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Morphometric Analysis of Relationship Between the Maxillary Sinus Floor and Roots of the Maxillary Posterior Teeth with the Help of Cone Beam Computed Tomography"

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KEYWORDS

Maxillary sinus, Pneumatization, CBCT,

ABSTRACT:

Aim: To access the vertical and horizontal relationship between the MSF and maxillary posterior teeth roots using CBCT.

Material and Methods:

In this randomized controlled trial study, a total 40 CBCT scans & 160 teeth including forty 1st premolars, forty 2nd premolars, forty 1st Molars & forty 2nd Molars was analysed, using in-built measurement tools. To access the relationship between the MSF and the posterior maxillary teeth, the classification implemented in the study of Jung in 2009 was used. All data underwent descriptive statistical analysis and was tabulated.

Result: The study showed that the buccal root tip of the second premolar was closest to the maxillary sinus floor (MSF), followed by the palatal root tip of the same tooth, the disto-buccal (DB) root tip of the second molar, and the palatal root tip of the first molar with a greater prevalence of thicker buccal cortical plates observed in the maxillary premolar region. The study found statistically significant differences in the relationship between various types and gender, with a higher prevalence of teeth root protrusion into the maxillary sinus noted in males compared to females. However, no statistically significant difference was observed between assessments of the right and left sides.

Conclusion: The study found that while most teeth did not contact the sinus floor, the likelihood of root protrusion into the maxillary sinus increased with more posterior maxillary teeth and was more common in males than females.

Clinical significance: Understanding the anatomical relationship between posterior teeth and the maxillary sinus helps clinicians enhance preoperative planning and reduce potential complications.

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Introduction: Maxillary sinuses are crucial anatomical structures that serve several important functions.[1] The topography of the floor of the maxillary sinus exhibits considerable variation. With advancing age, the size of the maxillary sinus can change, and pneumatization, particularly noticeable in cases of chronic tooth loss, may occur. [2]

In approximately half of the population, the floor of the maxillary sinus extends between adjacent teeth or individual roots, resulting in elevations on the sinus surface known as "hillocks" or protrusions of root apices into the sinus cavity.[3]

In dentistry, managing the anatomical proximity between the floor of the maxillary sinus (MSF) and maxillary posterior teeth during endodontic treatment, extraction, and implant placement is consistently challenging. Infection can spread from the periapical region to the maxillary sinus, often as a result of inadvertent perforation, leading to sinusitis.[4]

Conventional 2-dimensional radiography techniques such as intraoral periapical radiographs and panoramic radiographs, along with advanced 3-dimensional imaging modalities like CT imaging and CBCT, are employed in dental diagnostics. CBCT is favored as a 3D imaging modality in the maxillofacial region due to its ability to capture volumetric anatomical structures with reduced radiation exposure, cost-effectiveness, and shorter acquisition times compared to CT. Therefore, this study aimed to evaluate the relationship between the maxillary sinus floor (MSF) and posterior maxillary teeth using CBCT.[4]

