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Relationship between the Maxillary Molars Roots and Sinus in a Selected Iranian Population: A CBCT Study

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ABSTRACT

In regarding to the proximity of the maxillary molars roots to maxillary sinus and their susceptibility to the odontogenic and non-odontogenic lesions, the aim of this study is demonstrated the relationship between the maxillary molars roots and maxillary sinus floor and measuring the divergence angle of the roots by CBCT. This cross-sectional study was examined on 160 patients and on 419 teeth via Cone - Beam Computed Tomography images. The vertical relationship between each root and maxillary sinus was categorized into four classes in cross-sectional images. Class 0 (the root is located far away from the border of the maxillary sinus), Class 1 (the root is in contact with the maxillary sinus floor) the Class 2 (the root is projecting laterally on the maxillary sinus) and Class 3 (the root is projecting into the maxillary sinus) and divergence angle of roots was measured based on panorama and cross-sectional images. In this research data were analyzed in SPSS. The class 2 (39.1%) accounted the most common class in the maxillary molar teeth. The Class 0 has showed significantly more in men (31.7%) than women (18.7%). The most angular divergence among three roots of molars has been found in the first molar and the divergence angle between the buccal and palatal roots was greater than that between the buccal roots. The maxillary first molar has the highest divergence and its relation with the maxillary sinus floor is class 2; therefore, there is more accuracy during treatment to prevent errors.

Key words: Cone Beam Computed Tomography, Maxillary Sinus, Molar, Divergency

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INTRODUCTION

Maxillary sinus is the first paranasal sinuses, which develops and its growth is completed about 20 years old of human life [1]. The size of maxillary sinus and its development varies in different people and knowledge of its relationship with the roots of posterior teeth in the upper jaw is required [2]. The knowledge of the relationship between the maxillary molars apex and sinus floor plays an important role in the diagnosis of sinus diseases and periodontal and periapical infections of maxillary molars and premolars, which have the possibility to expand into the sinus [3]. Odontogenic infection is the origin of 10-12 % of maxillary sinusitis due to the closeness between sinus and tooth root [4]. Histological sections indicate that the majority of roots protruding radiographically into the sinus are lined with a thin layer of the cortical bone and also the perforations of sinus floor are found only in 14-28% of these cases [5]. The projected roots into the sinus are usually separated from each other with different thickness of the bones, but sometimes are separated only by the sinus mucosa [6].

Periapical and periodontal infections of maxillary molars and premolars may extend into the maxillary sinus [7], and endodontic treatment and extraction of these teeth can lead to penetration. In addition, the relationship between the roots and the lower wall of the maxillary sinus is usually effective in orthodontic teeth movements [3, 5].

Different results have been achieved in various studies. In a study, Class 3 in buccal roots and Class 2 in palatal roots were the most frequent. On the contrary, another study has showed that the relationship between sinus and root apex was more Class 0 and roots had distance from the sinus floor [2, 8, 9]. The correct interpretation of radiography of root morphology is important to tooth extraction and helps to avoid breaking the root [10].However the root anatomy follows a specific pattern; individual variations are seen in the number and shape of the roots. The number, curvature, divergence degree and geometry of the roots are the first factors, which must be evaluated [10]. Therefore, the aim of this study was to determine the relationship between the roots of the maxillary molars and divergence angle of roots using cone-beam computed tomography (CBCT).

MATERIALS AND METHODS

In this cross-sectional study, the CBCT scans of 160 patients (419 maxillary molar teeth) were selected from patient who referred private oral and maxillofacial radiology center for non-state reason. Inclusion criterion of the current study was patients with closed apex molars and the exclusion criteria were: a) patients with pathologic lesions in the posterior maxillary b) impacted third molar teeth and c) teeth with root canal therapy. All CBCT scans were taken via Cranex 3D system (Soredex) with parameters of (FOV: 6* 8 cm, KVp: 89, 6 mA tube current, and 0.2 mm voxel size) between 2015-2016.

Images and the vertical relationship of maxillary molars roots with the sinus floor and the divergence angle of the roots of the molars were examined and evaluated using Dental Ondemand 3D software.

