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RESEARCH ARTICLE

ROOT POSITION OF MAXILLARY MOLAR WITH MAXILLARY SINUS - A RETROSPECTIVE CBCT STUDY

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ABSTRACT

Background and Aim: Present retrospective study was performed to evaluate and investigate the relationship between the roots of the maxillary first molar and the maxillary sinus using cone beam computed tomography (CBCT), to measure the distances between the roots of the maxillary molars and the sinus floor as well as the thickness of the bone between the root and the alveolar cortical plate and to determine the correlation of these variability with different age groups and gender.

Materials and Methods: The study included 40 subjects aged between 14 and 77 years who were further divided into the following 2 group's i.e. <40 years, >40 years. Out of 40 subjects 20 were male and 20 were females. CBCT was performed using a standard exposure and patient positioning protocol. The data of the CBCT images were sliced in three dimensions. Image planes on the three axis axial, coronal and sagittal were sequentially analyze and the correlation of age and gender with all the variables was evaluated.

Results: The present retrospective study showed both gender wise and age wise significant differences in the distance of root of first molar and cortical bone thickness in coronal section. The mean value gender wise for mesiobuccal root of maxillary first molar with floor of maxillary sinus, for females was 3.080mm (±2.4107) and for males was 1.449mm(±2.6452) which showed significant result(p value 0.049). Distobuccal root of maxillary first molar with floor of maxillary sinus in AGE GROUP 1 was 0.784mm(±1.9326) and for GROUP 2, 3.042mm(±2.3215) respectively which showed significant result (p value 0.003). Bone thickness of buccal cortical plate for females was 1.295mm(±0.5053) and for male 2.532mm(±1.2083) which showed highly significant result(p value 0.000). When compared age group (<40yrs & > 40yrs) with gender then thickness of buccal cortical plate below 40yrs i.e. group 1 showed highly significant result having p value 0.000.

Conclusion: The present retrospective study highlights the importance of anatomy and morphology of maxillary first molar with maxillary sinus and cortical bone thickness to determine the age and gender of the individual.

INTRODUCTION

Maxillary sinus is a pyramid-shaped osseous cavity, with the base being represented by the nasal antral wall and the tip lying in the zygomatic bone. The apices of the maxillary posterior teeth roots may protrude into the sinus, therefore the thickness of sinus floor is markedly reduced. After extraction, various complications might occur, like oroantral fistulae or root displacement, especially for first and second maxillary molars. The first permanent molar is the first tooth to erupt, which is frequently prematurely extracted, thus exposing the maxillary sinus high risk of oroantral communication, Sinusitis, odontogenic infection[1].

The aim of the study was to assess the distances between the apices of the each root of maxillary first molar with the floor of the maxillary sinus, thickness of the cortical bony plate, with aids of the cone beam computed tomography (CBCT) and its relevance, with gender and between age groups.

MATERIALS AND METHODS

A total of 40 maxillary first molars in 40 patients were examined using CBCT images. The sample of patients comprised 20 males and 20 females with age of 14 years to 77 years which further divided into two age groups group 1(<40 yrs) and group 2 (>40 yrs). The CBCT examinations were made using a Kodak 9000 C. The data of the CBCT images were sliced in three dimensions i.e. axial, coronal, sagittal. CBCT images were evaluated to assess the roots of the maxillary first molars, maxillary sinus, and cortical plate.

The vertical relationship between each root of the first molar and the sinus floor was classified into four types based on the CBCT cross-sectional images: Type 0, the root was not in

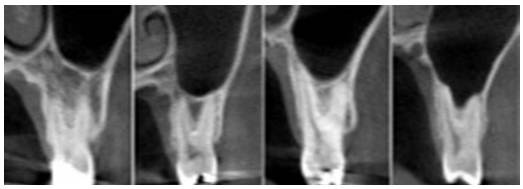
contact with the cortical borders of the sinus; Type 1, the root was in contact with the cortical borders of the sinus; Type 2, the root was projecting laterally on the sinus cavity, but its apex was outside the sinus borders; and Type 3, the root apex was projecting into the sinus cavity (Fig. 1). In Types 2 and 3, the horizontal relationship between the roots of the teeth and the sinus floor was classified into three types: Type B, the lowest point of the sinus floor was located on the buccal side; Type BP, the lowest point of the sinus floor was located between the buccal and palatal roots; Type P, the lowest point of the sinus floor was located on the palatal side of the palatal root. In Type 0 and Type 3, the distance between the apices of the first molars and the sinus floor was measured using CBCT cross-sectional images. The measurements were taken from the root apex to the cortical inferior wall of the sinus along the longitudinal axis of the root. The apices extending below the sinus floor were assigned positive values, whereas those above the sinus floor were assigned negative values. A dentomaxillofacial radiology specialist evaluated the images in a darkened quiet room with dual monitors (HP LP2475W, resolution 1920 × 1200; Hewlett-Packard, Houston, USA. Each viewing session lasted for 30 minutes. Care was taken to ensure that 24 hours elapsed between all sessions. For intra-examiner calibration and determination of reliability and reproducibility of the measurements, the images were evaluated a second time by the same observer 2 weeks interval.

