RESEARCH ARTICLE

A CBCT based evaluation of root proximity of maxillary posterior teeth to sinus floor in a subset of Pakistani population

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Abstract

Objective: To evaluate the vertical relationship of the roots of maxillary posterior teeth with maxillary sinus floor, and its association with age, gender and bilateral jaw symmetry.

Method: The cross-sectional study was conducted at a tertiary care hospital in Karachi from June to December 2018, and comprised patients who visited the dental clinics and underwent cone-beam computed tomography scans. The scans were evaluated in the axial, coronal and sagittal planes and roots were classified using Jungs classification for proximity to maxillary sinus floor. The distance between the sinus floor and the apices of maxillary posterior teeth was measured. Data was analysed using SPSS 23.

Results: There were 60 scans with 1066 roots. The most common maxillary tooth root in Type III group of Jung classification was the mesio-buccal root of the 2nd molar with the shortest mean distance of 0.44±3.05mm, followed by palatal roots of the 1st molar with the shortest mean distance of 1.58±4.01mm. The maxillary tooth root most frequent in Type I group was buccal root of 1st premolar with a mean distance of 8.15±6.65mm, and the 2nd premolar with a mean distance of 7.38±6.60mm. No significant difference was found in terms of gender and sides ($p \geq 0.05$).

Conclusion: The most common tooth root protruding in the sinus was found to be the mesio-buccal root of the 2nd molar, followed by palatal roots of the 1st molar. The most distant maxillary tooth root from the sinus was the buccal root of 1st and 2nd premolars.

Keywords: CBCT, Maxillary sinus, Maxillary teeth, Pakistani population, Jung classification. (JPMA 71: 1992; 2021)

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Introduction

The relationship of maxillary sinus with the surrounding anatomical structures, especially the maxillary posterior teeth (MPT) is an area of concern in dental practice, particularly while doing endodontic procedures, dento-alveolar surgeries and dental implants.[1] The maxillary sinus starts to develop in the intrauterine life and continues after birth, resulting in variable size and shape of the sinus.[2,3] The maxillary sinus floor (MSF) continues to expand around the roots of MPT and proximates between them. Thus this close association of the maxillary sinus with MPT apices poses a risk of damage to the sinus membrane while carrying out routine procedures, like endodontic treatment, extractions, implants, orthodontic tooth movements and dento-alveolar surgeries.[4,5] Perforation into the Schneiderian membrane can establish a communication between the sinus floor and the infected periapical tissue, resulting in acute or chronic sinusitis.[6-8] Infection and sinusitis may also result from over-instrumentation of endodontic instruments, extrusion of root-filling materials or introduction of foreign bodies into the sinus if the operator is careless.[9]

The proximity to and the thickness of bone between the roots and the sinus lining seem to be important indicators in predicting the likely complications of sinus floor perforation and spread of infection.[4,10] Evaluation of this critical relationship between MPT and MSF is most commonly done using 2-dimensional (2D) radiographs, such as the orthopantomogram (OPG). Though this radiograph is widely used because it is cheaper with relatively less exposure to ionising radiation,[11,12] a study concluded that OPG have limitations in the visualisation of the maxillary sinus.[13] It is a 2D view, resulting in superimposition of anatomical structures and magnification, and is thus of limited diagnostic value for evaluating the relationship of MPT with the maxillary sinus. Cone beam computed tomography (CBCT) provides the clinician with the ability to evaluate the third dimension of the anatomical structure, eliminating superimpositions and overcoming the limitations of 2D radiograph.[14] Additionally, lower radiation dose and cost of CBCT scan as opposed to conventional CT is proving to be a revolution in the practice of oral and maxillofacial radiology.[15]

A number of studies have been carried out in various population groups[4,9,12,16,17] in which CBCT scan was reported to be a better diagnostic tool than conventional radiographs and it proved to be accurate in evaluating the relationship of MPT with maxillary sinus.

A study in South Korea showed that 35.8% mesio-buccal

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(MB) roots of the second molars were protruding in sinus with the least vertical distance of 0.18mm to the MSF.[9] However, another study concluded that the disto-buccal (DB) root tips of the second molars were the closest on both sides.[18] One study in Romania reported that the maxillary first molar's palatal (P) root was in close proximity to the sinus floor (44.3%).[19] In a subset of Indian patients, a study concluded that the P root of second premolars and MB root of first molars were closest to the MSF.[4]

Several studies have been conducted globally in various races and populations, yielding different results, but, to the best of our knowledge, no such study has ever been conducted on Pakistani population. The current study was planned to fill the gap in literature by evaluating the relationship between the MPT roots and MSF, and its association with age, gender and bilateral jaw symmetry.

Materials and Methods

This cross-sectional study was conducted at a tertiary care hospital in Karachi from June to December 2018, and comprised CBCT scans obtained from the patients who visited the dental clinics. After approval from the institutional ethics review committee, the sample size was determined in the light of literature[4] using the World Health Organisation (WHO) calculator version 2.0.[20] The anticipated population proportion was kept at 0.96, absolute precision at 0.05 and level of confidence at 95%. The sample size came out to be 60 scans. The sample was raised using non-probability convenience sampling technique.