On the basis of CBCT cross-sectional images, the relationship between molars roots and maxillary sinus floor was categorized into 4 classes' figure 1:
Class 0: the root is located far away from the border of the maxillary sinus.

Class 1: the root is in contact with the maxillary sinus floor.
Class 2: the root is laterally projected on the maxillary sinus but its apex was outside of the sinus.
Class 3: the root is projected into the maxillary sinus.

Figure 1: A: class 0,B: class 1, C: class 2, D: class 3

In Class 0 and 3, the distance to sinus was measured, meaning that a horizontal line was drawn tangent to the deepest point of the sinus then a line from apex was vertically drawn across the horizontal line.figure 2.

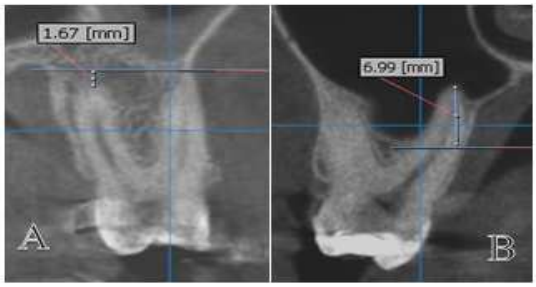

Figure 2; A: The distance from root to sinus floor in Class 0 was as positive: +1.67; B: the distance in class 3 indicated as a negative: -6.99

To measure the divergence angle, the longitudinal axis of both roots was drawn in the upper one third of the root and the commissure of them was considered as divergence angle. Divergence angle of buccal roots was measured using panorama images and divergence angle between buccal and palatal roots was measured using cross-sectional images (Figure 3).

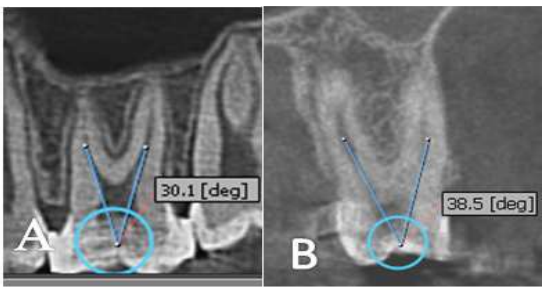

Figure 3: measuring the divergence angle, A) panorama images , B) cross-sectional images

RESULTS

In the present study, of 419 studied molars 21 ones were single-rooted , 22 cases were two-rooted and 376 molars were three- rooted. Totally, 51.8% of patients were female and 48.2% of them were male.

Class 2 with 39.1% was the most common class in the maxillary molar teeth. The chi-square test showed a significant association (pearson chi-square value: 28.54; DF: 16; P 0 .000) (Table1).

Based on root separation class 0 had the most frequency in the distobuccal root of the maxillary third (50.0%) molar and class 2 was the most frequent in the distobuccal root of first molar with 53.8%. Class III was the lowest frequent (9.5%), mainly observed in the palatal root of first molar (Table 2).

Class 0 was significantly more in men (31.7%) than women (18.7%) (Table 3).

In Class 3, some part of the root entered into the sinus was measured with negative value. And the distance from sinus in Class 0 was measured with positive value. Distance from sinus in class 0 was significantly more in men than women (Table 4).

Divergence angle was the greatest in first molar in all three angles (Post Hoc Test Multiple Comparisons;LSD P-Value = 0.000) and the divergence angle between the buccal and palatal roots was greater than that between the buccal roots(ANOVA ; Mes&Dis F=29.56 P-Value= 0.00) (Table 5).

The vertical relationship between the roots of the maxillary molars and sinus floor was observed in three-rooted teeth more as Class 2 (42.8%) and in single and two rooted molars, Class 1 had higher percentage (Class 1 was 57% in single-rooted and was 63.6% in two-rooted).(Chi-Square Test df=6 P-Value 0.000).