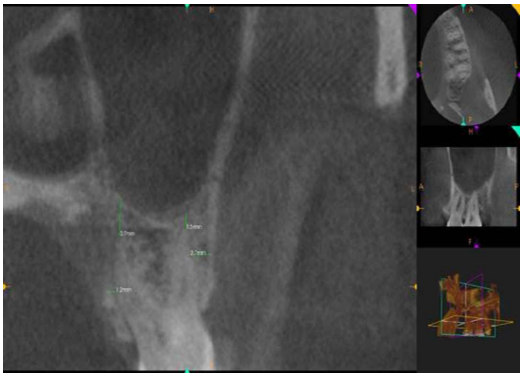
Statistical Analysis

The data were entered into the computer database. The response of frequencies were calculated and analyzed by using statistical software statistical package of social sciences (SPSS) version 17.0 IBM, U.S. The probability value $p<0.05$ considered as significant, and $p<0.001$ were considered as highly significant and value $p>0.05$ was considered as not significant.

RESULT

In the present study, forty maxillary first molar in forty patients were examined using CBCT images, which comprised of 20 females(50%) and 20 males(50%) , ranging from 14yrs-77yrs. which was further divided into two age groups < 40yrs(GROUP 1), having 16 subjects and >40yrs(GROUP 2), having 24 subjects.





The mean value gender wise for vertical distance of mesiobuccal root of maxillary first molar with floor of maxillary sinus, for females was 3.080mm(±2.4107) and for males was 1.449mm(±2.6452) which showed significant result(p value 0.049), which was less than 0.05. Vertical distance of distobuccal root of maxillary first molar with floor of maxillary sinus, for females showed a mean value of 2.733mm(±2.1710) and for males 1.545mm(±2.5681) showing no significant result(p value 0.125) as it was more than 0.05. Similarly the mean value for vertical distance of palatal root of maxillary first molar with floor of maxillary sinus, for females was 3.008mm(±1.9314) and for males 2.555mm(±3.2427) which showed no significant result(p value 0.595) as it was more than 0.05. (Table 1)

Table 1

	SEX	N	Mean	Std. Deviation	Std. Error Mean	t	P Value
Vertical Relationship Misiobuccal Root	F	20	3.080	2.4107	.5391		
	M	20	1.449	2.6452	.5915	2.038	.049
Vertical Relationship Distobuccal Root	F	20	2.733	2.1710	.4855		
	M	20	1.545	2.5681	.5742	1.579	.123
Vertical Relationship Palatal Root	F	20	3.008	1.9314	.4319		
	M	20	2.555	3.2427	.7251	.536	.595
Thickness of Buccal Cortical Plate	F	20	1.295	.5053	.1130		
	M	20	2.532	1.2083	.2702	-4.225	.000
Thickness of Palatal Cortical Plate	F	20	1.437	.7286	.1629		
	M	20	1.732	.6950	.1554	-1.310	.198

The mean value gender wise for bone thickness of buccal cortical plate for females was 1.295mm(±0.5053) and for male 2.532mm(±1.2083) which showed significant result(p value 0.000). Similarly the mean value for palatal cortical plate for females 1.437mm(±0.7286) and for male 1.732mm(±0.6950) which showed no significant result(p value 0.198). (Table 1).

Gender wise vertical relationship between each root of the first molar and the maxillary sinus floor were classified into 4 types, based on CBCT cross-sectional images. For females and males maximum relationship was observed in Type 0(16 cases, 80%) and Type 0(12 cases, 60%) respectively having p value 0.468 which showed no significant correlation. (Table 2)

SEX * TYPE

Table 2

Count						
		TYPE				Total
		0	1	2	3	
SEX	F	16	3	1	0	20
	M	12	4	2	2	20
Total		28	7	3	2	40

Chi-Square Tests

Asymp. Sig. (2-sided)
.384
.281
.093

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is 1.00.

b. The standardized statistic is 1.680.