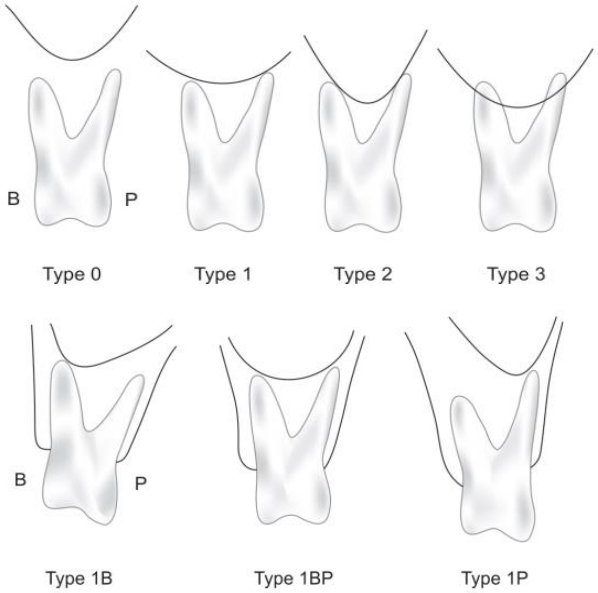
Material and method

In this randomized controlled trial study, the CBCT images presented in the Radiology department of Kothiwal Dental College and Research Centre was used. The study protocol was approved by the Institutional ethical committee and informed consent for willingness to participate in the study was obtained. Inclusion criteria was patients with no history of tooth extraction or surgeries involved sinus, orthodontic treatments including tooth movements or any other treatment intervention that affect morphologic situation of maxillary posterior region. Also patients should have no disease or pathologic condition involving the respected area. In order to be sure of the complete development of the maxillary sinus, patients older than 21-year-old were selected. It was attempted to include rather equal patients CBCT according to gender. A total 40 CBCT scans & 160 teeth was analysed, using CS8100 Carestream machine.

The relationship between MSF and roots of posterior teeth was classified into 4 types as given by Jung YH and Cho BH in 2009.[5] Type 0 - the MSF was located above the root tip, Type 1 - The root apex touched the sinus floor, Type 2- The MSF was interposed between the roots, Type 3 - Apical protrusion was observed over the MSF. Type 1 and Type 3 were further divided into Type 1B where buccal root touched the MSF, Type 1BP where buccal and palatal roots touched the MSF, Type 1P where palatal root touched the MSF, Type 3B where buccal root projected into the sinus cavity, Type 3BP where buccal and palatal roots projected into the sinus cavity, Type 3P where palatal root project into the sinus cavity.[5] (as shown in the figure that follows)

The thickness of buccal cortical plate was classified according to Kayleigh ET et al into: absence of the buccal plate (0mm), thick (>1mm) and thin (<1mm) bone.[6]

The vertical measurement from the furcation of maxillary molars to the maxillary sinus wall was categorized into two groups based on Katti et al. in 2020: below 5 mm and beyond 5 mm.[7]



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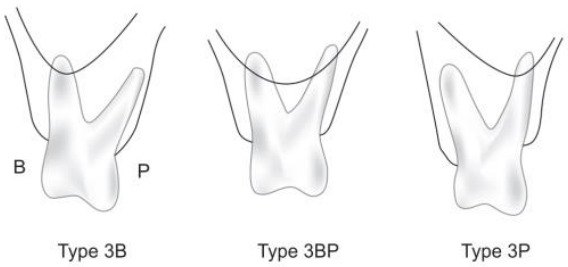


Fig 1: showing relationship between Maxillary sinus floor and roots of posterior teeth which was classified into 4 types as given by Jung YH and Cho BH in 2009.[5]

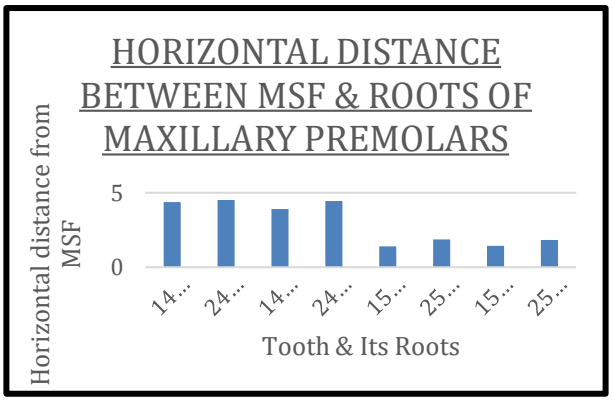
Result

40 CBCT scans for patients with mean age of 26 ± 9.7 year (21-40 years) were analyzed to study the relationship between the MSF and the root apices of the maxillary posterior teeth. Among those, 95.6% of participants were less than 30 years; 4.4% were more than 30 years. A total of 160 teeth (40 first premolars, 40 second premolars, 40 first molars and 40 second molars were recorded were evaluated.

