

# Proximity of maxillary posterior teeth roots to maxillary sinus and adjacent structures using Denta scan®

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## Abstract

**Aim:** The study aimed to investigate the proximity of maxillary posterior teeth roots to maxillary sinus and measure the distance of maxillary posterior teeth roots and the sinus floor as well as the thickness of bone between the roots and alveolar cortical bone using Denta scan®. **Materials and Methods:** The study samples include Denta scan® images of fifty patients with normally erupted bilateral maxillary first premolar to maxillary second molar. The vertical relationship of each tooth root with maxillary sinus is classified into four types of Denta scan® images (based on the classification by Jung in 2009). The distance between the sinus floor and root, and the bone thickness between the root and alveolar cortical plate will be measured and analyzed. **Conclusion:** The buccal root of the maxillary molars was more commonly protruded into the maxillary sinus. Among the roots of maxillary posterior teeth, mesiobuccal root of first molar and palatal root of second premolar were found in close proximity to the floor of maxillary sinus. The bone thickness on the buccal aspect to the root was significantly thinner in the maxillary first premolar and maxillary first molar as compared to other maxillary posterior teeth roots. **Clinical Significance:** Knowledge of anatomical relationship between the maxillary posterior teeth and maxillary sinus guides us not only in proper preoperative treatment planning but also avoids the possible complications encounter while performing the minor oral surgical procedures involving maxillary posterior teeth, which are close to the maxillary sinus.

**Key words:** Anatomical relationship, Denta scan®, maxillary sinus

## INTRODUCTION

The anatomical relationship between the floor of maxillary sinus and maxillary posterior teeth always possess a challenge in dentistry, especially during the endodontic and prosthetic procedure, extraction, or surgical removal involving maxillary posterior teeth which are close to maxillary sinus.<sup>[1]</sup>

Maxillary sinus starts developing during intrauterine fetal life which continues to develop even after birth. Size and shape of adult maxillary sinus are variable, and it may differ according to age of an individual, their size, and degree of pneumatization.<sup>[2,3]</sup> Maxillary sinus often expands between the molar roots and results in proximity between them. On radiograph, it seems that roots penetrate the sinus floor and protrude into

maxillary antrum, but instead, it is the maxillary sinus that has extended around the roots of the tooth.

Protrusion of posterior tooth roots into the maxillary sinus has some clinical implications. Extraction of tooth and/or endodontic surgery can lead to perforation and creation of oroantral fistula or root displacement into the maxillary sinus if it is very close or protrudes into the maxillary sinus.<sup>[2]</sup> The anatomical relationship among maxillary sinus and

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roots of maxillary posterior teeth plays a significant role in determining the orthodontic tooth movements. Sinusitis can appear as a consequence of iatrogenic perforation of the floor or spread of infection from periapical region to the sinus.<sup>[3]</sup>

The thickness of bone among the alveolar cortical plate and roots of maxillary molars affects the spread of odontogenic infection which decides the treatment planning.<sup>[3,4]</sup>

The present study aimed to investigate the proximity of roots of maxillary posterior teeth to maxillary sinus, measure the distance of maxillary posterior teeth roots and floor of maxillary sinus, and to measure the thickness of bone between the root and alveolar cortical plate using Denta scan®.

## MATERIALS AND METHODS

This is a retrospective, randomized, observational study with measurements taken from Denta scan® of fifty patients with normally erupted right and left maxillary first premolar to maxillary second molar. Denta scan® was obtained from the Maharishi Markandeshwar Institute of Medical Sciences and Research, the Department of Radio Diagnosis of the same university.

Denta scan® is a computer software program which gives computed tomographic (CT) imaging of the maxillofacial bones such as maxilla and mandible in three planes of reference: axial, panoramic, and oblique sagittal (or cross-sectional). The clarity and identical scale between the different views enables uniformity of measurements and cross-referencing of important anatomical structures (inferior alveolar nerve and mental foramen maxillary sinus) through all three planes. The Denta scan® has also been proven as a diagnostic modality for prediction of invasion in the mandible in those patients having oral squamous cell carcinoma.<sup>[5,6]</sup>

Inclusion criteria for the study included the Denta scan® of patients with normally erupted right and left maxillary first premolar to maxillary second molar, with no sign of tooth extraction or surgery involved sinus, orthodontic treatments including tooth movements, or any other treatment intervention that affects morphologic situation of maxillary posterior region (from first premolar to second molar bilaterally).