Gender wise horizontal relationship between the roots of first molar and sinus floor were classified into 3 groups. In present study we observed only 5 subjects having Type B and Type

BP relationship, in which females showed 1 case (5%) and males 4 cases (20%) having p value 0.407 which showed no significant result. (Table 3)

Table 3

		Horizontal Relationship		Total
		B	BP	
SEX	F	1	0	20
	M	2	2	20
Total		3	2	40

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.590[a]	2	.274	.407		
Likelihood Ratio	3.370	2	.185	.407		
Fisher's Exact Test	2.291			.407		
Linear-by-Linear Association	1.859[b]	1	.173	.342	.171	.088
N of Valid Cases	40					

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.00.

b. The standardized statistic is -1.363.

in females and no negative relationship was observed. For males, 12 cases (60%) showed positive relation and 2 cases (10%) showed negative relationship, having p value 0.260 which showed no significant relationship.(Table 4)

Table 4

		Positive & Negative Relationship		
		Positive	Negative	Total
SEX	F	16	0	16
	M	12	2	14
Total		28	2	30

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.971[a]	2	.226	.260		
Likelihood Ratio	3.749	2	.153	.260		
Fisher's Exact Test	2.601			.260		
Linear-by-Linear Association	.667[b]	1	.414	.366	.183	.046
N of Valid Cases	40					

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.00.

b. The standardized statistic is .816.

The mean value age group wise for vertical distance of mesiobuccal root of maxillary first molar with floor of maxillary sinus, in group 1 was 1.419mm(±2.5893) and for group 2 was 2.829mm(±2.5564) which showed no significant result(p value 0.097) as it was more than 0.05. The mean value of vertical distance of distobuccal root of maxillary first molar with floor of maxillary sinus, for age group 1 was 0.784mm(±1.9326) and for group 2, 3.042mm(±2.3215) respectively which showed significant result(p value 0.003) as it was less than 0.05. Similarly the mean value for, vertical distance of palatal root of maxillary first molar with floor of maxillary sinus, for age group 1 was 1.721mm(±2.2467) and for group 2, was 3.488mm (±2.6948) showing significant result(p value 0.37) as the value was less than 0.05.(Table 5)

Group Statistics(TABLE 5)

	Agegrp	N	Mean	Std. Deviation
Vertical Relationship Misiobuccal Root	<40yrs	16	1.419	2.5893
	>40 yrs	24	2.829	2.5564
Vertical Relationship Distobuccal Root	<40yrs	16	.784	1.9326
	>40 yrs	24	3.042	2.3215
Vertical Relationship Palatal Root	<40yrs	16	1.721	2.2467
	>40 yrs	24	3.488	2.6948
Thickness of Buccal Cortical Plate	<40yrs	16	2.160	1.0966
	>40 yrs	24	1.749	1.1081
Thickness of Palatal Cortical Plate	<40yrs	16	1.916	.7611
	>40 yrs	24	1.364	.6086

For vertical relationship between each root of the first maxillary molar and the maxillary sinus floor were classified into 4 types, based on CBCT cross-sectional images. For group 1 and group 2 maximum relationship was observed in Type 0(9 cases, 56.25%) and (19 cases, 79.16%) respectively having p value 0.200 which showed no significant correlation. (Table 6)

Crosstab(TABLE 6)

		TYPE				Total
		0	1	2	3	
Agegrp	<40 yr	9	3	2	2	16
	>40yr	19	4	1	0	24
Total		28	7	3	2	40

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.633[a]	3	.201	.238		
Likelihood Ratio	5.296	3	.151	.289		
Fisher's Exact Test	4.311			.200		
Linear-by-Linear Association	4.235[b]	1	.040	.053	.033	.020
N of Valid Cases	40					

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .80.

b. The standardized statistic is -2.058.

We observed only 5 subjects having Type B and Type BP relationship which were further divided into group 1, 4 case (25%)and group 2, 1 case (4.1%) having p value 0.133 which showed no significant result. (Table 7)

Table 7

		Horizontal Relationship		
		B	BP	Total
Agegrp	<40yrs	2	2	4
	>40yrs	1	0	1
Total		3	2	5

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.365[a]	2	.113	.133		
Likelihood Ratio	5.018	2	.081	.198		
Fisher's Exact Test	3.967			.133		
Linear-by-Linear Association	3.505[b]	1	.061	.138	.073	.040
N of Valid Cases	40					

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .80.

b. The standardized statistic is 1.872.