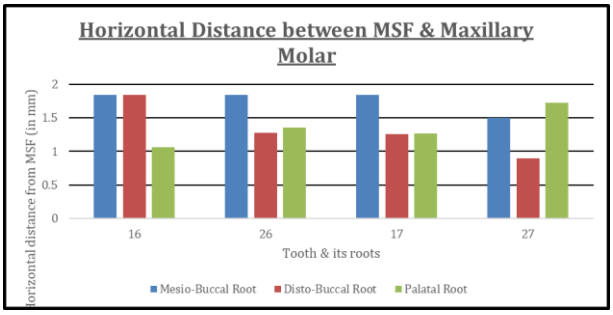
By analyzing the classification of the vertical relationship for each tooth, it was observed that Type 0 was most commonly seen in the maxillary first and second premolars (mean value 3.56mm) in which the MSF was located above the root tip [Graph 1].

Whereas, Type III was more often found in the first and second molars (mean value 1.45 mm) in which apical protrusion is seen over the MSF [Graph 2].

The minimum vertical distance recorded between the maxillary posterior root apices to the MSF was 0.0 mm in the age group of 31-40 while the longest vertical distance recorded was 14.9 mm in the age group of 21-30. Thus, it was found that the distance between the root apices and the MSF increases with the age in all roots of posterior teeth and there was significant difference among different age groups (P<0.05) [Table 1]. The mean horizontal distance between MSF and root apices of posterior teeth in males and females reported that the protrusion of teeth roots into maxillary sinus is more common in male than females.



Graph 1 - Shows the mean horizontal distance between MSF and buccal/palatal roots of maxillary first/second premolars on right/left side



Graph 2 - shows the horizontal distance between MSF and the roots of maxillary molar bilaterally.

Table 1: The horizontal relationship between the maxillary posterior teeth and the MSF according to gender

	Type 0		Type 1		Type 2		Type 3		Total
	N	%	N	%	N	%	N	%	N
Males	12	52.5	17	42.5	2	5	9	2.2	40
Females	33	41.2	29	36.2	4	2	14	17.5	80
Total	45	93.7	46	78.7	6	7	23	19.7	120
p-value	0.003								

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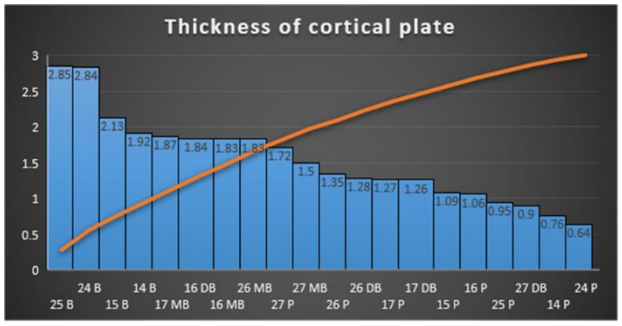
The vertical distance from the floor of the maxillary sinus to the furcation of maxillary molars having less than 5mm with Mean ± SD as 4.6 ± 1.14 and rest had more than 5mm with Mean ± SD as 5.3 ± 2.63, and it could be seen that the furcation to sinus distance is more than 5 mm makes them easy to be replaced by immediate implant loading in cases of extractions. Whereas, the maxillary left sided premolars showed a high prevalence of thick buccal plate as compare to right sided premolars [Graph 4].



Discussion

In the present CBCT study we assessed the relation between the root apices of posterior maxillary teeth and the maxillary sinus floor and also measured the thickness of buccal cortical plate and the vertical distance from the furcation of maxillary molars to the maxillary sinus wall, in order to avoid the problems that may occur during and after dental treatments.

There have been numerous reported instances indicating potential risks when teeth roots extend into the maxillary sinus.[8]

Research has demonstrated that traditional periapical radiographs may not reliably predict the risk of maxillary sinus perforation during periapical surgery on posterior maxillary teeth.[9] It is crucial to accurately assess the proximity of teeth roots to the maxillary sinus floor before undertaking any periodontal surgery or fixed prosthetic procedures.[10] Hence, in such situations, preoperative CBCT (cone beam computed tomography) is strongly recommended.[9] Huang and Brunsvold et al. documented a case where periodontal treatment of a first molar with deep pockets and bone defects resulted in maxillary sinusitis.[11]