Table 1: The relationship between upper molars and maxillary sinus floor

	Class 0*		Class 1**		Class 2***		Class 3****		Total	
	N	%	N	%	N	%	N	%	N	%
First molar	33	25	19	14.3	63	47.8	17	12.9	132	100
Second molar	31	17.4	60	33.7	69	38.8	18	10.1	178	100
Third molar	36	33	36	33	32	29.4	5	4.6	105	100
Total	100	23.9	115	27.5	164	39.1	40	9.5	419	100

**: all roots was class 0*
***: at least one root was class 1 and other roots were class 0 or 1*
****: at least one root was class 2 and class 3 is not observed in another roots*
*****: at least one root was class 3*

Table 2: The relationship between the roots of the upper molars and maxillary sinus floor

		Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Total
		%	N	%	N	%	N	%	N	N
First molar	Mesiobuccal	32.6	43	11.4	15	52.2	69	3.8	5	132
	Distobuccal	28	37	15.2	20	53.8	71	3	4	132
	Palatal	34.1	45	11.4	15	43.2	57	11.4	15	132
Second molar	Mesiobuccal	21.8	36	32.1	53	38.2	63	7.9	13	176
	Distobuccal	30.9	51	32.1	53	33.3	55	3.6	6	165
	Palatal	29	51	32.4	57	33	58	5.7	10	176
Third molar	Mesiobuccal	40.5	32	22.8	18	34.2	27	2.5	2	104
	Distobuccal	50	39	23.1	18	25.6	20	1.3	1	77
	Palatal	45.8	44	33.3	32	19.8	19	1	1	95

Table 3: Vertical relationship of upper molars with the maxillary sinus floor based on gender

	Class 0		Class 1		Class 2		Class 3		Total	
	N	%	N	%	N	%	N	%	N	%
Female	38	17.5	66	30.4	92	42.4	21	9.7	217	100
Male	62	30.7	49	24.3	72	35.6	19	9.4	202	100
Total	100	23.9	115	27.5	164	39.1	40	9.5	419	100

Chi-Square Test (Pearson chi-square value:10.288;df:3 ;P-Value:0.016)

Table 4: distance from sinus floor and roots in Class 0 and 3

		Distance		T- Test for Equality of Means	
		Female (mm)	Male (mm)	df	p-value
Class 0	Mesiobuccal Root	2.08±1.7	3.14±2.6	109	0.02
	Distobuccal Root	1.62±1.3	3.30±2.3	123	0.000
	Palatal Root	1.54±0.93	2.97±2.04	136	0.000
Class 3	Mesiobuccal Root	-3.33±1.9	-2.83±1.2	25	0.44
	Distobuucal Root	-3.38±2.1	-3.96±0.75	9	0.67
	Palatal Root	-3.79±2.3	-2.83±1.2	23	0.26

T-Test Independent Samples Test

Table 5: Divergence angle of roots in the maxillary molars

	Tooth number		
Root	First molar+Std Error	Second molar	Third molar
MB,DB	35.87±0.65	30.24±0.62	28.09±0.86
MB,P	46.40±0.8	40.05±0.6	37.5±1.0
DB,P	45.10±0.82	39.72±0.63	34.3±0.92
MB,DB/MB,P/DB,P	42.4±0.64	36.75±0.54	33.3±0.82

MB: mesiobuccal, DB: distobuccal, P: palatal

The mean of divergence angle in different classifications is illustrated in diagram 1. The highest divergence angle was obtained in Class 3 (40.8) and the lowest one was found in Class 1 (34.5) and class 1 had a significantly the lowest divergence angle among groups (Figure 1).

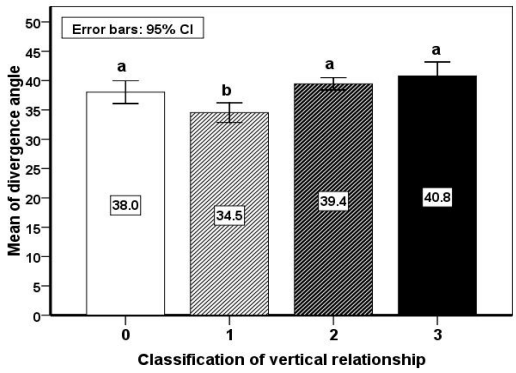

Figure 1: relationship between divergency angle and vertical relationship

DISCUSSION

The most common vertical relationship between the roots and sinus floor was observed in Class 2 (the root was projecting laterally on the maxillary sinus,but its apex was outside of the sinus). Although the class 0 was found in the distobuccal and palatal roots of the third molar ,and while in the study of Yun-Hoa Jung [11], it was seen in the palatal root of the second molar , considering that the maxillary third molars were not investigated in their study.