CBCT scans included were of males and females of Pakistani origin aged 20-65 years with normally erupted right and left maxillary first premolar to maxillary second molar with visible maxillary sinuses obtained using CBCT GALAXIS 1.9. Scans of patients who underwent extraction or surgery involving the sinus, orthodontic treatments including tooth movements, trauma, exostosis, hypoplasia, pathology, evidence of moderate or severe bone-loss or any other intervention that affected the morphological situation of MPT were excluded.

CBCT images were taken using Sirona Dental system (D-64625 Bensheim, Germany) operated at 85kVp and 7mA. Longitudinal cross-sectional images in the sagittal planes were reconstructed using GALAXIS 1.9 (SICAT GmbH & Co. KG, Bonn, Germany) on a 21-inch personal computer (PC) monitor. Images were adjusted for brightness and contrast by using the adjustment tool in the software for optimal visualisation. On CBCT scans, the minimum vertical distance was taken from the root end to the MSF along the long axis of the root. The measurements of root end below the sinus floor were given positive values, whereas those protruding into the sinus were given negative values. The roots were classified based on Jung classification[21] (Figure), where Type 0 = root apex away from MSF; Type 1 = maxillary sinus touching the root apex; Type 2 = MSF interposed between the roots; and Type 3 = root apex projecting into the sinus.

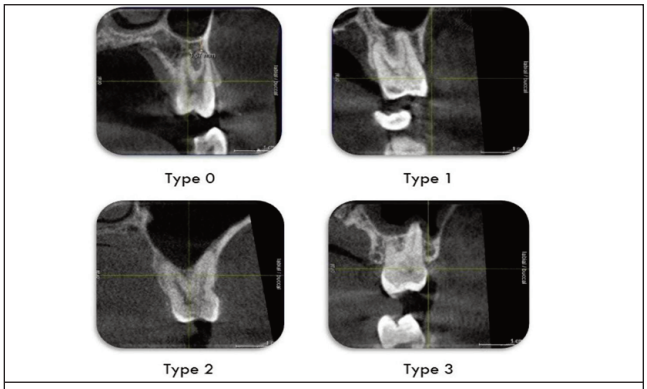

Figure: Jung classification Type 0 = Away from sinus; Type 1 = Touching the sinus; Type 2 = Sinus between roots; Type 3 = Roots dipping in sinus.

Data was analysed using SPSS 23.0. Data was expressed as frequencies and percentages or mean and standard deviation (SD) for MPT. Paired t-test was used to assess bilateral symmetry between right and left sides. Independent sample t-test was used to compare the difference between males and females, and to evaluate differences according to age categories. Pearson's correlation test was applied for the determination of linear relationship with age. Level of significance was kept at $p \leq 0.05$.

Results

There were 60 CBCT scans related to as many subjects;

Table-1: Vertical relationship (Proximity) according to Jung classification.

Proximity	1st PM B n(%)	1st PM P n(%)	2nd PM B n(%)	2nd PM P n(%)	1st M MB n(%)	1st M DB n(%)	1st M P n(%)	2nd M MB n(%)	2nd M DB n(%)	2nd M P n(%)
0	77 (64)	38 (58.4)	77 (64)	28 (58.3)	48 (40)	42 (35)	34 (28.3)	23 (19.6)	33 (28.4)	43 (35.8)
1	4 (3)	2 (3)	22 (18.3)	8 (16.6)	44 (36.6)	41 (34)	23 (19.1)	51 (43.5)	52 (44.8)	47 (39.1)
2	0 (0)	0 (0)	0 (0)	0 (0)	17 (14.1)	22 (18.3)	31 (25.8)	4 (3.4)	6 (5.1)	9 (7.5)
3	2 (1)	1 (1.5)	12 (10)	4 (8.3)	8 (6)	11 (9.1)	30 (25)	36 (30.7)	22 (18.9)	18 (15)
4	37 (30)	24 (36)	9 (7.5)	8 (16.6)	3 (2.5)	4 (3.5)	2 (1.6)	3 (2.5)	3 (2.5)	3 (2.5)

PM: Premolar; M: Molar; B: Buccal; P: Palatal; MB: Mesiobuccal; DB: Distobuccal; 4- Not traceable

Table-2: Vertical distance (mm) from maxillary sinus floor (MSF) to the maxillary teeth.

