Assessment of the relationship between roots of maxillary first molar to the floor of the maxillary sinus on cone beam computed tomography

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Abstract

Background: The thickness of maxillary sinus floor may reduce markedly because of protrusion of root apices of posterior teeth into the sinus. The possibility of oro-antral communication after extraction is highest for a maxillary first molar, as this tooth erupts first and is frequently extracted early.

Aim: To assess the relationships between the roots of the maxillary first molar and the maxillary sinus floor.

Materials and Methods: This is a retrospective study in which 29 cone-beam computed tomography scans of maxillary first molar and floor of the maxillary sinus was obtained. The relationship between maxillary first molar teeth and the maxillary sinus floor was analyzed and among three roots which are most likely to be closest assessed. A t-test was used to compare measurements between female and male patients. ANOVA with Tukey test was used to compare between age groups.

Results: Totally, 21 (72.41%) mesiobuccal roots, 18 (62.06%) distobuccal roots, and 14 (48.27%) palatal roots showed a Class 1 relationship. Of 8 cases 2 (37.5%) cases which belonged to Class 0 had protrusion of root into the sinus.

Conclusion: Any suspected periapical pathologies of maxillary molars needs thorough three-dimensional radiographic assessment to understand the approximation of the maxillary sinus.

Clinical Significance: In our study, Class 0 relationship was the highest for palatal root. Most of the root apices had Class 1 relationship with the floor of the sinus. Hence, one should keep this in mind while conducting periapical or pre-prosthetic surgical procedure in the maxillary posterior region to prevent complications.

Keywords
Cone-beam computed tomography, maxillary sinus, three-dimensional imaging

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Introduction

The maxillary sinus is the first paranasal sinus to develop and ends its growth at approximately 20 years of age with the eruption of the third molars.[1] The extension of the adult maxillary sinus is variable. The floor of the maxillary sinus creates elevations in the antral surface, if it extends between roots of adjacent teeth, which are commonly referred as “hillocks.”[2] The age of an individual, presence or absence of teeth and pneumatization of the maxillary sinus contributes to variation in the topography of the inferior wall of the maxillary sinus.³ It is essential to assess the proximity of the roots of the maxillary posterior teeth to the maxillary sinus floor before planning any periapical surgical treatment for maxillary posterior teeth. If the root apices of the maxillary posterior teeth protrude into the maxillary sinus, the thickness of the floor of the maxillary sinus markedly reduces. After extraction, some complications such as oro-antral fistulae or root displacement, most commonly for the maxillary first and second molars may occur. As the first maxillary molar is the first permanent tooth to erupt and is frequently prematurely extracted, the possibility of oro-antral communication after extraction is higher.[3] The roots of first and second molar and the floor of maxillary sinus have a close relationship to each
Materials and Methods

The study was approved by the Institutional Ethics Committee. This was a retrospective study in which CBCT scans obtained with Planmeca Promax three-dimensional (3D) Max, CBCT unit and Kodak CBCT 9300 unit were retrieved from radiology archives. CS 3D imaging software which included CBCT scan volume of 200 μm × 200 μm × 200 μm and Planmeca Romexis software with image size 291 × 291 × 291 and voxel size 200 μm were used for the analysis. 29 CBCT scans which included the floor of the maxillary sinus and maxillary first molar without any periapical pathologies were included in our study.

The vertical relationship between apices of 29 maxillary first molar teeth to the maxillary sinus floor was assessed by measuring the shortest distance between two. The distances between the roots of maxillary first molar (mesiobuccal, distobuccal, and palatal) and the sinus floor were measured in the coronal section and grouped according to classification given by Didilescu et al. Class 0: distance (d) = 0 mm; Class 1: 0 mm < d < 2 mm; Class 2: 2 mm ≤ d < 4 mm; Class 3: 4 mm ≤ d < 6 mm; Class 4: 6 mm ≤ d.[3]

Statistical analysis

The mean distance from mesiobuccal, distobuccal, and palatal root to the maxillary sinus floor between groups was compared by ANOVA with Tukey test. The measurements were compared between males and females using the t-test. P < 0.05 was considered as statistically significant.

Results

CBCT scans of 29 maxillary first molars were included in our study, among which for five CBCT scans patients details on age was not available. Hence, 24 scans were included for assessing age-related changes.

Of 24 CBCT scans, 12 were of males and 12 were of females. The age of the subjects ranged from 14 to 52 years with mean age of 27.3 years. Most subjects, 10 in number (41.7%) belonged to age group 20-29 years. The mean distance of maxillary sinus floor to the mesiobuccal root was 1.6410 mm; to that of distobuccal root was 1.5469 mm, and to that of the palatal root was 1.1855 mm. In most of the cases the relationship of tip of three roots to the sinus floor belonged to Class 1 group according to classification given by Didilescu et al. 21 (72.41%) mesiobuccal roots, 18 (62.06%) distobuccal roots, and 14 (48.27%) palatal roots showed a Class I relationship [Table 1].

The mean distance for mesiobuccal, distobuccal, and palatal root to the maxillary sinus floor was highest for the age group of 40-49 years, which was statistically significant (ANOVA test). There was no statistical significant age-related difference among other age groups.