Positive relation was observed age wise in 9 cases (56.25%) in group 1 and 2 cases (12.5%) showed negative relationship. For group 2, 19 cases (79.16%) showed positive relation and no cases showed negative relationship, having p value 0.119 which showed no significant relationship. (Table 8)

Table 8

Positive and Negative Relationship

		Positive	Negative	Total
Agegrp	<40YRS	9	2	11
	>40yrs	19	0	19
Total		28	2	30

Chi-Square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.137[a]	2	.126	.147		
Likelihood Ratio	4.813	2	.090	.147		
Fisher's Exact Test	3.713			.119		
Linear-by-Linear Association	.726[b]	1	.394	.291	.160	.028
N of Valid Cases	40					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .80.

When we compared age group (<40yrs & > 40yrs) with gender then thickness of buccal cortical plate below 40yrs i.e. group 1 showed significant result having p value 0.000 which was less than 0.05. None of the other parameters showed significant result when age with gender was compared.(Table 9- Table 16).

Group Statistics below 40 yrs(TABLE 9)

	SEX	N	Mean	Std. Deviation	Std. Error Mean	t	P VALUE
Vertical Relationship Misiobuccal Root	F	6	2.848	2.4285	.9914	1.842	.087
	M	10	.561	2.3913	.7562		
Vertical Relationship Distobuccal Root	F	6	1.902	1.4444	.5897	1.953	.071
	M	10	.113	1.9321	.6110		
Vertical Relationship Palatal Root	F	6	2.935	1.9307	.7882	1.793	.095
	M	10	.993	2.1842	.6907		
Thickness of Buccal Cortical Plate	F	6	1.022	.3098	.1265	-5.565	.000
	2M	10	2.842	.7554	.2389		
Thickness of Palatal Cortical Plate	F	6	1.772	.7423	.3030	-.572	.576
	M	10	2.002	.7983	.2525		

below 40 yrs(TABLE 10)

Count

		TYPE				Total
		0	1	2	3	
SEX	F	5	1	0	0	6
	M	4	2	2	2	10
Total		9	3	2	2	16

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	3.674[a]	3	.299	.443		
Likelihood Ratio	4.986	3	.173	.443		
Fisher's Exact Test	3.036			.443		
Linear-by-Linear Association	3.258[b]	1	.071	.108	.058	.047
N of Valid Cases	16					

a. 7 cells (87.5%) have expected count less than 5. The minimum expected count is .75.

b. The standardized statistic is 1.805.

Table 11

		Horizontal Relationship		
		B	BP	Total
SEX	F	0	0	0
	M	2	2	4
Total		2	2	4

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	3.200[a]	2	.202	.357		
Likelihood Ratio	4.534	2	.104	.357		
Fisher's Exact Test	2.446			.357		
Linear-by-Linear Association	2.982[b]	1	.084	.179	.115	.115
N of Valid Cases	16					

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .75.

b. The standardized statistic is -1.727.

SEX * T&FR

below 40 yrs(TABLE 12)

Count

		Positive and Negative Relationship		
		Positive	Negative	Total
SEX	F	5	0	5
	M	4	2	6
Total		9	2	11

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	3.105[a]	2	0.212	0.281		
Likelihood Ratio	3.801	2	0.15	0.281		
Fisher's Exact Test	2.584			0.281		
Linear-by-Linear Association	1.135[b]	1	0.287	0.378	0.136	0.079
N of Valid Cases	16					

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .75.

b. The standardized statistic is 1.065.

Group Statistics above 40 yrs (Table 13)

	SEX	N	Mean	Std. Deviation	Std. Error Mean	T	P VALUE
Vertical Relationship Misiobuccal Root	1	14	3.180	2.4879	.6649	.789	.438
	2	10	2.338	2.7019	.8544		
Vertical Relationship Distobuccal Root	1	14	3.089	2.3730	.6342	.113	.911
	2	10	2.978	2.3731	.7504		
Vertical Relationship Palatal Root	1	14	3.039	2.0037	.5355	-.966	.345
	2	10	4.118	3.4648	1.0957		
Thickness of Buccal Cortical Plate	1	14	1.412	.5359	.1432	-1.858	.077
	2	10	2.222	1.5158	.4794		
Thickness of Palatal Cortical Plate	1	14	1.293	.6999	.1871	-.661	.516
	2	10	1.462	.4695	.1485		

above 40 yrs (Table 14)