The Denta scan® images were evaluated and analyzed. The vertical relationship between the tooth root apex and floor of maxillary sinus is classified into four types of Denta scan® images, based on Jung classification (2009) [Figure 1].<sup>[7]</sup>

- Type 0: The maxillary sinus floor is located above the root apex
- Type 1: The root apex touches the floor of maxillary sinus
- Type 2: The floor of maxillary sinus is interposed between roots
- Type 3: Apical protrusion is observed over the maxillary sinus floor.

For vertical relationship measurement in type 0 and 3, the distance between tooth root apex and sinus floor was measured on Denta scan® images. A positive value is given for the root apices extending below the floor of the maxillary sinus and negative value for the root apices above the floor of maxillary sinus.

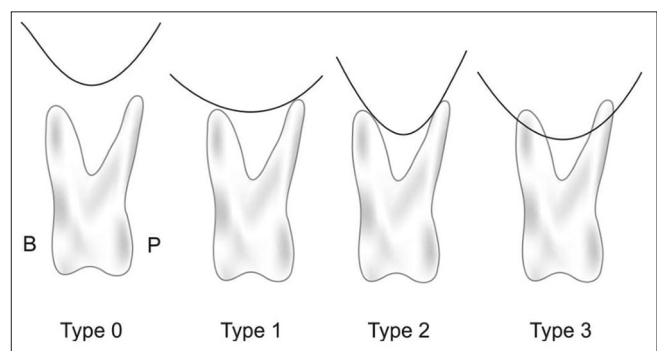
For measurement of the bone thickness, the distance from roots of maxillary posterior teeth to their corresponding alveolar cortical plate was measured on Denta scan®. For the buccal and palatal root, the distances of buccal and palatal cortical plate were measured, respectively [Figure 2].<sup>[2]</sup>

For analysis and comparison of the left and right sides measurement, a paired *t*-test was done. Data analysis was presented as mean, frequency, and standard deviation.

ANOVA test was used to assess the bone thickness of all four vertical relationships that exists between the floor of maxillary sinus and teeth roots.

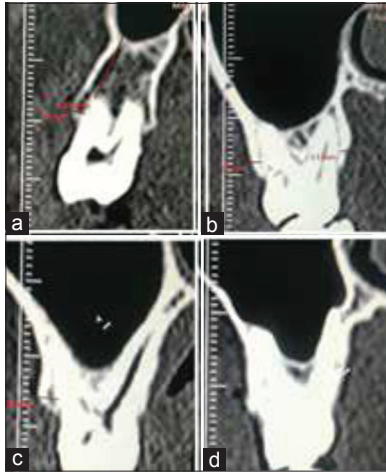
## RESULTS

In the study, fifty Denta scan® of the patients (17 females and 33 males) with age range from 15 to 17 years was analyzed. Type 0 relationship was most commonly seen in the first and second premolars, whereas in the first and second maxillary molars, type 1 relationship was commonly seen [Table 1]. The mean distance from the floor of maxillary sinus to apex of root was longest for the palatal root of molars and the buccal



**Figure 1:** Vertical relationship of maxillary sinus floor and maxillary posterior teeth<sup>[7]</sup>

root of first premolar. However, it was shortest for the mesiobuccal root of maxillary first molar and the palatal root of second premolar [Table 2].



**Figure 2:** Denta Scan images shows – Four types of vertical relationship between the root apex of maxillary molars and the floor of maxillary sinus. (a) Type 0 - Maxillary sinus floor is located above the root apex (b) Type 1 - The root apex touches the floor of maxillary sinus (c) Type 2 - The floor of maxillary sinus is interposed between roots (d) Type 3 - Apical protrusion is observed over the maxillary sinus. Denta Scan Images also shows the thickness of bone to their corresponding cortical plate

The difference between relationship of maxillary sinus and teeth root for the right and left sides was not statistically meaningful ( $P > 0.001$ ); the relation between different types and gender was also not statistically significant ( $P > 0.001$ ).

The buccal root of maxillary first premolar and the mesiobuccal root of maxillary first molar were seen very close to the cortical plate. The distobuccal root of maxillary second molar observed farthest from the cortical plate [Table 3]. Among the four vertical relationships, a statistically significant difference was found in the bone thickness surrounding the roots.

