

# Assessment of the relationship between maxillary sinus floor and maxillary posterior teeth root apices using spiral CT scan

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## ABSTRACT

**Background:** The purpose of this study is to investigate the relationship between the roots of the maxillary posterior teeth and the maxillary sinus using spiral computed tomography, and measured the distances between the roots of the maxillary posterior teeth and the sinus floor.

**Materials and Methods:** The sample of the present study was a total of 120 Iraqi subject (60 males & 60 females) aged (20-60) years old, who admitted to spiral Computed Tomography scan unit in AL-Zahraa hospital in AL-Kut city to have Computed Tomography scan of the brain and paranasal sinuses who had complaints of headaches or with suspicion of sinusitis but without pathological findings in maxillary sinuses. From November 2012 to April 2013, CT sagittal reconstructed images were used in this study, Images were classified according to the relation between the root apices and the maxillary sinus floor into type1: Root apices below the sinus floor, type 2: Root apices in cosines floor. Vertical distance were measured between the deepest point of the maxillary sinus floor and the root apices of the maxillary first and second premolars and first, second molar contact with the sinus floor) and type 3: Root apices penetrate or inside the r using built-in measurement tools. Means, standard deviations and minimum and maximum values were calculated for all right and left premolars and molars. t-tests were used to compare measurements between left and right sides and between female and male patients.

**Results:** The distance between sinus floor and root apex was longest for the first premolar palatal root apex and shortest for the second molar mesio Buccal root apex for both right and left sides. No statistically significant differences were found between the right and left side measurements or between females and males patients.

**Conclusion:** There was no significant difference in vertical relation of maxillary posterior teeth to floor of maxillary sinus between male and female and between right and left side.

The mesiobuccal root of the maxillary 2<sup>nd</sup> molar was closest to the maxillary sinus floor and palatal root of 1<sup>st</sup> premolar was farthest to the sinus floor.

**Keywords:** Maxillary posterior teeth, Maxillary sinus, Spiral CT scan. (J Bagh Coll Dentistry 2013; 25(3):80-86).

## INTRODUCTION

The maxillary sinus is the first of the paranasal sinuses to develop, and its growth ends with the eruption of the third molars at approximately 20 years of age <sup>1</sup>. Sinusitis can result from the spread of a periapical or periodontal infection to the sinus or iatrogenic perforation of the sinus <sup>2</sup>. The roots of the maxillary premolar, molar and occasionally canine teeth may project into the maxillary sinus <sup>3</sup>. Because of the implications this can have on surgical procedures, it is essential for clinicians to be aware of the exact relationship between the apical roots of the maxillary teeth and the maxillary sinus floor. An anatomical description and the relationship between the root apex of the maxillary tooth and the inferior wall of the maxillary sinus are essential for diagnosing sinus pathoses and planning a proper dental implant. The topography of the inferior wall with the maxillary root apices varies according to an individual's age, size and the degree of pneumatization of the maxillary sinus and the state of dental retention <sup>4</sup>. The first and second molar roots are most commonly in close proximity

to the inferior wall of the maxillary sinus. Occasionally the projecting roots are usually separated from it by various bone thicknesses, but they are some times separated by the sinus mucosa alone.

A periapical or periodontal infection of the upper premolars and molars may spread beyond the confines of the supporting dental tissue into the maxillary sinus, causing sinusitis <sup>5</sup>. The close relationship of the maxillary sinus and the roots of the maxillary molars can lead to accidental oroantral communication <sup>2</sup>. The relationship between the dental roots and the inferior sinus wall is known to influence orthodontic tooth movement <sup>6</sup> and the intrusion or bodily movement of teeth across the sinus floor that occurs with orthodontic treatment has been shown to cause moderate apical root resorption and a high degree of tipping <sup>7</sup>.

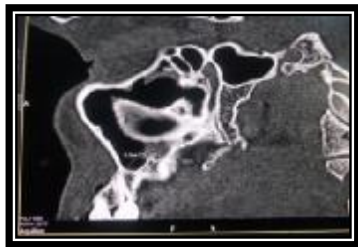
The 3-dimensional reconstruction allows greater accuracy of measurements and an improved visualization of the anatomical situation of the inferior wall with the maxillary root apices <sup>8</sup>.

