

ORIGINAL RESEARCH

Assessment of the Relationship between the Maxillary Sinus Floor and Maxillary Posterior Teeth Roots using Cone Beam Computed Tomography

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ABSTRACT

Aim: This study was conducted to assess the vertical and horizontal relationship between the maxillary sinus floor and maxillary posterior teeth roots using cone beam computed tomography.

Materials and methods: In this cross-sectional study, the CBCT images presented in the radiology department of Hamadan dental school was used. From 450 observed CBCT, 340 of them did not have the inclusion criteria of the study and ultimately 110 CBCT were selected. Totally 214 first premolars, 217-second premolars, 220 first molars and 220-second molars were included. For evaluating the relationship between the maxillary sinus floor and the posterior maxillary teeth, the classification implemented in the study of Jung in 2009 was used. The relation was evaluated by two radiologists twice with a 2-week time interval.

Results: One hundred and ten patients with a mean age of 31.06 ± 9.7 years were assessed. Type 0 relationship (the maxillary sinus floor is located above the root tip) was most frequently observed with the first and second premolars. The most common type observed in the first and second molars was type 3 (apical protrusion is seen over the maxillary sinus floor). The relation between different types and gender was statistically meaningful, while no statistically significant difference was found between the right and left side assessments.

Conclusion: This study showed that although most of the teeth did not have contact with the sinus floor, but the more posterior the maxillary teeth, the more probability for root protruding into the maxillary sinus. It also confirmed that protrusion of teeth roots into the maxillary sinus is more common in male than female.

Clinical significance: Knowing the anatomical relation between the posterior teeth and the maxillary sinus, help the clinician in preoperative treatment planning of the posterior maxillary teeth and avoid problems that may occur during dental practice.

Keywords: Maxillary sinus, Tooth root, Cone Beam Computed Tomography, Anatomical conditions, Cross-sectional study.

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INTRODUCTION

The development of maxillary sinus begins during fetal period and continues after birth.¹ The adult sinus is variable in its extension.² The topography of the inferior wall with the posterior maxillary teeth root apices varies according to an individual's age, size and degree of pneumatization of the maxillary sinus and the state of teeth.³ In about half of population, the inferior wall of the maxillary sinus extends between adjacent teeth or roots and make projections at antral level that are generally named Hillocks.⁴

There are many important clinical implications for protrusion of posterior roots into the maxillary sinus.⁵ Spread of maxillary molar and premolar periapical or periodontal infections to the maxillary sinus or iatrogenic perforations of the maxillary sinus floor can lead to sinusitis.⁶

Tooth extraction or endodontic surgery can lead to perforation, formation of an oroantral fistula or root displacement into the maxillary sinus in a case of presenting tooth root protrusion in the maxillary sinus.⁷ The relationship between the dental roots and the inferior sinus wall is known to influence orthodontic tooth movement.² The influence of root protrusion in the maxillary sinus floor may lead to tooth roots resorption or tipping during orthodontic treatment.^{8,9} Wehrbein and Diedrich described a positive correlation between the length of root projection into the maxillary sinus as observed on panoramic radiographs and the amount of pneumatization that occurs after extraction.⁹ Sinus expansion following extraction can greatly decrease the amount of bone height available for implant placement.¹⁰ Therefore, accurate evaluation of anatomic relation of maxillary sinus and posterior teeth roots is essential in

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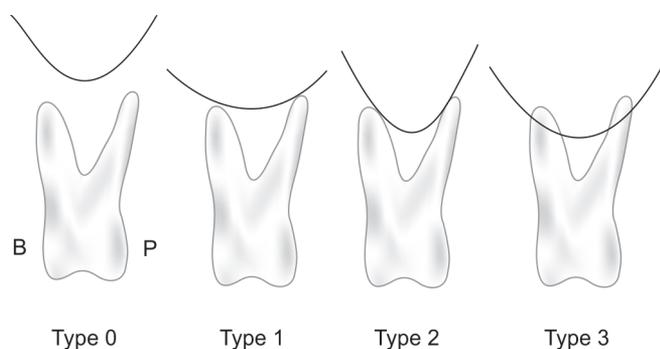


Fig. 1: The vertical relationship between the maxillary sinus floor and the roots of maxillary molars and premolars on CBCT (B: buccal; P, palatal)