## DISCUSSION

It is very crucial to assess the relationship between maxillary posterior teeth roots and floor of the maxillary sinus before planning any treatment procedure to avoid any procedural complication. Many potential risks are associated with maxillary posterior root tips in proximity to the sinus floor. For example, during endodontic procedure, there is increased risk of perforation of sinus floor with the root canal instruments in Type 1 and 3 relationships. A case of

**Table 1: Vertical relationship between root apex of maxillary posterior teeth and floor of maxillary sinus**

Tooth	Type 0, n (%)	Type 1, n (%)	Type 2, n (%)	Type 3, n (%)
Maxillary first premolar				
B	48 (96)	2 (4)	-	-
P	48 (5)	2 (5)	-	-
Maxillary second premolar				
B	35 (70)	14 (28)	-	1 (2)
P	32 (65)	17 (34)		1 (1)
Maxillary first molar				
MB	15 (30)	28 (57)	2 (4)	4 (9)
DB	18 (36)	22 (45)	8 (17)	1 (2)
P	21 (41)	21 (42)	7 (15)	1 (2)
Maxillary second molar				
MB	14 (28)	30 (61)	-	6 (11)
DB	28 (57)	21 (42)	1 (1)	-
P	33 (66)	16 (32)	1 (1)	1 (1)

B: Buccal, P: Palatal, MB: Mesiobuccal, DB: Distobuccal

**Table 2: The mean distance from the floor of maxillary sinus to apex of root (in mm)**

Maxillary first premolar		Maxillary second premolar		Maxillary first molar			Maxillary second molar		
B	P	B	P	MB	DB	P	MB	DB	P
6.9	6.06	2.8	2.7	0.77	0.97	1.19	0.85	2.1	2.23

B: Buccal, P: Palatal, MB: Mesiobuccal, DB: Distobuccal

**Table 3: Mean distance from root of maxillary posterior teeth to their respective cortical plate (in mm)**

Maxillary first premolar		Maxillary second premolar		Maxillary first molar			Maxillary second molar		
B	P	B	P	MB	DB	P	MB	DB	P
0.7	1.5	1.7	1.8	1	1.8	1.3	2.2	2.5	1.9

B: Buccal, P: Palatal, MB: Mesiobuccal, DB: Distobuccal

orbital abscess has been reported in the literature as a complication resulted from a rapid exacerbation of periapical inflammation after endodontic treatment of a maxillary first molar.<sup>[8]</sup>

It has proved that during the periapical surgery, conventional periapical radiographs cannot be used in prediction of maxillary sinus perforation. Therefore, in such cases, advanced imaging modalities such as Denta scan or cone beam CT (CBCT) are highly recommended.<sup>[9]</sup>

CBCT analysis has shown that a correlation exists between thickening of sinus mucosa and carious maxillary posterior teeth and/or periodontal disease.<sup>[13]</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>[10,11]</sup>

The relationship between tooth root and sinus floor plays a significant role in periodontal surgery. A case reported by Huang and Brunsvold, maxillary sinusitis resulted from periodontal treatment of the first molar having deep periodontal pockets and bony defects.<sup>[12,13]</sup>

Eberhardt *et al.* found that the mesiobuccal roots of maxillary second molar were seen close to floor of the maxillary sinus. Another study done by Kilic *et al.* observed that the distobuccal root of maxillary second molar was found close to the sinus floor.<sup>[14,15]</sup>

Jung and Cho in their study done by using CBCT images for maxillary molars observed that the buccal root more commonly protrudes into the maxillary sinus.<sup>[3]</sup>

The results of our study revealed that the mesiobuccal roots of maxillary first molar seen at the shortest distance from the sinus floor, and for premolars, the palatal root of second premolar was found close to the sinus floor. Type 1 relationship was observed more commonly for molars and type 0 for the maxillary premolars.

Ariji *et al.*, in their study, observed that for maxillary molars, the buccal root was seen close to the buccal cortical plate.<sup>[16]</sup> The result of our study revealed that the thickness of bone was found thinnest for mesiobuccal roots of maxillary first molar and thickest for the distobuccal roots of maxillary second molar.

## CONCLUSION

A different relationship was observed between the maxillary posterior teeth and floor of maxillary sinus with the buccal and palatal roots. The buccal root of the maxillary molars was more commonly protruded into the maxillary sinus. Among the roots of maxillary posterior teeth (from first premolar to second molar), mesiobuccal root of first molar and palatal root of second premolar were found in close proximity to the floor of maxillary sinus. The bone thickness on the buccal aspect to the root was significantly thinner in the maxillary first premolar and maxillary first molar as compared to other maxillary posterior teeth roots.

### Clinical significance

Knowledge of anatomical relationship between the maxillary posterior teeth and maxillary sinus guides us not only in proper preoperative treatment planning but also avoids the possible complications encounter while performing the minor oral surgical procedures such as endodontic and prosthetic procedure, extraction, or surgical removal involving maxillary posterior teeth, which are close to maxillary sinus.

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### Conflicts of interest

There are no conflicts of interest.

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