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## MATERIALS AND METHOD

The sample of the present study was a total of 120 Iraqi subjects (60 males & 60 females) aged 20-60 years old, attending the radiology center of AL-Zahraa hospital in Al-Kut city for any maxillofacial complaints for period between November 2012 to April 2013. CT sagittal reconstructed images were used in this study. Assessment vertical relation by measuring the shortest distance between the apex of root of posterior teeth and inner margin in maxillary sinus floor in mm figure 1. The apices extending below the sinus floor were assigned as positive values figure 1 where as those above sinus were assigned as negative values and those contact MS floor but not penetrate inner margin where assigned as 0 value figure 3.



**Figure 1. CT scan show sagittal image of 1<sup>st</sup> premolar and its palatal root with its positive relation to the floor of MS.**

Images were classified according to the relation between the root apices and the maxillary sinus floor into:

Type1: Root apices below the sinus floor Figure 2

Type 2: Root apices in contact with the sinus floor Figure (3)

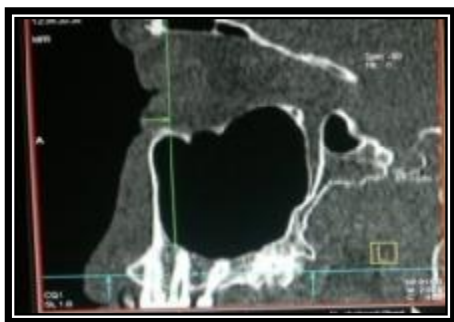
Type 3: Root apices penetrate or inside the sinus floor Figure (4).

### Statistical analyses

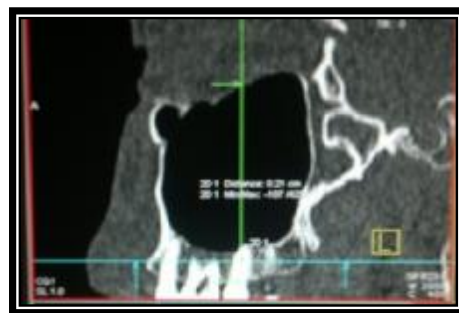
Means, standard deviations and minimum and maximum values were calculated for all right and left premolars and molars. T-tests were used to compare measurements between left and right sides and between female and male patients.



**Figure 2. Type1 (buccal root of left first premolar below MS floor)**



**Figure 3. Type 2 (show palatal root of the left second premolar in contact with MS)**



**Figure 4. Type 3 (show palatal root of left second molar penetrates or inside the M.S).**

## RESULTS

Means, standard deviations and minimum and maximum values obtained from right and left premolars and molars are given in Tables 1 and 2. The distance between sinus floor and root apex was longest for the first premolar root apex and shortest for the second molar mesiobuccal root apex for both right and left sides as in table 1 and 2. No statistically significant differences were found in the measurements for right sides between females and males patients table1. In table 2 showing no significant difference between male and female for left side in all root of posterior teeth in their relation to the floor of MS except the palatal root of second premolar.

In male group, there was no significant difference between right and left side in distance of premolars and molars root apices to inner wall of MS except the palatal root of 1<sup>st</sup> molar and distobuccal root of 2<sup>nd</sup> molar as in the table 3.

In female group, there was no significant difference between right and left side in distance of premolars and molars root apices to inner wall of MS as in the table 4. In 1<sup>st</sup> premolar there was 99.2% of buccal roots was type 1 from total sample, there was no root type 3 and about 0.83 % type 2. In 2<sup>nd</sup> molar the high percentage of type 3 was in MB root, high percentage of type 2 was observed in palatal root as in 1<sup>st</sup> molar and high percentage of type 1 was observe in buccal root (MB, DB) as in the table 5.

