Relationship of Maxillary Sinus and Maxillary First Molar Root Using Cone Beam Computed Tomography

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A B S T R A C T

Background: Cone beam CT (CBCT) is an advancement of conventional CT that uses a divergent pyramidal or conical X-ray beam for imaging the craniofacial complex. Studies on the maxillary sinus and its relationship with the roots present within its close proximity are mostly based on computed tomography imaging and rarely being based on cone-beam computed tomography (CBCT). This study aims to determine the relationship of maxillary sinus and the mesiobuccal root of maxillary first molar using cone beam computed tomography (CBCT).

Methods: The study was conducted in Armed Forces Institute of Dentistry (AFID) from Sept, 2019 to Feb, 2020. 142 CBCTs were studied in the duration of six months. The distance between the maxillary mesiobuccal root and floor of maxillary sinus was measured using the built in software. The data collected was analyzed using SPSS 23. p-value of <0.005 was considered significant.

Results: The mean distance was -0.85 mm ± 2.56 on left side and -0.74mm ± 2.40 on right side. There was no significant difference between left and right side. The correlation between age and left and right-side measurements was statistically significant, p-value 0.000.

Conclusion: The relationship of maxillary sinus and the mesiobuccal root of maxillary first molar is significant. The study shows that in dentate healthy patients, the maxillary mesiobuccal molar root is nearly in contact with the sinus floor. These findings lead to the conclusion that performing surgical procedures in maxillary molar region may invariably lead to sinus perforation if one is not care full.

Key words: Cone beam computerized tomography, Dental implant, Maxillary sinus, Molar

Introduction

Maxillary sinus is one of the four pairs of paranasal sinuses, the other three being ethmoidal, sphenoidal and frontal. Maxillary sinus is mucosa-lined, air filled spaces situated in the maxillofacial area, also communicating with the nasal cavity.[1] Maxillary sinus is small in size at birth, and the size gradually increases with age. The growth of Maxillary sinus continues until the twenties in females and thirties in males.[2] The anatomical relationship between maxillary posterior teeth and maxillary sinus affects endodontics and surgical removal of posterior teeth. The roots and roots apices of maxillary molars may extend into maxillary sinus.[3] There is a risk factor for maxillary sinusitis and spread of odontogenic infections due to close relation of maxillary posterior root to maxillary sinus.[4] It also affects orthodontic tooth movement. During orthodontic treatment, if the root protrudes into the sinus it can result in tipping and apical root resorption during movement of teeth horizontally across the maxillary sinus floor.[5] There is also a risk factor for oroantral communication due to this close proximity.[6]

A clinician must have an adequate knowledge regarding proximity of roots and root apices to maxillary sinus, only then he can recognize the risk of sinus perforation and manage it accordingly.[7] However, use of routine dental radiographs such as panoramic radiographs and periapical radiographs is not very helpful in determining the relationship between maxillary sinus and root, mainly because of overlapping images and incomplete visualization of maxillary sinus. Cone-beam computed tomography (CBCT) is a valuable diagnostic aid in this regard.[8,9]

The aim of our study was to assess the relationship between the mesio-buccal root of maxillary first molar and the maxillary sinus using CBCT in Pakistani population. This study will assist the dental practitioners who are performing procedures in rural areas without the aid of proper radiographic equipment.

Methodology

This cross-sectional descriptive study with non-probability consecutive sampling technique was performed in Armed Forces Institute of Dentistry. The duration of the study was 06 months from Sept, 2019 to Feb, 2020. 142 CBCTs were performed during this duration. The sample size was calculated using WHO calculator. The parameters used for sample size calculation were: Confidence interval: 95%, anticipated population proportion: 10%, absolute Precision required: 5%. Although CBCTs were not done for the purpose of this study, however the areas of interest for this study were present in the scan. The inclusion criteria were all patients above the age of eighteen years and bilateral presence of teeth from canine to first molar in maxillary arch. Patients with history of orthodontics treatment, fracture and periapical radiolucency in premolar/molar region were excluded. Approval from ethical committee was taken prior to started this study.

All images were taken with a NewTom VGi CBCT machine (QR s.r.l, Italy) in Armed Forces Institute of Dentistry, Rawalpindi, Pakistan. Image parameters were set to 110kV and 10 mA, and an exposure time of 18s. Field of view was 15x15 cm and 250μm voxel size. The images were studied using the built in software (NNT Viewer). The cross-section area of interest was observed and relationship was recorded. The distance between the floor of maxillary sinus and the mesio buccal root of maxillary first molar was measured by marking the tip of the root and the floor of the maxillary sinus. The software automatically measured the distance in millimeters. The measurement was then recorded. (Figure 1) The mesio buccal root was selected as it is the farthest from the sinus and its

approximation to the sinus means that the other roots are already within the sinus.
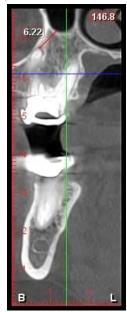

Figure 1: Image of the measurement using the built in software.

