 on CBCT were 12.8% whereas 2.2% showed same score on OPG.[Table 03 & Graph 03].

Table 1: Left Premolar.

|       | Score 0    | Score 1    | Score 2    | Score 3    | Chi Square Value | P value |
|-------|------------|------------|------------|------------|------------------|---------|
| CBC T | 12 (40.0%) | 8 (26.7%)  | 08 (26.7%) | 02 (6.7%)  | 17.448           | 0.001   |
| OPG   | 06 (20.0%) | 04 (13.3%) | 03 (10.0%) | 17 (56.7%) |                  |         |

[Table 1] indicates the comparison of grading of distance between the floor of maxillary sinus and maxillary left premolar roots between OPG and CBCT

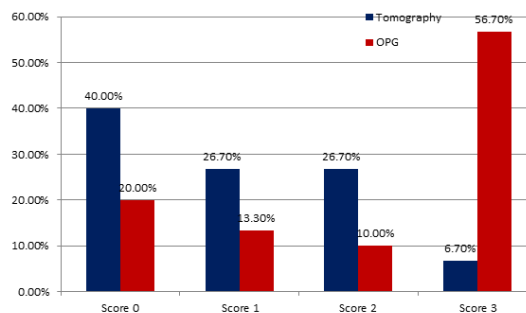
Table 2: IST Molar-Right

|       | Score 0    | Score 1    | Score 2    | Score 3    | Score 4    | Chi Square Value | P value |
|-------|------------|------------|------------|------------|------------|------------------|---------|
| CB CT | 05 (16.7%) | 14 (46.7%) | 03 (10.0%) | 01 (3.3%)  | 07 (23.3%) | 17.448           | 0.001   |
| OP G  | 03 (10.0%) | 06 (20.0%) | 01 (03.0%) | 18 (60.0%) | 02 (6.7%)  |                  |         |

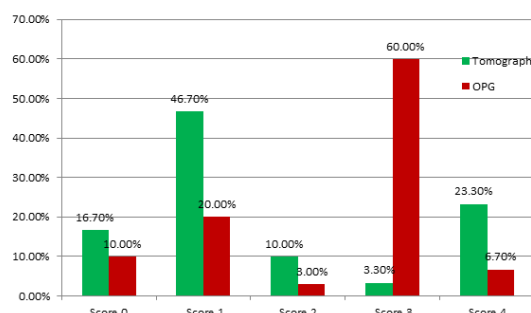
[Table 2] Indicates the comparison of grading of distance between the floor of maxillary sinus and maxillary right 1st molar roots between OPG and CBCT

Table 3: indicates overall comparison of maxillary teeth roots to floor of maxillary sinus using OPG and CBCT.

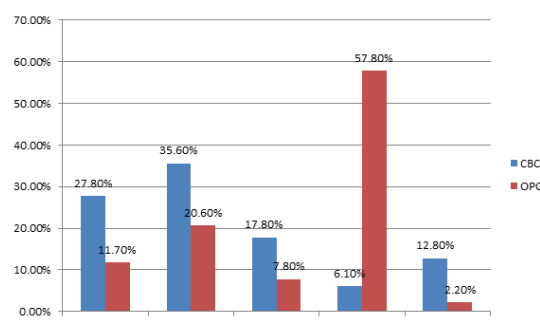
|       | Score 0    | Score 1    | Score 2    | Score 3     | Score 4    | P value |
|-------|------------|------------|------------|-------------|------------|---------|
| CBC T | 50 (27.8%) | 64 (35.6%) | 32 (17.8%) | 11 (6.1%)   | 23 (12.8%) | 0.001   |
| OPG   | 21 (11.7%) | 37 (20.6%) | 14 (7.8%)  | 104 (57.8%) | 4 (2.2%)   |         |



Graph 1: Analysis of results revealed that Score 0: CBCT (40.0%) OPG (20.0%), Score 1 CBCT (26.7%) OPG (13.3%), Score 2 CBCT (26.7%) OPG (10%) Score 3 CBCT (6.7%) OPG (56.7%)



Graph 2: Analysis of results revealed that Score 0: CBCT (16.7%) OPG (10.0%), Score 1 CBCT (46.7%) OPG (20%), Score 2 CBCT (10.0%) OPG (3.0%) Score 3 CBCT (3.3%) OPG (60%), score 4 to CBCT (23.3) OPG(6.7%)



Graph 3: indicates overall comparison of maxillary teeth roots to floor of maxillary sinus using OPG and CBCT