Discussion

This study was conducted to assess the anatomical relationship of roots of maxillary first molar to the floor of the maxillary sinus. The influence of the age of the distance between root apices and floor of the maxillary sinus is also evaluated. There is a close relation of the maxillary sinus floor to the root apices of maxillary first and second molars in most cases, whereas in some cases the apices of these teeth protrude into the sinus.[4] The floor of the maxillary sinus extending between the roots of molar teeth leads to a marked reduction in the thickness of the sinus floor. The most of the roots that protrude radiographically into the sinus are actually enveloped by a thin cortical layer with perforations in 14-28% of the cases when viewed under histological sections.[4] The age of an individual, pneumatization of the maxillary sinus, and presence or absence of teeth contributes to variation in the topography of the inferior wall of the maxillary sinus.[4] Before conducting surgical procedures such as pre-prosthetic and preimplant surgeries on the maxillary posterior region, a clinician must be aware of the relation between teeth roots and the sinus floor. This is because of the high-risk of pneumatization of maxillary sinus after extraction of maxillary posterior teeth causing a reduction in the amount of available bone for implant/denture placement. Any endodontic surgery of maxillary posterior teeth can result in accidental oroantral communication leading to the passage of bacteria from periapical tissue causing acute or chronic sinusitis.[2] Different radiographic techniques can be used to assess the relationship between the roots of maxillary teeth and sinus such as two-dimensional (2D) intraoral periapical radiographs and orthopantomograms and 3D CBCT. 2D radiographs have the main disadvantage of superimposition of anatomic structures and also the horizontal and vertical magnification of up to 33% and a lack of cross-sectional information.[1] 2D radiographs produced superimposition artifacts frequently resulting in over
projection of roots of maxillary posterior teeth into the sinus floor.\textsuperscript{[5]} Among the recent radiographic techniques, CBCT is appropriate to evaluate the integrity of the floor of the sinus after extraction of the tooth.\textsuperscript{[5]} Any suspected periapical pathologies of maxillary molars need thorough 3D radiographic assessment to understand the approximation of the maxillary sinus. Sharan and Madjar reported that only 39% showed root protrusion into the sinus in the CT images which showed root projecting into the sinus when examined in panoramic radiographs. The panoramic radiographs consistently showed a 2.1 times longer projection of the roots of posterior teeth into the maxillary sinus when compared to that on CT.\textsuperscript{[1]}

Hassan found that neither periapical radiographs nor panoramic radiographs were reliable to determine the exact relationship between the floor of the maxillary sinus and the roots of the maxillary posterior teeth. He also concluded that periapical radiology was more reliable to assess this relationship than panoramic radiography.\textsuperscript{[5]}

Kilic \textit{et al}. reported that the root tip of the maxillary first premolar had the longest distance from sinus floor and the second molar bucco-distal root tip had the shortest distance for both left and right side.\textsuperscript{[2]} Ali \textit{et al}. concluded from their study that roots protruding into the sinus in CT showed shorter projection length when compared to panoramic radiography. The 2D panoramic image is sufficient to provide information to the clinician about the true relationship between the teeth roots and the sinus. However, when additional information is required when panoramic radiographs show root protrusion into the sinus, CT should be advised.\textsuperscript{[4]} Jung and Cho reported that among maxillary molars the frequency of root protrusion into the sinus was more common for the buccal roots. They also found that the mesiobuccal root of the maxillary second molar was in close proximity to the floor of the maxillary sinus.\textsuperscript{[6]} Didilescu \textit{et al}. reported that in the maxillary first molar, the palatal root was the closest to the sinus floor. Earlier Freisfeld \textit{et al}. suggested three types of vertical relationship, whereas few others suggested five vertical classifications. Based on the thickness of the bony plate, authors have suggested a new classification in 2012, which helped to assess furcation relation also. They classified the relationship of root apex of the maxillary first molar to the maxillary sinus floor as: Class 0: Distance (d) = 0 mm; Class 1: Between 0 and 2 mm; Class 2: Between 2 and 4 mm; Class 3: Between 4 and 6 mm; Class 4: More than 6 mm. In their study, the palatal root had the highest prevalence of Class 0 (44.33%), followed by mesiobuccal root (40.21%) and distobuccal root (38.14%).\textsuperscript{[5]} A search of literature in search engines Google and PubMed using keywords ”Relationship of maxillary first molar to maxillary sinus in Indian population” and ”proximity of maxillary first molar to maxillary sinus in Indian population” did not reveal any previous studies in Indian population. In this study, in most of the cases, the relationship of tip of three roots to the sinus floor belonged to Class 1 group; 21 (72.41%), 18 (62.06%), and 14 (48.27%) cases for mesiobuccal, distobuccal, and palatal root, respectively [Table 1 and Figures 1-5]. The prevalence for Class 0 relation was highest for the palatal root seen in 8 (27.58%) cases. Of 8 cases 2 (37.5%) cases had protrusion of root into the sinus. There was statistically significant the highest mean distance observed for mesiobuccal, distobuccal, and palatal root to the sinus.
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maxillary sinus floor for the age group of 40-49 years. However, as the sample size was very small for this age group (two cases) it cannot be concluded as an age-related change. Although we found no other significant association of distance of maxillary molar root tips to the floor of the maxillary sinus, further studies are required to large sample to evaluate for age-related changes.

Conclusion

Multiple factors affect the distance between the root tips of maxillary molar and the maxillary sinus floor and each patient needs to be evaluated individually. As observed in our study, in most cases it can be expected that the distance is a Class 1 relation, that is, between 0 and 2 mm.

References
