

Comparison between the Maxillary Molar Roots with Maxillary Sinus in High-Resolution Cone Beam Computed Tomography

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Abstract

Background: The maxillary sinus, the most extensive paranasal sinuses, is located within the maxilla and is closely associated with the posterior maxillary teeth and Cone Beam Computed Tomography (CBCT) has emerged as a valuable diagnostic tool in dental practice.

Objective: To investigate the relationship of maxillary sinus and the mesiobuccal root of the maxillary first molar using high-resolution cone beam computed tomography.

Methods: This cross sectional study was conducted at the Department of Periodontology, Altamash Institute of Dental Medicine, Karachi from September 2023 to August 2024. In this study distance from the floor of the maxillary sinus to the mesiobuccal root of the maxillary 1st molar was measured by marking the apex of the root and the maxillary sinus floor, with the software automatically calculating the distance in millimeters and recorded. The mesiobuccal root was specifically selected for measurement as it is maximum distance from the sinus, and its proximity to the sinus indicates that the other roots are already located within the sinus.

Results: The mean age of our study patients was 42.71±6.81 years. There were 47 (37.3%) patients ≤40 years, and 79 (62.7%) patients >40 years of age. There were 71 (56.3%) males and 55 (43.7%) females. The average right and left side measurements were -0.73±0.53 mm and -0.84±0.23 mm, respectively ($p=0.287$).

Conclusion: The study demonstrates that in healthy dental patients, the mesiobuccal root of 1st molar is in close proximity to floor of maxillary sinus, with nearly direct contact.

Key words: Maxillary molar roots, CBCT, maxillary sinus, dental implant.

Introduction

It's important in dentistry and oral surgery that the maxillary sinus and roots of 1st molar are strongly closed with each other.^{1,2} The maxillary sinus, the most extensive paranasal sinuses, is located within the maxilla and is closely associated with the posterior maxillary teeth, particularly the

first molar.^{3,4} Understanding this relationship is important in which planning for treatment like extractions, implant placements, and root canal procedures are practiced. Due to variations of the maxillary sinus to the roots of 1st molar may cause complications such as sinus perforation, sinusitis, or oroantral communication, underscoring the need for accurate assessment before dental interventions.⁵

No doubt, Cone Beam Computed Tomography (CBCT) is known as an important diagnostic tool of dental practice in the whole world, offering detailed three-dimensional imaging of maxillofacial region.⁶ Another hand traditional radiography, CBCT provides precise visualization of the regional relationship with anatomical structures, including the roots of teeth and maxillary sinus.⁷ This capability allows clinicians to evaluate the root morphology and proximity to the sinus floor as well as potential anatomical variations with high accuracy, thereby enhancing treatment planning and minimizing risks.⁸

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Authors Contribution

SA & ZAK conceptualized the project. ZHC & MA did the data collection. FQ & MK did the literature search and performed the statistical analysis. Drafting, revision & writing of manuscript were done by SA, ZAK & MK.

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The maxillary first molar is particularly interesting due to its anatomical and functional significance. The roots of this tooth often extend toward the sinus floor, with variations influenced by factors such as age, gender, and individual anatomy.⁹ Studies have shown that the proximity of the sinus to the molar roots can vary between individuals, populations, and even between both sides (i.e., right and left) of the same individual.^{10,11} However, there remains a need for region-specific data to inform clinical practices, particularly in populations where such relationships may not have been thoroughly studied.

Dentists must have sufficient knowledge regarding the root apices, maxillary sinus and proximity of roots to identify the complications of sinus perforations and their treatment plans.¹² However, routine periapical and panoramic radiographs are not helpful, and they are not practical diagnostic tools for determining the association between root and maxillary sinuses due to overlapping sinus views. Literature proved that the CBCT is an essential and reliable aid.¹³

The present study was aimed at evaluating the association between roots of Maxillary 1st molar and maxillary sinus by using CBCT in a defined population. By analyzing root length, proximity to the sinus floor, and anatomical variations, the study seeks insights that can aid in improvement of outcomes and clinical decision-making. The findings will contribute to update the knowledge on maxillofacial anatomy and its implications for dental practice, particularly in preventing and managing related complications.

Methods

This cross sectional study was conducted at Department of Periodontology, Altamash Institute of Dental Medicine, Karachi from September 2023 to August 2024. Patients requiring CBCT imaging for dental evaluation were recruited. Study was started after approval from hospital legal committee of ethical approvals. Sample size was calculated by using WHO software, using 80% power, CI; 95%, and anticipated population 10%. Patients of age 18 years or older with fully erupted maxillary molars, no prior surgical intervention in the maxillary sinus region, and no significant dental anomalies were included. Exclusion criteria included patients with systemic diseases affecting bone morphology, incomplete root formation, or artifacts affecting CBCT imaging quality.

CBCT scans were acquired using a standardized protocol, ensuring consistent patient positioning and imaging parameters. All images for

the study were acquired using a CBCT machine (NewTomVGI) at the oral & maxillofacial surgery department, Larkana, Sindh, Pakistan. The parameters of imaging studies were set to 10 mA and 110 kV, with an 18 seconds exposure time. The 15x15cm field view was set, and 250µm voxel size was adjusted. The built in software was used to analyze the images, to observe the cross-sectional area and record the association between anatomical structures. The distance was recorded in millimeters from floor of maxillary sinus to the mesiobuccal root of 1st molar by marking the apex of maxillary root and floor of sinus with automatically calculating software. The mesiobuccal root was specifically selected for measurement as it is maximum distance from the sinus, and its proximity to the sinus indicates that the other roots are already located within the sinus. Data were analyzed using descriptive and inferential statistics, with comparisons made between different molar types and chi-square was applied for categorical variables.