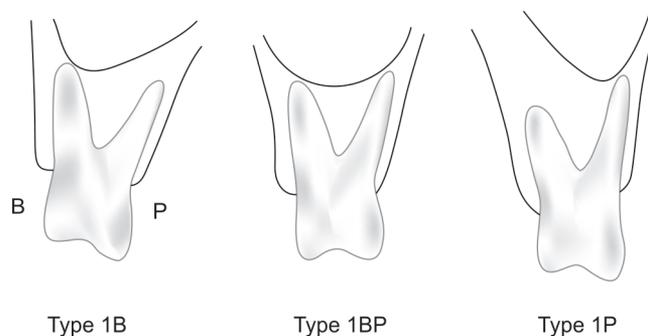


Fig. 2: Three classifications of root apex touching the sinus floor (B: buccal; P: palatal). Type 1B: The buccal roots touch the sinus floor; Type 1BP: the buccal and palatal roots touch the sinus floor; Type 1P: The palatal root touches the sinus floor

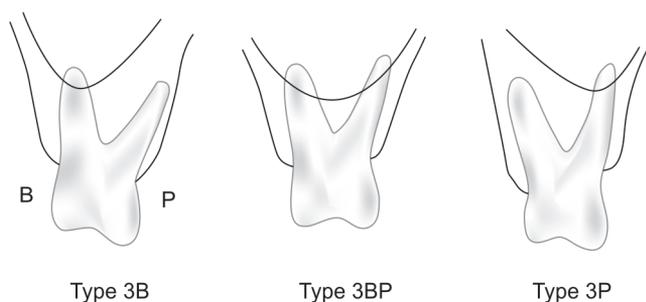


Fig. 3: Three classifications of apical protrusion (B: buccal; P: palatal). Type 3B: The buccal roots project into the sinus cavity; Type 3BP: The buccal and palatal roots project into the sinus cavity; Type 3P: The palatal root projects into the sinus cavity

diagnosing maxillofacial pathologies and preoperative treatment planning.^{2,5,6}

The localization of teeth relative to the maxillary sinus can be assessed by different radiographic techniques. Although a panoramic radiograph is of considerable help to the dental surgeon for a preoperative control, it may present certain deficiencies in terms of distortion, blurred images and also providing 2D image, while the real relations are 3D.¹¹

Several studies assessed the vertical and horizontal relationship between the tooth root apex and the inferior wall of the maxillary sinus using computed tomography (CT). It was concluded that CT is more accurate than panoramic radiography in assessing the tooth root and sinus relationship.¹²⁻¹⁶ Otherwise, cone beam computed tomography (CBCT) scanning technology, which has been in wide use in dentistry for recent years, is advantageous over CT scanning technology, since it provides comparable image quality at reduced dose and cost.^{17,18}

The aim of this study is assessing the vertical and horizontal relationship between the maxillary sinus floor and the posterior maxillary teeth roots using CBCT technique.

MATERIALS AND METHODS

In this cross-sectional study, the CBCT images presented in the Radiology department of Hamadan dental school was used. The study protocol was approved by the Research

Council of Hamadan University of Medical Sciences (Hamadan, Iran).

Inclusion criteria was patients with no history of tooth extraction or surgeries involved sinus, orthodontic treatments including tooth movements or any other treatment intervention that affect morphologic situation of maxillary posterior region (from canine to second molar bilaterally). Also patients should have no disease or pathologic condition involving the respected area, which influences the extension of sinus and its relation to the teeth. In order to be sure of the complete development of the maxillary sinus, patients older than 21-year-old were selected.¹⁰ It was attempted to include rather equal patients CBCT according to gender. From 450 observed CBCT, 340 of them did not have the inclusion criteria of the study and ultimately 110 CBCT were selected. All the CBCTs were imaged by NewTom 3G (Quantitative Radiology, Verona, Italy).

The six first premolars and three second premolars had periapical lesion, but the other tooth areas were intact. As finding patients with the study inclusion criteria was difficult, we had to omit these teeth, but enroll the CBCT of these patients for their other tooth areas. Therefore, totally 214 first premolars, 217-second premolars, 220 first molars and 220-second molars were included.

For evaluating the relationship between maxillary sinus floor and the first premolar, second premolar, first molar and second molar, the classification implemented in the study of Jung in 2009 was used (Fig. 1).¹⁹

Type 0: The maxillary sinus floor is located above the root tip.

Type 1: The root apex touches the sinus floor.

Type 2: The maxillary sinus floor is interposed between the roots.

Type 3: Apical protrusion is observed over the maxillary sinus floor.

Horizontal relationship between the teeth with type 1 and 3 to the maxillary sinus floor was also assessed (Figs 2 and 3).