**Table 1. Distance from the root apex of the maxillary posterior teeth to the MS floor in each gender in right side (unit mm)**

Tooth	Root	Genders	Descriptive Statistics						Genders Differences	
			N	Mean	S.D.	S.E.	Min.	Max.	t-test	P-value
1 <sup>st</sup> premolar	Buccal	Males	60	7.10	3.46	0.45	1	14.2	-1.92	0.06 (NS)
		Females	60	8.15	2.47	0.32	2.3	13		
	Palatal	Males	60	7.88	3.80	0.49	1	15.9	-1.80	0.07 (NS)
		Females	59	8.95	2.59	0.34	3.5	14.3		
2 <sup>nd</sup> Premolar	Buccal	Males	60	3.52	3.07	0.40	-4	10	-1.93	0.06 (NS)
		Females	60	4.47	2.26	0.29	0	9.4		
	Palatal	Males	35	3.39	3.06	0.52	-3	9	-1.94	0.06 (NS)
		Females	34	4.72	2.60	0.45	0	8.8		
1 <sup>st</sup> Molar	MB	Males	60	1.40	2.76	0.36	-3	13.3	1.40	0.16 (NS)
		Females	60	0.75	2.27	0.29	-4	6.7		
	DB	Males	60	1.89	2.42	0.31	-2	10.6	0.01	0.99 (NS)
		Females	60	1.89	2.10	0.27	-2	7.2		
	Palatal	Males	60	1.56	2.38	0.31	-1.8	9.2	0.90	0.37 (NS)
		Females	60	1.17	2.37	0.31	-3	7.2		
2 <sup>nd</sup> Molar	MB	Males	60	0.16	1.90	0.25	-3	5.1	-1.32	0.19 (NS)
		Females	60	0.60	1.69	0.22	-3	4		
	DB	Males	60	1.87	2.27	0.29	-1.7	8.5	1.07	0.29 (NS)
		Females	60	1.47	1.75	0.23	-1	5		
	Palatal	Males	60	0.87	1.98	0.26	-4	5.2	0.58	0.56 (NS)
		Females	60	0.67	1.73	0.22	-5	4		

**Table 2. Distance from the root apex of the maxillary posterior teeth to the MS floor in each gender in left side (unit mm)**

Tooth	Root	Genders	Descriptive Statistics						Genders Differences	
			N	M	S.D.	S.E.	Min.	Max.	t-test	P-value
1 <sup>st</sup> Premolar	Buccal	Males	60	7.23	3.49	0.45	1	15.5	-0.83	0.41 (NS)
		Females	60	7.71	2.88	0.37	0	15		
	Palatal	Males	60	7.99	3.46	0.45	2	15	-1.23	0.22 (NS)
		Females	58	8.74	3.17	0.42	0	15.8		
2 <sup>nd</sup> Premolar	Buccal	Males	60	3.61	2.83	0.37	-3	9.6	-1.18	0.24 (NS)
		Females	60	4.12	1.78	0.23	0	7.4		
	Palatal	Males	32	3.04	2.84	0.50	0	8.8	-2.63	0.01 **
		Females	39	4.56	2.02	0.32	0	7.9		
1 <sup>st</sup> Molar	MB	Males	60	1.47	2.30	0.30	-4	7.1	1.79	0.08 (NS)
		Females	60	0.78	1.91	0.25	-3.5	5.1		
	DB	Males	60	1.81	2.31	0.30	-3.40	7.1	0.67	0.50 (NS)
		Females	60	1.56	1.83	0.24	-1	6		
	Palatal	Males	60	1.03	2.04	0.26	-3	5.2	-0.16	0.87 (NS)
		Females	60	1.09	2.00	0.26	-2.3	5.6		
2 <sup>nd</sup> Molar	MB	Males	60	-0.04	1.78	0.23	-3	4.4	-0.67	0.50 (NS)
		Females	60	0.18	1.81	0.23	-4	4		
	DB	Males	60	1.24	1.72	0.22	-2	5.3	-0.43	0.67 (NS)
		Females	60	1.38	1.83	0.24	-3	4.5		
	Palatal	Males	60	0.79	1.89	0.24	-2.40	6.2	0.52	0.60 (NS)
		Females	60	0.62	1.80	0.23	-3	5		

**Table 3. Vertical distance of root apex of posterior teeth to the floor of maxillary sinus and sides differences in male group**