In the current study, there was a significant correlation between the vertical relationship of apex with the maxillary sinus floor and gender so it is concluded that the gender can be an effective variable in relationship between sinus and root. Class 2 had the highest value in both genders but Class 0 was more in men than women. Also mean of root distances from sinus floor in Class 0 was more in men than women.

This may be due to different growth pattern of men and women. Kilic had found in his study no significant difference between men and women[2]. Shokri in 2014 [12] stated that in terms of the relationship between the root of molars and sinus, Class 3 was higher in men, and in women class 0 was higher in the first molar and Class 0 and 3 in the second molar of women was higher. Kilic[2] and Pagin [13]suggested that the apices which were closest to the sinus but did not protrude into the sinus floor were more than those protrude into the sinus. In the present study also, the roots protruding into the sinus were less than those that are closest to it.In the current study, the roots protruded into the sinus in Class 2 and 3 but the apex was seen outside the sinus in Class 0 and 1. The addition of the Classes 0 and 1 was 39%, 50% and 66% in the first, second and third molar teeth, respectively. This indicates that the distance from sinus floor to the tooth apex is increased from first molar towards third molar, which might be due to the convexity of the sinus floor that the lowest one was located in the region of first and second maxillary molars [14]. The Kwak *et al.,* [15] illustrated that the distance from the root apex of maxillary posterior teeth to the inferior wall of the sinus towards the posterior tended to decrease, which is different from the present results, since the third molars were excluded from their study and premolars were not investigated in the present study. In this study, the frequency of class 1 in the second molar and also the Class 2 frequency in the first molar were the highest, which are similar to the study of Sharan 2006 [9]

The sinus size and its development vary in different people. Sinus floor extends between the roots in half of the population and causes elevation in the antral sinus surface or root protrusion into the sinus. In these cases, the thickness of the sinus floor significantly reduces [9].

It has been observed that there is the risk of post-extraction pneumatization [16] .which decreases the amount of bone necessary for the implant or denture area of the maxillary in some cases of root protrusion into the sinus [1]. The results of the present study indicated that the most relationship between sinus and molar apex was related to the root protruding laterally into the sinus. Therefore, according to this relationship, accuracy in preventing the problems during and after treatment is necessary.

The protruding roots into the sinus have been separated from it by a thin layer of bone which may be fractured or displaced during the extraction, and may cause sinus extension of the socket area and conclusively pneumatization [17].The close relationship between sinus and roots of the first molar lead to a problem in periodontal and prosthetic treatments. Some cases reported sinusitis with a very deep pocket and a bony defect followed by a periodontal treatment of first molar [18]Or for the prosthetic treatment , it was reported that the dental impression materials were pushed into the sinus through an invisible oroantral fistula in the extracted area of first molar [19]. The current study has demonstrated that class 2 and class 3 to be included 60.7% cases in first molar. Didilescue studied on the maxillary first molar and explained that in the most cases, root was projecting into the sinus [20].

In connection with the divergence angle, the buccal roots of the maxillary first molar are typically close together, but they are far from the palatal root and the divergence angle is high .So the dentist must evaluate the size, curve and divergence of tooth in radiography before it is extracted. If the divergence angle of root is great, the tooth extraction will be difficult, and the surgical plan should be considered by the dentist. On the other hand, the high divergence of the roots and their projection into the maxillary sinus increase the risk of sinus floor perforation during tooth extraction. In the present study, the highest divergence angle has been discovered in Class 3 and 2 .Thereafter it indicates the projection of sinus floor into the roots enhances through the increase of divergence angle.so the roots protrude into the sinus are more divergent and more accuracy is required during the tooth extraction.

CONCLUSION

The maxillary first molar has the highest divergence and its relation with the maxillary sinus floor is class 2; therefore, there is more accuracy during treatment to prevent errors.

Conflict of interest

The authors declare that they have no conflict of interest

Acknowledgments

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