Posterior teeth relation to the inferior wall of the maxillary sinus according to the Jung classification was evaluated by two radiologists. The condition of assessment was similar for both observers. The observation was repeated with a 2-week time interval. The relation of this morphologic classification with age, gender and tooth region was analyzed using SPSS version.¹⁶

RESULTS

About 110 patients (63 females and 47 males) with a mean age of 31.06 ± 9.7 years (21-65 years) were assessed. In that, 56.4% of participants were less than 30 years; 27.3% were between 30 and 40, and 16.4% were more than 40 years. A total of 871 teeth were evaluated.

Interobserver correlation in evaluating the relationship between posterior maxillary teeth and the maxillary sinus was high (Kappa = 0.796). Also intraobserver correlation for first and second observers was 0.844 and 0.829 respectively.

The relation between tooth area and type of mentioned classification was statistically meaningful (p < 0.001). Accordingly, type 0 relationship in which the maxillary sinus floor is located above the root tip was most frequently observed with the first and second premolars. The most common type observed in the first and second molars was type 3 in which apical protrusion is seen over the maxillary sinus floor (Table 1).

The relation between different types and gender was statistically meaningful (p = 0.003) and it can be stated that gender is an effective variable in determining the tooth relationship with the maxillary sinus floor. The most common type observed in both male and female was type 0 and the less common was type 2 (Table 2).

The difference between teeth relationship with the maxillary sinus floor in the right and left sides was not statistically meaningful (p = 0.929) and the prevalence of types observed in both sides was similar (Table 3).

The most frequent horizontal relationships observed in type 1 were as follows—in the first premolar, first and second molar, both buccal and palatal roots were projected into the maxillary sinus and in the second premolar, the buccal root projected into the sinus cavity.

In evaluating the horizontal relationship of teeth with roots protruded into the maxillary sinus (type 3) in the premolar teeth, buccal root protrusion was mostly seen; while in molars, palatal root protrusion was common (Table 4).

DISCUSSION

Assessing the relation between posterior maxillary teeth and the maxillary sinus floor, in order to avoid the problems that occur during and after dental treatments is critical. The reason of this importance is the potential risks associated with the penetration of teeth root tips into the maxillary sinus. For instance, there is a high risk of perforating the apical tissues as well as the sinus floor with the file in type 3 relationships. It has been reported a case of orbit abscess after RCT of a maxillary first molar, caused by a rapid exacerbation of periapical inflammation.²⁰

For planning endodontic surgery of the maxillary molars, it should be considered that oroantral communication may occur. It has been proven that conventional periapical radiographs cannot be used as predictors of perforating the maxillary sinus during periapical surgery of posterior maxillary teeth.²¹ Therefore, in such cases, preoperative CBCT is highly recommended.

The close proximity of teeth roots and the maxillary sinus floor is also important for periodontal surgery and dental prosthetic procedures.¹ Huang and Brunsvold reported a case in which the periodontal treatment of first molar with deep pockets and bony defects was led to the maxillary sinusitis.²² Also using CBCT, it was shown that

Table 1: The vertical relationship between the maxillary posterior teeth and the sinus floor

	Type 0		Type 1		Type 2		Type 3		Total
	N	%	N	%	N	%	N	%	N
First premolar	204	95.3	8	3.7	1	0.5	1	0.5	214
Second premolar	147	67.7	40	18.4	3	1.4	27	12.4	217
First molar	59	26.8	48	21.4	37	16.8	76	34.5	220
Second molar	44	20	70	31.8	18	8.2	88	40	220
Total	454	52.1	166	19.1	59	6.8	192	22	871
p-value	0.000								

Table 2: The relationship between the maxillary posterior teeth and the sinus floor according to gender

	Type 0		Type 1		Type 2		Type 3		Total
	N	%	N	%	N	%	N	%	N
Male	178	47.6	68	18.2	23	6.1	105	28.1	374
Female	276	55.5	98	19.7	36	7.2	87	17.5	497
Total	454	52.1	166	19.1	59	6.8	192	22	871
p-value	0.003								



Table 3: The relationship between the maxillary posterior teeth and the sinus floor according to tooth side

	Type 0		Type 1		Type 2		Type 3		Total
	N	%	N	%	N	%	N	%	N
Right	228	52.4	83	19.1	27	6.2	97	22.3	435
Left	226	51.8	83	19	32	7.3	95	21.8	436
Total	454	52.1	166	19.1	59	6.8	192	22	871
p-value	0.929								

Table 4: The horizontal relationship between the roots of the maxillary posterior teeth and the sinus floor

