Scholars Journal of Applied Medical Sciences (SJAMS)
Abbreviated Key Title: Sch. J. App. Med. Sci.
ISSN 2320-6691 (Online)
ISSN 2347-954X (Print)

A Unit of Scholars Academic and Scientific Society, India
www.saspublisher.com

Dentistry

Maxillary Sinus Floor and Maxillary Posterior Teeth: A Biometric Assessment using Cone Beam Computed Tomography in a Tunisian Population

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Original Research Article

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Article History
Received: 18.12.2017
Accepted: 25.12.2017
Published: 30.12.2017

DOI:
10.21276/sjams.2017.5.12.52

Abstract: The aim of this study to assess the vertical relationship between the maxillary sinus floor (MSF) and maxillary posterior teeth (MPT) roots using cone beam computed tomography in a Tunisian population. In this cross-sectional study, CBCT of 60 patients were selected including 33 males and 27 females. Totally 100 Maxillary sinuses were analyzed; enclosing 500 MPT i.e 1256 root tips. The vertical relationship between each root of the MPT and the MSF was classified into three types: type 1; the roots were in contact with the MSF, type 2; the roots penetrated into the MSF and type 3; the roots were distant from the MSF. For the vertical relationships according to the maxillary teeth, type 3 occurred most frequently in the first premolar (94%). Type 2 was most frequently observed with the second molar (32%). For the vertical relationships according to the each root of these teeth and the MSF, the results were as follow: Type 3 occurred most frequently in the first premolar buccal root (98%). For the type 2, the mesio-buccal root of the second molar had the closest proximity with the MSF with 48%. No statistically significant difference was found between the right and left side assessments but several differences were found between males and females. This relationship between MPT and MSF should be considered in order to prevent an iatrogenic procedure and minimize the risks from an infectious disease within the sinus.
Keywords: Premolars; Molars; Maxillary sinus; Cone-beam computed tomography.

INTRODUCTION

The maxillary sinus is the first of the paranasal sinuses to develop, and its growth ends with the eruption of the third molars [1]. At about the age of 12 years, the sinus floor is level with the nasal floor. Around the age of 20 years, the floor of the maxillary sinus is situated 5 mm inferior to the nasal floor [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].

Knowledge of the relationship between maxillary sinuse floor (MSF) and the maxillary posterior teeth (MPT) is a constant challenge in dentistery. The MPT root tips lie in close proximity to, and in some cases within, the maxillary sinus. In fact, the close proximity between the root apices and the MSF is significant during clinical operation because it may result in various complications, such us sinusitis [4,5], oroantral fistulae, endoantral syndrome, or root displacement into the maxillary sinus [6,7]. Moreover, sinus expansion after the loss of maxillary posterior roots can greatly decrease the bone height available for implant placement and occasionally reaches the alveolar ridge [6,8]. Also, the relationship between the dental roots and the inferior sinus wall is known to influence orthodontic tooth movement [9]. In this context, the influence of root protrusion in the MSF may lead to tooth roots resorption or tipping during orthodontic treatment [9-11].

Many radiographic techniques can assess the localization of teeth roots apex relative to the MSF. 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 [12]. Several studies assessed the vertical and horizontal relationship between the tooth roots apex and the inferior wall of the maxillary sinus using cone beam computed tomography (CBCT).

It was concluded that computed tomography scan (CTS) is more accurate than panoramic radiography in assessing tooth roots and sinus

relationship. Otherwise, CBCT, which has been in wide use in dentistry for recent years, is advantageous over CTS, since it provides comparable image quality at reduced dose and cost [13,14].

The aim of this study is to investigate the relationship between the roots of the maxillary posterior teeth and the maxillary sinus floor using CBCT by measuring distances from each root of these teeth to the inferior wall of the maxillary sinus.

MATERIALS AND METHODS

In this cross-sectional study, CBCT of 113 patients were enrolled from the archives of the outpatients and implantology department in Monastir Dental Clinic (Tunisia) from August 2015 to July 2016. CBCT were obtained by using settings Sirona galileos unit (Sirona, German), and images were performed with Galileos implant software. Scanning parameters were 85 kVp, 24 seconds, 5-7 mA, a voxel size of 0.15 mm or 0.3 mm, and a field of view of 15 cm×15 cm with exposure times of 6 seconds and radiation dose of 29 µSv.