Count

		TYPE				Total
		0	1	2	3	
SEX	F	11	2	1	0	14
	M	8	2	0	0	10
Total		19	4	1	0	24

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.830[a]	2	.660	1.000		
Likelihood Ratio	1.192	2	.551	1.000		
Fisher's Exact Test	.929			1.000		
Linear-by-Linear Association	.152[b]	1	.697	1.000	.514	.278
N of Valid Cases	24					

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .42.

b. The standardized statistic is -.389.

above 40 yrs (Table 15)

Count

		Horizontal Relationship		Total
		B	BP	
SEX	F	1	0	1
	M	0	0	0
Total		1	0	1

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.745[a]	1	.388	1.000	.583	
Continuity Correction[b]	.000	1	1.000			
Likelihood Ratio	1.109	1	.292	1.000	.583	
Fisher's Exact Test				1.000	.583	
Linear-by-Linear Association	.714[c]	1	.398	1.000	.583	.583
N of Valid Cases	24					

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .42.

b. Computed only for a 2x2 table

c. The standardized statistic is .845.

SEX * T&FR above 40 yrs (Table 16)

Count

		Positive and Negative Relationship		Total
		Positive	Negative	
SEX	F	11	0	11
	M	8	0	8
Total		19	0	19

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.007[a]	1	.932	1.000	.668	
Continuity Correction[b]	.000	1	1.000			
Likelihood Ratio	.007	1	.932	1.000	.668	
Fisher's Exact Test				1.000	.668	
Linear-by-Linear Association	.007[c]	1	.934	1.000	.668	.385
N of Valid Cases	24					

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.08.

b. Computed only for a 2x2 table

c. The standardized statistic is -.083.

DISCUSSION

Present study examined the relationship between the root of the maxillary first molar and the maxillary sinus floor based on CBCT images and its correlation to determine gender and age of the individuals. Our study is in accordance to the previously published study on most frequent relationship of the sinus floor which did not contact the roots of the molars in which we determined the maximum relationship for gender determination for females and males was observed in Type 0 (16 cases, 80%) and Type 0 (12 cases, 60%) respectively. For group 1 & group 2 maximum relationship for age determination was observed in Type 0 (9 cases, 56.25%) and (19 cases, 79.16%) respectively. Meanwhile, according to Jung HY *et al*[2] apical protrusion into the maxillary sinus (Type 3) of one or more roots of the second molars was most frequent although the roots being separate from the sinus (Type 0) was most frequent in each root of the second molars[2].

The mean value gender wise for vertical distance of mesiobuccal root of maxillary first molar with floor of maxillary sinus, for females was 3.080mm(±2.4107) and for males was 1.449mm(±2.6452) which showed significant result(p value 0.049). The mean value of vertical distance of distobuccal root of maxillary first molar with floor of maxillary sinus, for age group 1, 0.784mm(±1.9326) and for group 2, 3.042mm(±2.3215) respectively which showed significant result(p value 0.003). Eberhardt *et al*[3] and Georgescu *et al*[4] reported that the mesiobuccal roots of second molar were closest to the sinus floor, and Kilic *et al*[5] reported that the distobuccal root of second molar was closest to the sinus floor. Jung HY[2] showed that the distance between the sinus floor and the root of the second molar was shortest for the mesiobuccal roots of second maxillary molar. Whereas our study reported that distobuccal root of maxillary first molar closer to the sinus floor which showed similar result as reported by Kilic *et al*[5].

The mean value gender wise for bone thickness of buccal cortical plate for females was 1.295mm(±0.5053) and for male 2.532mm(±1.2083) which showed significant result(p value 0.000), when we compared age group (<40yrs & > 40yrs) with gender then thickness of buccal cortical plate below 40yrs i.e. group 1 showed significant result having p value 0.000 which was less than 0.05 which was in accordance with Jung HY[2] who also showed buccal thickness to be more than palatal bone.

CONCLUSION

Cone beam computed tomography (CBCT) should be recommended as a dose-sparing technique compared with standard medical computed tomography (MDCT) scans for dentomaxillofacial imaging. Regardless of type of imaging technique used kV, mA, exposure time, and field of view increase the radiation dose. The effective dose (International Commission on Radiological Protection - ICRP 2007) from a standard dental protocol scan with MDCT is 1.5 to 14 times greater than from comparable small–field of view dental CBCT scans. Thus, CBCT is frequently used for preoperative assessment of the alveolar ridge and maxillary sinus in patients receiving implants in the posterior maxilla and also can also be used for age and gender determination by cortical bone thickness and distance between maxillary first molar root and inferior border of maxillary sinus.

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