In a study conducted by Freisfeld et al., comparing panoramic radiography and CT images of 30 patients, the disparity in measurements between panoramic and CT scans was statistically significant. Based on their findings, the authors concluded that the prevalence of premolar root protrusion into the maxillary sinus follows this order: highest in the maxillary right second premolar, followed by the maxillary left second premolar, then the maxillary right first premolar, and least common in the maxillary left first premolar, consistent with our observations. [12]

In Jung et al.'s 2012 study, which used CBCT to assess the relationship between the roots of 332 molar teeth and the maxillary sinus, they found that the buccal root exhibited the greatest extent of protrusion into the sinus.[5] In the present study, the relation of molar teeth with the maxillary sinus showed that the chances of root tip protruding into the maxillary sinus were highest for DB root of left sided 2nd molar, followed by the palatal root of right sided 1st molar. This difference may be due to the growth pattern discrepancy in male and female, and the fact that roots in male teeth are longer than that in females.

In Bassam et al.'s 2010 study, they analysed and compared the protrusion of teeth roots into the maxillary sinus using periapical radiographs, panoramic radiographs, and CBCT scans, the authors concluded that the maxillary first premolar did not protrude into the sinus, while maxillary molar teeth were most frequently observed to protrude into the sinus.[13] This study results the same, as our study stated that, type 0 was most common class among maxillary first and second premolars while type 3 was the most common variant seen in the 1st and 2nd molars.

In a study conducted by Pagin et al. in 2013, assessing the relationship between posterior teeth roots and the MSF using CBCT scans in a Brazilian population, they concluded that 21.6% of roots did not exhibit close proximity to the maxillary sinus floor, whereas penetration into the sinus was observed in 14.3% of cases.[14] The findings of this study match with our results as our study stated that most of the roots (45.8%) did not have proximity with the sinus. Also , the least frequent variant was type 2, while in this study, type 3 had the less frequency.

In studies conducted by Shokri et al. and Hussein Z et al. in the Iranian population, it was also noted that males exhibit a higher susceptibility to root protrusion into the

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sinus compared to females.[15] This study results the same, as our study stated, that the occurrence of root protrusion into maxillary sinus is more likely in males as compared to females and it should be taken into consideration during dental practices. These differences in values may be attributed to the distinct growth patterns between males and females. It is well-established that males typically have longer overall tooth length and root length compared to females. [16]

In the study by Ariji et al. in 1992, it was demonstrated that the distance between the root apices and the maxillary sinus floor increases with age across all roots of posterior teeth.[12] The present study, also reported the same result that the distance between the root apices and the MSF increase with the age in all roots of posterior teeth and there was significant difference among different age groups.

Our study revealed a higher prevalence of thick buccal plates in maxillary left-sided premolars compared to right-sided premolars, consistent with findings from Fayed et al.[17]

In the present study, it could be seen that the distance between furcation to MSF is more than 5 mm for a majority (75%) of the teeth with the mean value of 5.3 ± 2. 63mm. According to Didilescu et al., in their 2012 study, they found that a distance greater than 5 mm between the furcation and the sinus floor is required for safe immediate implant placement without the risk of perforation into the sinus.[18]

As indicated by the findings, CBCT effectively depicts the relationship between the roots of posterior teeth and the MSF. Therefore, utilizing CBCT analysis is strongly recommended as a critical tool for assessing the positioning of maxillary premolars and molars in relation to adjacent structures before dental procedures, aiming to prevent complications in post-procedural outcomes.

Conclusion

This study revealed that while the majority of teeth did not contact the sinus floor, there was an increased likelihood of root protrusion into the maxillary sinus with more posterior maxillary teeth. Also showed that the buccal root of the right sided maxillary second premolar is closest to the sinus floor and the palatal root of the same tooth is farthest from the sinus floor. It also confirmed that protrusion of teeth roots into the maxillary sinus is more common in male than female. The prevalence of thick buccal cortical plate was highest in maxillary premolars.

Clinical significance:

Knowing the anatomical relation between the posterior teeth and the maxillary sinus, helps the clinician in better preoperative treatment planning of the posterior maxillary teeth and avoid problems that may occur during further interventions.

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