The inclusion criteria used were patients who had normally full erupted maxillary posterior teeth (first premolar, second premolar, first molar, second molar and third molar). Patients with maxillary sinus pathologies, orthodontic treatment, facial trauma antecedents or impacted teeth in the lateral region of the maxilla were excluded from the study.

Only CBCT of 60 patients were analyzed, including 33 males and 27 females with a mean age of 29,9 ± 1.3 years . A total of 100 maxillary sinus were analyzed enclosing 52 on the right side and 48 on the left side. A total of 500 maxillary posterior teeth: 100 first premolars, 100 second premolars, 100 first molars, 100 second molars and 100 third molars that is 1256 root apex were examined.

Lines were drawn on the cross-sectional images between the deepest point of the MSF and the maxillary posterior root tips of the MPT and the distances were measured using Galileos software built-in measurement tools. The vertical relationship between each root and the MSF was classified into 3 types: T1, root was in contact with the MSF (Figure 1); T2, root was projecting in the MSF (Figure 2); and T3, root was not in contact with the MSF (Figure 3). Distances in T1 were equal to zero, those in T2 were given negative values and those in T3 were given positive values. Means, standard deviations and minimum and maximum values were calculated for all right and left premolars and molars. Chi-square test was used to compare the frequency of each root type with gender and sides (left and right). The relation of this morphologic classification was analyzed using Statistical Package for the Social Sciences (SPSS) V.20.

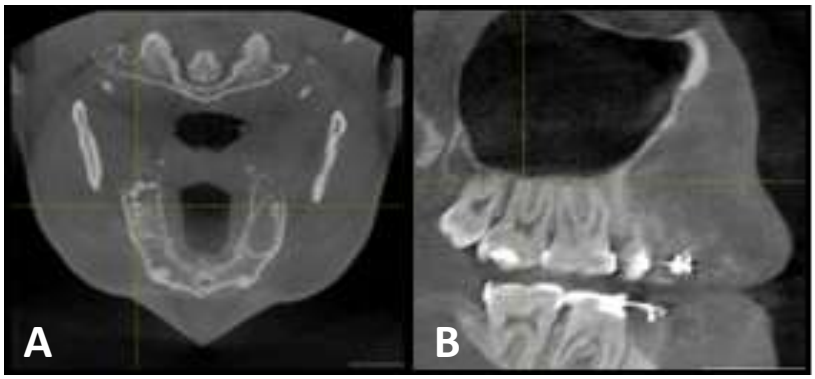

Fig-1: Measurement of a distance between a T1 root apex and the maxillary sinus floor. A. Root tip locating on the axial slide. B. Measurement of the distance on the cross-sectional images

Fig-2: Measurement of a distance between a T2 root apex and the maxillary sinus floor. A. Root tip locating on the axial slide. B. Measurement of the distance on the cross-sectional images

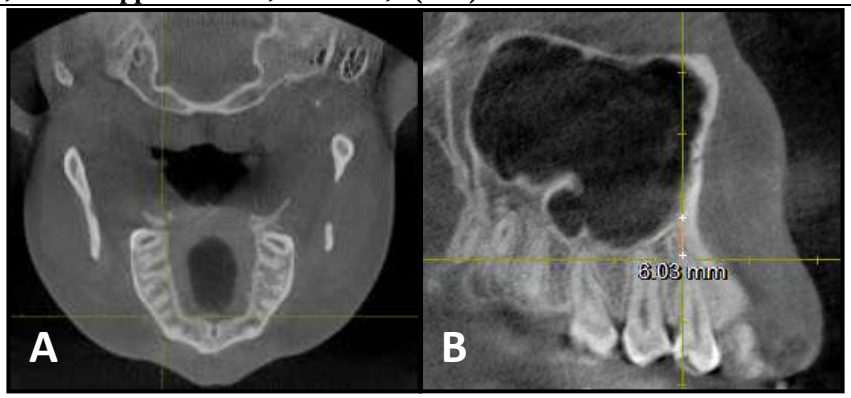

Fig-3: Measurement of a distance between a T3 root apex and the maxillary sinus floor. A. Root tip locating on the axial slide. B. Measurement of the distance on the cross-sectional images

RESULTS

Means, standard deviations and minimum and maximum values obtained from MPT are given in Table 1, The mean distance between MSF and root tip was the longest for the first premolar buccal root tip (11.20 ± 6.37 mm) and the shortest for the second molar mesio-buccal root tip (-0.02 ± 2.43 mm).