Age Category	1st PM B (mm)	1st PM P (mm)	2nd PM B (mm)	2nd PM P (mm)	1st M MB (mm)	1st M DB (mm)	1st M P (mm)	2nd M MB (mm)	2nd M DB (mm)	2nd M P (mm)
<30 years	7.18±6.91	6.50±7.61	4.39±5.03	5.69±4.94	1.41±2.31	0.85±2.42*	1.14±3.52	-0.41±1.77*	0.23±1.49*	0.43±2.14*
> 30 years	9.24±6.29	9.03±4.19	4.80±4.14	4.60±3.04	2.85±4.90	5.19±9.86*	2.08±4.52	1.46±3.87*	2.84± .97*	3.66±4.17*
p-value	0.27	0.43	0.73	0.68	0.14	0.02	0.37	0.02*	0.002*	0.000*

PM: Premolar; M: Molar; B: Buccal; P: Palatal; MB: Mesiobuccal; DB: Distobuccal; Independent sample t test; *p-value ≤ 0.05

Table-3: Correlation with respect to age.

Pairs of Right and Left Vertical Distance (mm)	Pearson correlation	*p*-value
1st Premolar Buccal	0.06	0.66
1st Premolar Palatal	0.13	0.57
2nd Premolar Buccal	0.06	0.67
2nd Premolar Palatal	-0.09	0.73
1st Molar MesioBuccal	0.25	0.06
1st Molar DistoBuccal	0.16	0.22
1st Molar Palatal	0.17	0.19
2nd Molar MesioBuccal	0.35	0.007*
2nd Molar DistoBuccal	0.45	0.001*
2nd Molar Palatal	0.47	0.000*
Pearson correlation	r = 0.47	

*p-value ≤ 0.05

30(50%) males and 30(50%) females, with an overall mean age of 34.80±13.88 years. There were 23(38.3%) subjects from Sindh, 14(23.3%) from Punjab, 10(16.6%) from Balochistan and 13(21.6 from Khyber Pakhtunkhwa (KP). There were 120 maxillary sinus with 1066 roots of 480 MPT. The tooth root in closest proximity to the maxillary sinus was MB roots of the 2nd molars, followed by P roots of the 1st molar, while the most common roots type was 0 (Table 1).

The shortest mean distance of MPT roots from the sinus floor was 0.44±3.05mm for MB root of 2nd molar, and the longest mean distance was for the buccal roots of 1st premolars 8.15±6.64mm (Table 2).

There was no significant difference in the measurements between males and females or between right and left sides (p>0.05).

Age variations were assessed by dividing into two <30 and >30 years age categories. Significant difference was observed among the DB roots of 1st molars and all roots of 2nd molars between the age groups (p≤0.05), while a moderate positive correlation (r=0.47) was recorded among the roots of 2nd molars with increasing age (Table 3).

Discussion

The relationship of MSF to root apices of MPT is critical while performing different surgical procedures involving the maxilla. It is important to be aware of the proximity, especially the ones closer or protruding into the sinus to minimise the risk of sinus perforation and related sinus complications.

Most studies used panoramic radiographs as it is easily available to assess the relationship. However, one study concluded that CBCT allowed better assessment of anatomical structures compared to panoramic radiographs.[11] Although CT scans are superior and considered the gold standard, they are associated with higher radiation doses.[22] Newer multi-slice CTs are present, but they are not easily available or accessible. In contrast, CBCT gives high-resolution images with limited radiation dose for better analysis to serve as an important diagnostic tool.[23] The current study, therefore, used CBCT scans.

The data was categorised according to Jung classification and MB roots of the 2nd maxillary molars were found to be closest to the sinus, while the buccal roots of 1st and 2nd premolars were the farthest. In contrast, a study[24] in Colombia reported the P root of maxillary first molars to be inside the sinus contributing 12.5% and the least common root near the sinus was the P root of the first premolar. According to a study done in South Korea, the closest root from the sinus was the MB root of the 2nd maxillary molar, while the P root of the 2nd premolar was well away.[25] These differences and variability in results may be due to the fact that the respective populations are a mix of various races and ethnicities.

Our results are in line with a study done in Brazil[16] This may be due to the convex shape of the sinus which made these roots dip inside the sinus, with 1st and 2nd molars closest to the sinus and the roots of the premolars being far away.

In the current study, there was no difference in the proximity of roots among males and females or between right and left sides. In contrast, a study noticed meaningful difference between the genders, suggesting close proximity of roots to sinus in males compared to females. It also found no difference between right and left sides though.[2]

Age also has a significant impact on the association between teeth roots and maxillary sinus. In a study,[17]

distance between the root ends and MSF increased with increasing age. In the current study, only a moderate positive correlation was found for the three roots of 2nd molars with increasing age. This may be due to the fact that more bone is deposited between the sinus and the tooth as years pass by. According to a study, mechanical stress induces bone deposition.[26] We assume that the presence of teeth and its mechanical stimulation lead to bone deposition between the teeth and the sinus floor.

Conclusion

Among the roots of the maxillary molars, the most common tooth root protruding in the sinus was found to be the MB roots of the 2nd molar, followed by P roots of the 1st molar. The most distant maxillary tooth root from the sinus was the buccal root of 1st and 2nd premolars. The difference between right and left sides or between males and females was not significant. A moderate positive corelation was found between the roots of 2nd maxillary molars with increasing age.

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