Tooth	Root	Side	Descriptive Statistics				Sides Difference		
			N	Mean	S.D.	S.E.	Mean Difference	t-test	P-value
1 <sup>st</sup> Premolar	Buccal	Right	60	7.10	3.46	0.45	-0.13	-0.60	0.55 (NS)
		Left	60	7.23	3.49	0.45			
	Palatal	Right	60	7.88	3.80	0.49	-0.12	-0.49	0.62 (NS)
		Left	60	7.99	3.46	0.45			
2 <sup>nd</sup> Premolar	Buccal	Right	60	3.52	3.07	0.40	-0.09	-0.38	0.71 (NS)
		Left	60	3.61	2.83	0.37			
	Palatal	Right	35	3.39	3.06	0.52	0.67	1.57	0.13 (NS)
		Left	32	3.04	2.84	0.50			
1 <sup>st</sup> Molar	MB	Right	60	1.40	2.76	0.36	-0.07	-0.28	0.78 (NS)
		Left	60	1.47	2.30	0.30			
	DB	Right	60	1.89	2.42	0.31	0.08	0.37	0.71 (NS)
		Left	60	1.81	2.31	0.30			
	Palatal	Right	60	1.56	2.38	0.31	0.54	2.48	0.02 *
		Left	60	1.03	2.04	0.26			
2 <sup>nd</sup> Molar	MB	Right	60	0.16	1.90	0.25	0.20	1.16	0.25 (NS)
		Left	60	-0.04	1.78	0.23			
	DB	Right	60	1.87	2.27	0.29	0.63	2.83	0.01 **
		Left	60	1.24	1.72	0.22			
	Palatal	Right	60	0.87	1.98	0.26	0.08	0.33	0.74 (NS)
		Left	60	0.79	1.89	0.24			

**Table 4. Descriptive Statistics and Sides Differences for the female group**

Tooth	Root	Side	Descriptive Statistics				Sides Difference		
			N	Mean	S.D.	S.E.	Mean Difference	t-test	P-value
1 <sup>st</sup> Premolar	Buccal	Right	60	8.15	2.47	0.32	0.44	1.91	0.06 (NS)
		Left	60	7.71	2.88	0.37			
	Palatal	Right	59	8.95	2.59	0.34	0.28	0.93	0.36 (NS)
		Left	58	8.74	3.17	0.42			
2 <sup>nd</sup> Premolar	Buccal	Right	60	4.47	2.26	0.29	0.35	1.56	0.12 (NS)
		Left	60	4.12	1.78	0.23			
	Palatal	Right	34	4.72	2.60	0.45	0.21	0.73	0.47 (NS)
		Left	39	4.56	2.02	0.32			
1 <sup>st</sup> Molar	MB	Right	60	0.75	2.27	0.29	-0.03	-0.15	0.88 (NS)
		Left	60	0.78	1.91	0.25			
	DB	Right	60	1.89	2.10	0.27	0.33	1.99	0.052 (NS)
		Left	60	1.56	1.83	0.24			
	Palatal	Right	60	1.17	2.37	0.31	0.09	0.41	0.68 (NS)
		Left	60	1.09	2.00	0.26			
2 <sup>nd</sup> Molar	MB	Right	60	0.60	1.69	0.22	0.42	1.64	0.11 (NS)
		Left	60	0.18	1.81	0.23			
	DB	Right	60	1.47	1.75	0.23	0.09	0.36	0.72 (NS)
		Left	60	1.38	1.83	0.24			
	Palatal	Right	60	0.67	1.73	0.22	0.06	0.22	0.82 (NS)
		Left	60	0.62	1.80	0.23			

**Table 5. Frequency and percentage of roots and their relation to the maxillary sinus in total sample (240 teeth).**

Tooth	Root	Relation of the root to the maxillary sinus							
		Inside the sinus type3		With the level of the sinus type2		Below the Sinus type1		No Root	
		No.	%	No.	%	No.	%	No.	%
1 <sup>st</sup> Premolar	Buccal	0	0	2	0.83	238	99.2	0	0
	Palatal	0	0	2	0.83	235	97.9	3	1.25
2 <sup>nd</sup> Premolar	Buccal	4	1.67	33	13.8	203	84.6	0	0
	Palatal	2	0.83	22	9.17	116	48.3	100	41.7
1 <sup>st</sup> Molar	MB	43	17.9	82	34.2	115	47.9	0	0
	DB	11	4.58	87	36.3	142	59.2	0	0
	Palatal	20	8.33	126	52.5	94	39.2	0	0
2 <sup>nd</sup> Molar	MB	80	33.3	63	26.3	97	40.4	0	0
	DB	22	9.17	73	30.4	145	60.4	0	0
	Palatal	26	10.8	131	54.6	83	34.6	0	0