Table-1: Mean, standard deviation, minimum and maximum values obtained from maxillary posterior teeth

		N	Mean	Sd.Dev.	Min	Max	P
First premolar	Buccal root	100	11.20	6.37	-3.03	26.35	.004
	Palatal root	100	9.46	6.04	0.00	28.50	.182
Second premolar	Buccal root	100	4.01	4.54	-2.97	24.12	.020
	Palatal root	056	3.36	4.72	-6.21	17.19	.033
Fisrt molar	Mesio-buccal root	100	1.41	2.91	-4.40	09.85	.236
	Disto-buccal root	100	1.18	2.61	-4.12	09.20	.005
	Palatal root	100	1.11	3.68	-7.71	15.70	.927
Second molar	Mesio-buccal root	100	-0.02	2.43	-6.13	06.73	.040
	Disto-buccal root	100	0.64	2.56	-4.26	12.15	.040
	Palatal root	100	1.50	2.94	-3.52	10.67	.341
Third molar	Mesio-bucal root	100	1.10	2.65	-4.22	11.00	.111
	Disto-buccal root	100	1.35	2.86	-4.79	12.75	.091
	Palatal root	100	2.02	2.99	-2.82	12.06	.075

The vertical relationship between MSF and MPT was statistically meaningful ($p<.05$). Accordingly, type 3 in which the MSF is located above the root tip was most frequently observed with the first premolars (94%). Whereas, type 2 in which apical protrusion is seen over the MSF was the most observed with the second molars (32%) (Table 2).

Table-2: The vertical relationship between the maxillary sinus floor and maxillary posterior teeth

	Type 1		Type 2		Type 3		Total	p
	N	%	N	%	N	%	N	
First premolar	05	05	01	01.0	94	94.0	100	.002
Second premolar	16	16	14	14.0	70	70.0	100	.011
Fisrt molar	42	42	23	23.0	35	35.0	100	.056
Second molar	38	38	32	32.0	30	30.0	100	.003
Third molar	39	39	17	17.0	44	44.0	100	.049
Total	140	28	87	17.4	273	54.6	500	

According to the vertical relationship between MSF and each root of MPT, the first premolar buccal root was frequently the furthest from the inferior wall of the maxillary sinus with 98% in type 3. Whilst, the second molar mesio-buccal root was the closest to the MSF with 48% in type 2 (Table 3).

Table-3: The vertical relationship between the maxillary sinus floor and each root of maxillary posterior teeth

		Type 1		Type 2		Type 3		Total	p
		N	%	N	%	N	%	N	
First premolar	Buccal root	01	01.00	1	01.00	98	98.00	100	.021
	Palatal root	05	05.00	0	00.00	95	95.00	100	.277
Second premolar	Buccal root	12	12.00	10	10.00	78	78.00	100	.049
	Palatal root	11	11.00	9	09.00	36	36.00	56	.628
Fisrt molar	Mesio-buccal root	26	26.00	21	21.00	53	53.00	100	.017
	Disto-buccal root	21	21.00	26	26.00	53	53.00	100	.989
	Palatal root	17	17.00	34	34.00	49	49.00	100	.555
Second molar	Mesio-buccal root	15	15.00	48	48.00	37	37.00	100	.019
	Disto-buccal root	20	20.00	36	36.00	44	44.00	100	.019
	Palatal root	14	14.00	25	25.00	61	61.00	100	.333
Third molar	Mesio-bucal root	28	28.00	24	24.00	48	48.00	100	.190
	Disto-buccal root	22	22.00	24	24.00	54	54.00	100	.144
	Palatal root	16	16.00	18	18.00	66	66.00	100	.098
Total		208	16.00	276	21.23	772	59.38	1256	

The relation between different types and gender was statistically meaningful ($p<.05$) and it can be stated that gender is an effective variable in determining the tooth relationship with the MSF. The most common type observed in both male and female was type 3 and the less common was type 2 (Table 4).