	Type 1						Total	Type 3						Total
	Buccal		Buccal-palatal		Palatal			Buccal		Buccal-palatal		Palatal		
	N	%	N	%	N	%	N	%	N	%	N	%	N	
First premolar	3	37.5	4	50	1	12.5	8	1	100	0	0	0	0	1
Second premolar	33	84.6	5	12.8	1	2.6	39	25	89.3	2	7.1	1	3.6	28
First molar	10	20.8	38	79.2	0	0	48	10	13.2	30	39.5	36	47.4	76
Second molar	16	22.9	52	74.3	2	2.9	70	20	23	30	34.5	37	42.5	87
Total	62	37.6	99	60	4	2.4	165	56	29.2	62	32.3	74	38.5	192

there is a relation between mucosal thickening of sinus and posterior teeth decay or periodontitis.²³

Using CBCT as the preferred imaging modality was due to its tomographic nature and inherent high contrast in comparison to conventional imaging in assessing the relation of posterior teeth with the maxillary sinus.

In a study done by Freisfeld et al with the aim of the comparison between panoramic radiography and CT images of 30 patients, the difference between the panoramic and CT measurements was meaningful. In panoramic radiography, 64 of 129 roots seemed to penetrate into the maxillary sinus; while in transverse sections of CT, this was only 37 roots.²⁴ Therefore, in order to avoid limitations such as anatomical structures, superimposition, horizontal and vertical magnification and lack of cross-sectional data, which are all visible in panoramic images, CBCT was used in this study.

According to results in the premolars, the most frequent relation with the maxillary sinus was type 0 and in the first and second molars it was type 3, which is stated the more penetration of posterior teeth roots into the sinus. Maxillary arch shape and upper location of the posterior teeth can justify this shorter distance of posterior teeth with the maxillary sinus floor.

Pagin et al in 2013 evaluated the relation of 601 posterior teeth roots with the maxillary sinus floor using CBCT and founded that 21.6% of roots had no closed proximity with the sinus floor, and in 14.3% of cases, penetration into the sinus was seen.²⁵ This study results the same, as our study stated that most of the roots did not have proximity with the sinus. In our study, the most frequent one after type 0 was type 3, while in this study, type 3 had the less frequency. This result can be due to individual differences and the variations in the sinus pneumatization of different ethnics.

In the study done by Bassam et al in 2010, protrusion of teeth roots into the maxillary sinus were compared in periapical and panoramic radiographs with CBCT. They concluded that first premolar did not protruded into the sinus, but the molar teeth were the most common teeth protruded into the sinus.⁵

In the present study, teeth with type 1 and 3 were separately evaluated according to the horizontal relation of their involved roots with the maxillary sinus. In type 1, the most common roots contacted the sinus floor were buccal and palatal roots and the less one was palatal root. In type 3, the most frequency was related to the protrusion of palatal root into the maxillary sinus, while it did not have a significant difference with the protrusion of buccal-palatal and buccal roots.

In the study of Jung et al in 2012 in which the relation between the roots of 332 molar teeth with the maxillary sinus was assessed in CBCT, they concluded that buccal root had the most protrusion into the sinus.⁶

In the present study, the relation of molar teeth with the maxillary sinus in both sides for male was type 3, but for women, it was different. In the first molar in both sides, it was type 0, and for the second molar in the right side was type 1 and in the left side was type 3. This difference may be due to the growth pattern discrepancy in male and female, and the fact that roots in male teeth are longer than that in females. So their roots have more probability for protrusion into the sinus and it should be taken into consideration during dental practices.

As the results showed, CBCT can clearly demonstrate the status of posterior teeth toward the maxillary sinus. So it is suggested that in condition of posterior teeth roots proximity with the sinus floor, a CBCT is ordered prior to orthodontic implant or any other treatment involving the posterior teeth.

An important issue, which is not completely cleared up to now is that whether there is a significant relation between the type of maxillary teeth relation with the sinus floor, and the prevalence of sinusitis and other odontogenic diseases are involved in the maxillary sinus or not, which can be investigated in future studies.

CONCLUSION

This study showed that although most of the teeth did not have contact with the sinus floor, but the more posterior the maxillary teeth, the more probability for root protruding into the maxillary sinus. It also confirmed that protrusion of teeth roots into the maxillary sinus is more common in male than female.

CLINICAL SIGNIFICANCE

Knowing the anatomical relation between the posterior teeth and the maxillary sinus, help the clinician in preoperative treatment planning of the maxillary posterior teeth, diagnosing pathologic conditions and avoiding problems that may occur during dental practice.

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