Figure 1: Kodak 9300 Cs Dental Imaging Software with 3d Reconstruction



**Figure 2: Cropped Panoramic Radiographs Showing Close Approximation of Maxillary Sinus with Maxillary Teeth.**



**Figure 3: CBCT Showing Relation Of Maxillary Left 2nd Premolar With Floor Of Sinus**



**Figure 4: CBCT showing the relation of maxillary left 2nd molar with floor of maxillary sinus**

## DISCUSSION

The immediate relationship between the position of the tip of the root and the maxillary sinus is a predictive factor for oroantral communication. Thus, the proximity between root tips and the maxillary sinus floor may be a reflection of bone resorption caused by chronic apical periodontitis, stage of teeth development, ageing, maxillary sinus pneumatization and the degree of tooth impaction.<sup>[10]</sup> The panoramic radiography is the most common diagnostic aid used to assess the proximity between maxillary posterior roots and the maxillary sinus, but assessments of relationship between the upper dental roots and the maxillary sinus showed that panoramic radiography and CT scans differ significantly.<sup>[11]</sup> CBCT analysis has shown that a correlation exists between thickening of sinus

mucosa and carious maxillary posterior teeth and/or periodontal disease.<sup>[11]</sup> Microorganisms and their toxins present in the periapical lesions of involved teeth may infiltrate maxillary sinus through either the blood/lymph vessels or porous maxillary bone. Hence, there is positive correlation exist between the periodontal lesions and maxillary sinus mucosal thickening.<sup>[12]</sup>

In the present study, OPG and CBCT assessment was done for 180 teeth (360 roots) of 30 patients. The diagnostic information was classified from 0 to 4 types similar to that suggested by Sharan&Madjar et al (2006).<sup>[13]</sup> The topographic relation of roots of maxillary second premolar, maxillary first and second molar on both right and left sides to the floor of maxillary sinus was classified as both OPG and CBCT according to Sharan&Majdar et al.<sup>[13]</sup> The results were statistically analysed. In this study conducted, grading of distance between the floor of maxillary sinus and the maxillary posterior teeth roots between OPG and CBCT, it was found statistically significant p value = 0.001. The topographic relation of roots of maxillary second premolar, maxillary first and second molar on both right and left sides to the floor of maxillary sinus was classified as both OPG and CBCT according to Sharan & Majdar et al (2006).<sup>[13]</sup> The results were statistically analysed. Grading of distance between the floor of maxillary sinus and the maxillary posterior teeth roots between OPG and CBCT, it was found statistically significant p value = 0.001. It was found that CBCT was statistically more significant than OPG. There are some reports on the relationship between the root apices of the maxillary teeth and the inferior wall of maxillary sinus.

It was Freisfeld et al (2010) were the first to suggest a classification of the relationship between the teeth and the sinus.<sup>[14]</sup> The drawback in their method of classification was applicable only to first molar, but did not relate to the sinus floor topography, and did not include a situation of a root that 0 = projects laterally on the sinus, the present study have overcome the drawback.

Kwak et al (2004) suggested that, only one case in maxillary first molar (4.5%) and three cases (14.2%) in maxillary second molar shows apical protrusion of the buccal root over the inferior wall of sinus ( type III). In maxillary first molar (13.6%) shows apical protrusion of the palatal root over the inferior wall of the sinus.<sup>[6]</sup>

In overall comparison of maxillary teeth roots in relation to the floor of sinus using OPG and CBCT. In our study, cases in which CBCT showed roots with score 0 are 27.8% whereas 11.8% have same score on opg, 35.6% showed roots with score 1 on CBCT whereas 20.6% have same score on opg. 6.1% showed roots with score 3 on CBCT whereas 7.8% have same score on opg. Roots which showed

score 4 on CBCT were 12.8% whereas 2.2% showed same score on OPG.[Table 3,Graph3]

This could be due to 2- dimensionality of the panoramic radiograph, which causes roots that are buccal/ lingual to the sinus to be projected on the sinus cavity.

Therefore, when presented with a panoramic radiograph alone, the clinician cannot determine whether the root is actually protruding into the sinus or not. This is in contrast to the cross sectional image of the CBCT, which allows an accurate interpretation of the true buccolingual relationships of the teeth roots to the sinus. Thus panoramic radiograph presents certain drawbacks, such as superimposition of anatomic structure, horizontal and vertical magnification and a lack of cross- sectional information.<sup>[4]</sup>

Martinez G et al (2010) observed that the diagnostic capacity of panoramic radiograph was 28.57% for sinus pathology due to overlapping of anatomical structures. Panoramic radiograph, which is still the first test to be requested in the dental practice, is not a good method for diagnosing the sinus disorders.<sup>[15]</sup>

The present study confirms that due to anatomical complexities, it is difficult to identify three dimensional human structures using conventional radiographic techniques especially in case of evaluation of the relationship between the floor of the sinus and the apices of maxillary teeth. Cross sectional images have been proven to be useful in diagnosis. It is difficult to analyse precisely a three dimensional sinus with a one dimensional panoramic radiograph. The clinician cannot determine whether the root is actually protruding into the sinus or not. This is in contrast to the cross-sectional image of the CBCT, which allows an accurate interpretation of the true buccolingual relationships of the teeth roots to the sinus.. CBCT was better than panoramic radiograph with measurements that were more exact and closer to anatomical reality.

## CONCLUSION

It is difficult to analyse precisely a three dimensional sinus with a one dimensional panoramic radiograph.In contrast CBCT allows an accurate interpretation of the true buccolingual relationships of the teeth roots to the sinus. Henceforth to avoid complications in treating maxillary lesions, asking for CBCT scans in the pre-operative work-up of the posterior maxilla is justified.

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