Table-4: The relationship between the maxillary sinus floor and maxillary posterior teeth according to the gender

	Type 1		Type 2		Type 3		Total	p
	N	%	N	%	N	%	N	
Male	81	30.6	41	15.5	143	53.9	265	.046
Female	59	25.1	46	19.6	130	55.3	235	.044
Total	140	28.0	87	17.4	273	54.6	500	

No statistically significant difference was found between the right and left side assessments and the prevalence of types observed in both sides was almost similar (Table 5).

Table-5: The relationship between the maxillary sinus floor and maxillary posterior teeth according to sides

	Type 1		Type 2		Type 3		Total	p
	N	%	N	%	N	%	N	
Right	101	15.60	141	21.60	409	62.80	651	.19
Left	107	17.70	135	22.20	363	60.10	605	.08
Total	208	16.56	276	21.97	772	61.46	1256	

DISCUSSIONS

The evaluation of anatomic relationship between MSF and MPT is one of the keys in diagnosing maxillofacial pathologies and preoperative treatment planning [9,15].

The protrusion of posterior roots into the maxillary sinus is related to several important clinical manifestations [15]. Also, spread of MPT periapical or periodontal infections to the maxillary sinus can lead to sinusitis (16); in this context, Irima tried to identify the odontogenic maxillary sinusitis etiology. He noted from his meta-analysis, which looked at 770 cases, that molars are the most incriminated with 47,68%.

Moreover, the extraction or endodontic surgery of a root in close proximity with the MSF is most likely to cause an oroantral fistula or root displacement into this cavity (17). Besides, the intrusion or bodily movement of teeth across the sinus floor by orthodontic treatment have been shown to cause a moderate apical root resorption and a high degree of tipping [10,11], sinus as observed on panoramic radiographs and the amount of pneumatization that occurs after extraction [11].

MPT extraction is usually followed by sinus expansion and bone resorption which reduces the capital bone available for implant placement. Therefore, sinus floor augmentation procedures seem primordial.

In our study, according to the relationship between MPT and MSF, we found that the First premolar was most frequently observed in type 3, being

so far from the inferior wall of the maxillary sinus with 94%. This result was concordant with Ok's study [18] that proved the implication of the first premolar by 92.4% in type 3. Moreover, this tooth presented 95.3% and 90.5% in type 3 according to respectively Shokri and Kang [19,20].

In addition, according to our study we found that the first premolar buccal root was frequently below the MSF with 98% in type 3. This root presented 92.1% in Kang's [20] study.

In return, the fisrt premolar showed a very low percentage (1%) in type 2 in which the root was projecting into the sinus cavity. The studies of Ok [18], Shokri [19] and Kang [20] were similar as ours with respectively 1.2% 0.5% and 1.5%. Both of Otavio [21] and Yoshimine [22] affirmed that first premolars presented 0% in type 2 outright. This fact can explain that difficulties or risks in the preoperative treatment planning including premolar area are neglected.

In type 2, we noted that the second molar had the closest proximity with the MSF with 32%. The majority of studies showed the same result; both Yung [16] and Yoshimine [22] noted that this tooth showed 36.7% in the same type. Finally, Shokri [19] and Kang [20] found respectively 40% and 44.7%.

Besides, most studies revealed that the second molar buccal roots were closely related to the MSF: Lavasani [17], Estrela [23], Kang [20], Pagin [21], Yung [16], Ok [18], Georgescu [24] and Eberhardt [25] reported that second molar mesiobuccal root was the closest to the sinus floor. This result was concordant with our study as we noted that this same root was the nearest to the MSF with 48% in type 2. However, Kilic [9] reported that the distobuccal root of the second molar was the closest to the sinus floor.

In this context, our results showed that the distance between the sinus floor and the root of the molar was the shortest for the mesiobuccal roots of M2 (-0.02 ± 2.43 mm).

In our study, no statistically significant differences were found between the measurements for right and left sides ($P>.05$), the same result noted by Shokri [19] and Kilic [9]. Whereas, the relation between different types and gender was statistically meaningful ($p<.05$), which concorded with Shokri's study and it can be stated that gender is an effective variable in determining the tooth relationship with the maxillary sinus floor [19].

CONCLUSION

The knowledge of the anatomical relationship between the MSF and MPT is very important for the preoperative treatment planning. Clinicians must be particularly cautious when performing dental procedures involving the molars area specially the second molar.

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