Results

A total of 126 CBCTs were performed in our study. There, 95 (75.4%) had the right side of the first molar, and 31 (24.6%) patients had the left side of the first molar (Figure). The average age of the patients was 42.71±6.81 years. There were 47 (37.3%) patients had ≤40 years, and 79 (62.7%) patients had >40 years of age. There were 71 (56.3%) males and 55 (43.7%) females. The average right and left side measurements were -0.73±0.53 mm and -0.84±0.23 mm, respectively. ($p=0.287$).

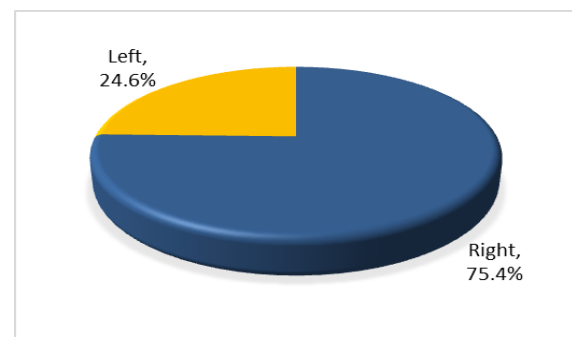


Figure: Side of first molar.

There was no statistically significant association between the side of first molar and age groups ($p=0.504$) and gender ($p=0.845$) (Table).

Table: Association of side of first molar with age and gender.

Variable	Side of First Molar		p-value
	Right	Left	
Age (years)			
≤40	37 (38.9)	10 (32.3)	0.504
>40	58 (61.1)	21 (67.7)	
Gender			
Male	54 (56.8)	17 (54.8)	0.845
Female	41 (43.2)	14 (45.2)	

Discussion

CBCT is ideal for implant and sinus lift surgeries due to its 3D imaging but is often unavailable in Pakistan due to economic constraints.¹⁴ Panoramic radiographs (OPG), commonly used, provide limited 2D data. Our study's measurements aim to offer average sinus relationships to aid treatment planning using OPG.

In present study the average measurement on the right side was -0.73 ± 0.53 mm, while the average on the left side was -0.84 ± 0.23 mm. The similar type of study was conducted by Mir et al¹⁵ in which the mean distance on the left side was reported to be -0.85 ± 2.56 mm, and on the right side, it was -0.74 ± 2.40 mm. However, our study results showed significant correlation between age and both sides (i.e., left and right) measurements as $p = 0.00$.

Ragucci et al¹⁶ and Al-Dajani et al¹⁷ emphasized the critical importance of being aware for proximity of maxillary sinus during the dental procedures. They noted that involvement of the sinus could lead to various complications, including treatment challenges like, sinusitis, implant failure and other related problems. Sinus perforation may necessitate an additional surgical procedure to repair the defect, which not only causes significant discomfort with pain but also extends the overall treatment duration for patients.

The study findings indicate that, in majority of cases, maxillary roots of posterior teeth are closed to the sinus of maxillary region. For instance, research by Orhan et al¹⁸ reported mean difference between posterior maxillary teeth and maxillary sinus floor distance was approximately 1.97 mm. Similarly, a study by Zhang et al,¹⁹ which focused on the Chinese population, reported that 62% maxillary roots of posterior teeth were closely linked with sinus. These findings underscore the anatomical relationship and the potential clinical implications for dental and maxillofacial procedures.

Themkumkwun et al²⁰ analyzed 354 roots with CBCT and found most common roots as molar

roots that were extending beyond the sinus floor. Motiwala et al²¹ conducted a study in Karachi found roots in the palate of maxillary 1st molar the closest root to the maxillary sinus, as they were showing distance of 1.48 ± 4.01 mm and showed significant variation, with the mesiobuccal root tip being 1.41 ± 2.31 mm away from the sinus floor in those under 30, and 2.85 ± 4.90 mm in those above 30. In this study negative sign in measurements showed maxillary roots of mesiobuccal were inside the maxillary sinus.

In this study, the evaluation of proximity between molar roots and maxillary sinus showed insignificant difference between genders. However, another study reported the sinus was more closed to the roots in male because the better root formation was seen in male only.²²

Sinus elevation procedures are performed when the sinus is in close proximity, with a higher risk of perforation. Various techniques and materials are used based on the case and dentist's preference, and precautions are essential to prevent sinus complications.²³

A limitation of this study was that the measurements were not correlated with the participants' history of respiratory diseases, which may influence sinus size. Furthermore, patients with sinus diseases (e.g., sinusitis, polyps) or periapical lesions were excluded, which might limit the understanding of pathological interactions.

Future studies should include a larger and more diverse population to validate findings and assess demographic variations, such as age, gender, and ethnicity. Additionally, comparative studies should be conducted to evaluate CBCT findings against other imaging modalities, such as MRI and conventional radiography, to determine the most accurate diagnostic tool.

Conclusion

The study demonstrates that mesiobuccal root of 1st molar is in close proximity to floor of maxillary sinus with nearly direct contact, in healthy dental patients. Further, findings indicate that first molar positioning does not significantly differ by side, age or gender in the studied population. The slight lingual inclination observed in molar position warrants further investigation to assess its clinical relevance. These results contribute to the understanding of molar anatomy and may aid in treatment planning for restorative, orthodontic and surgical interventions.

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Availability of Data: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval: The Research Ethics and Review Committee of Altamash Institute of Dental Medicine, Karachi approved the study via letter no. AIDM/ERC/08/2023/03.

Conflict of Interest: None declared

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