## DISCUSSION

The anatomical relation between the maxillary sinus and the teeth is a complex one, due to the variable extension of the sinus. The relations between the dental roots apices and the sinus floor are critical elements for the diagnosis and surgical treatment of antral pathology. The results obtained in this study are useful both in endodontics and in oral surgery, the antrum-teeth relations interfere with teeth removal and immediate placement of dental implants in the lateral maxillary region. Identification of the distance between the dental roots apices and the sinus floor and the establishment of the available

bone thickness are imperative requirements in case of surgical procedures of this area <sup>9</sup>.

In the present study the classification was considered into three types of the vertical dento-antral relations, simpler and much useful with regard to oral surgery than the classification of Kwak et al<sup>4</sup> that presents five types of these relations who found that the most frequent vertical relationship was a sinus floor that did not contact the dental roots. Eberhardt et al<sup>10</sup> found the mean distance between the maxillary posterior teeth and the maxillary sinus floor to be 1.97 mm(not contact MS floor), Sharan and Madjar and Kilic et al<sup>11,12</sup> found that the sinus floor did

not contact the roots of the molars which disagreed with present study that found apical protrusion into the maxillary sinus (Type 3) of one or more roots of the molars was frequent although the roots being separate from the sinus (Type 1) was most frequent in each root of the molars this result agree with Jung and Cho<sup>13</sup> found apical protrusion into the maxillary sinus of one or more roots of the molars was most frequent in the study although the roots being separate from the sinus was most frequent in each root of the molars. Because of the very close anatomical relationship that exists between the maxillary posterior teeth root apices and the sinus floor, endodontic surgery of premolars and molars can result in accidental oroantral communication that can allow bacteria from infected periapical tissue, resected root tips, or bony drilling dust to be displaced into the sinus and cause acute or chronic sinusitis<sup>14,15</sup>.

Sharan et al<sup>11</sup> reported that only 39% of the teeth roots that projected on the sinus cavity in panoramic radiographs showed protrusion on the sinus with CT and the panoramic radiographs showed a statistically significant 2.1 times longer root projection on the sinus cavity in comparison to the root protrusion length into the sinus measured by using CT images. In order to avoid disadvantages such as superposition of anatomic structures, horizontal and vertical magnification and a lack of cross-sectional information that are associated with panoramic radiographs, the present study was conducted using CT images only.

Kilic et al<sup>12</sup> reported that the distobuccal root of M2 was closest to the sinus floor because he used cone beam CT the present study disagree with their results. The results of the present study showed that the distance between the sinus floor and the root of the molar was shortest for the mesiobuccal roots of 2<sup>nd</sup> molar, for which Type 3 was frequent and longest for the palatal roots of 1<sup>st</sup> premolar, for which Type 1 was most frequent this result agree with Yoshimine et al<sup>16</sup> who found vertical distance between the apex of the roots and the maxillary sinus floor showed a positive correlation on the maxillary 1<sup>st</sup> premolar ( $P = 0.003$ ).

As with other apicectomies, complications encountered during periapical surgery of the maxillary molars and premolars can include damage to a neighboring tooth. With regard to the specific treatment of maxillary molars and premolars, careful aperture of the maxillary sinus wall or floor is necessary, and attention must be paid to avoid sinus membrane perforation and the

introduction of foreign bodies into the maxillary sinus<sup>15,17-19</sup>.

Ericson et al<sup>14</sup> reported that out of 159 maxillary premolars and molars treated with periapical surgery, aperture of the wall or floor of the maxillary sinus occurred in 18 percent of cases. The authors also stated that the introduction of foreign bodies into the maxillary sinus during surgery could cause thickening of the sinus mucosa and symptoms of maxillary sinusitis.

Knowledge of the distances between the roots and the sinus floor is useful for evaluation of the diameter and length of the dental implants, especially for immediate implant placement and preoperative treatment planning of maxillary posterior teeth<sup>12</sup>.