Mean and standard deviations were calculated for age and distance between the maxillary mesio buccal root and maxillary sinus. Frequency was calculated for gender. t-test and Chi Square test was used to compare the distance between left and right side, and with age and gender. The data was analyzed using SPSS 23.

Results

A total of 142 CBCTs were studied. As there is one first molar per side so there were 142 first molars on right side and 142 molars on left side. Mean standard deviation and standard error of mean of the age was 40.38 ± 17.90, 1.50.

Table I shows the distribution of gender in the sample and the values of measurements of left and right side. The relationship of age with the distance between maxillary sinus and the mesiobuccal root of maxillary first molar was calculated by using t-test as shown in Table II. Chi square test was used to relate gender with measurements of left and right side.

The result was non-significant with p-values of 0.676 and 0.300 respectively.

Measurements of left side and right side were compared with each other and non-significant relation was found (p-value 0.168).

Table I Gender Distribution		
Gender Distribution %(n)		
Male	**Female**	**Total**
58.5% (n=83)	41.5% (n=59)	100% (n=142)
Measurements (mm, SD, SE Mean)		
	Left	Right
Mean	-0.85	-0.74
SD	2.56	2.40
SE Mean	0.24	0.22

Table II Relationship of age with the distance between maxillary sinus and the mesiobuccal root of maxillary first molar					
		Mean	**SD**	**SE Mean**	**p-value**
Pair 1	Age in Years	37.26	16.97	1.57	0.000
	Distance Left Side	-0.85	2.56	0.24	
Pair 2	Age in Years	26.45	16.43	1.53	0.000
	Distance Right Side	-0.74	2.40	0.22	

Discussion

The study documents the relationship of maxillary first molar mesiobuccal root tip with maxillary sinus. Mesiobuccal root is farthest away from the sinus. In case the roots of maxillary first molar are in close

proximity of the maxillary sinus, it signifies that the roots of other posterior teeth are also in near or even within the sinus.

CBCT is the recommended radiograph for implant and sinus lifting surgeries as it provides a three-dimensional picture of the region.[10] Unfortunately, due to economic conditions of Pakistan CBCT is not available everywhere. At best, Panoramic radiograph (OPG) is available. This provides a 2D picture which does not provide enough data. The measurements in our study will provide average readings of the relationship with the sinus which can be used in conjunction with OPG for implant and sinus surgery treatment planning.

It is very important to be aware of sinus proximity. Involvement of sinus can cause complications in the treatment, failure of implant, sinusitis and other problems.[11,12] Perforation of sinus may require another surgical procedure for its repair causing pain and discomfort to the patient and prolonging the treatment time.

Our study shows that the majority of the cases the roots of maxillary posterior teeth are in close proximity of the sinus. The mean distance between the maxillary posterior teeth and the maxillary sinus floor was found to be 1.97 mm by Orhan K.[13] Another study done in Chinese population showed that 62% of the roots were in close proximity with sinus.[14] Motiwala M A found that the closest root to maxillary sinus was palatal root of maxillary first molar with a mean distance of 1.48 ± 4.01mm.[15] Themkumkwun et al. analyzed CBCT images of 354 roots and concluded that molar roots extending beyond the sinus floor was most common.[16] In another study conducted on Pakistani population showed great variation. A study conducted in Karachi showed that the mesio buccal root tip was away from the sinus floor with the mean of 1.41 ± 2.31 mm in below 30 years of age group and 2.85 ± 4.90mm in above 30 years of age group. Whereas our study showed that the maxillary mesiobuccal

roots were within the maxillary sinus as designated by the negative sign.[17]

In our study evaluation of proximity in both males and females show that there is no significant difference, but Von Arx et al found that the sinus was closer to the roots in men than women. This was due to better root formation and longer roots in men. Another reason to this is that the sinus is larger and broader in males as compared to females.[18]

The proximity increases with age. This is due to pneumatization of the sinus with age as well as extraction of teeth creates space for the sinus to expand. There is an increased risk of sinus involvement during various procedures of the oral cavity as the patient gets older the patient. This was shown in the study by Von Arx when he measured the distance of premolar roots with maxillary sinus.[18] Due to close proximity, there is a chance of sinus membrane perforation which may cause infection and ultimately failure of the procedure.[19] Regarding sinus membrane perforation, a perforation rate of 4% correlated with the surgical instrumentation alone, 12% linked to the graft insertion procedure, and 24% associated with the implant placement was found.[20] So it's very important to know the position of sinus before performing surgical procedures in maxillary posterior region.

Sinus elevation procedures may be performed if there is close proximity of sinus and sinus perforation risk is higher. There are multiple techniques and materials that can be employed depending on the case and dentist's preference.[21] In any case, one has to take some kind of precautionary step to avoid sinus complications.

Limitation of this study was that the measurements were not correlated with history of respiratory diseases as they have an effect on the size of the sinuses.

Conclusion

The relationship of maxillary sinus and the mesiobuccal root of maxillary first molar is significant. The study shows that in dentate healthy patients, the maxillary mesiobuccal molar root is nearly in contact with the sinus floor. These findings lead to the conclusion that performing surgical procedures in maxillary molar region may invariably lead to sinus perforation if one is not care full.

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