CT scan is an excellent imaging modality used to evaluate the vertical relation of root apex of posterior teeth to the inner wall of maxillary sinus. In 2<sup>nd</sup> molar the high percentage of type 3 was in MB root, high percentage of type 2 was observe in palatal root The shortest distance to the floor of MS was for mesiobuccal root of 2<sup>nd</sup> molar and the longest was palatal root of 1<sup>st</sup> premolar.

## REFERENCES

- 1- Misch CE. Contemporary implant dentistry. 2nd ed. St. Louis: CV Mosby Co; 1999. pp. 76–194.
- 2- Hauman CH, Chandler NP, Tong DC. Endodontic implications of the maxillary sinus: a review. *Int Endod J* 2002; 35:127–141.
- 3- Tank PW. Grant's Dissector. 13<sup>th</sup> ed. Philadelphia: Lippincott Williams & Wilkins; 2005. p. 198.
- 4- Kwak HH, Park HD, Yoon HR, et al Topographic anatomy of the inferior wall of the maxillary sinus in Koreans. *Int J Oral Maxillofac Surg* 2004; 33: 382-8.
- 5- Monkhouse S. Cranial Nerves Functional Anatomy. 2<sup>nd</sup> ed. New York: Cambridge University Press; 2006. p. 59
- 6- Fuhrmann R, Bucker A, Diedrich P. Radiological assessment of artificial bone defects in the floor of the maxillary sinus. *Dentomaxillofac Radiol* 1997; 26: 112–6.
- 7- Wehrbein H, Diedrich P. The initial morphological state in the basally pneumatized maxillary sinus—a radiological-histological study in man. *Fortschr Kieferorthop* 1992; 53: 254–62.
- 8- Annabelle bouquet, Jean-Loup Coudert, Denis Bourgeois, et al, Contributions of reformatted computed tomography and panoramic radiography in the localization of third molars relative to the maxillary sinus. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004; 98: 342-7.
- 9- Nimigean V, Vanda R, Nicoleta Măru. Sălăvăstru, Daniela Bădiță, Mihaela jana Țuculină The maxillary sinus floor in the oral implantology. *Romanian Morphology and Embryology* 2008; 49(4): 485–9.
- 10- Eberhardt JA, Torabinejad M, Christiansen EL. A computed tomographic study of the distances between the maxillary sinus floor and the apices of the

- maxillary posterior teeth. *Oral Surg Oral Med Oral Pathol* 1992; 73: 345–6.
- 11- Sharan A, Madjar D. Correlation between maxillary sinus floor topography and related root position of posterior teeth using panoramic and cross-sectional computed tomography imaging. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006; 102: 375-81.
  - 12- Kilic C, Kamburoglu K, Yuksel SP, et al. An assessment of the relationship between the maxillary sinus floor and the maxillary posterior teeth root tips using dental cone-beam computerized tomography. *Eur J Dent* 2010; 4: 462-7.
  - 13- Jung YH, Cho BH. Assessment of the relationship between the maxillary molars and adjacent structures using cone beam computed tomography. *Imaging Sci Dent* 2012; 42 (4): 219-24.
  - 14- Ericson S, Finne K, Persson G. Results of apicoectomy of maxillary canines, premolars and molars with special reference to oroantral communication as a prognostic factor. *Int J Oral Surg* 1974; 3: 386–93.
  - 15- Watzek G, Bernhart T, Ulm C. complication of sinus perforation and their management in endodontic. *Dental clinic of North America* 1997; 41: 563-83.
  - 16- Yoshimine S, Nishihara K, et al. Topographic analysis of maxillary premolars and molars and maxillary sinus using cone beam computed tomography. *Implant Dent* 2012; 21(6): 528-35.
  - 17- Persson G. Periapical surgery of molars. *Int J Oral Surg* 1982; 11: 96–100.
  - 18- Wallace JA. Trans-antral endodontic surgery. *Oral surgery Oral Med Oral Pathol* 1996; 82: 80-3.
  - 19- Khongkhunthian P, Reichart PA. Aspergillosis of the maxillary sinus as a complication of overfilling root canal material into the sinus: report of two cases. *J Endod* 2001; 27: 476–8.