

Proximity of Posterior Teeth to the Maxillary Sinus and Buccal Bone Thickness: A Biometric Assessment Using Cone-beam Computed Tomography

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Abstract

Introduction: The aims of this study were to evaluate the vertical and horizontal relationships between the maxillary sinus floor (MSF) and the root apices of maxillary posterior teeth with various root configurations and the distance from the root apex to the MSF and the buccal cortical plate. **Methods:** Serial axial, coronal, sagittal, and paraxial cone-beam computed tomographic images of 132 Korean patients with fully erupted bilateral maxillary posterior teeth were analyzed. The vertical and horizontal relationships between the roots of maxillary posterior teeth and the MSF were determined. Distances from the apex to the MSF and the buccal bone plate were measured. The data were correlated with age, sex, side, and tooth type. **Results:** In total, 2159 apices in 1056 teeth were evaluated. For the vertical relationships, the frequency in group 1, in which a root apex protruded into the MSF, significantly increased toward the posterior (first premolars: 1.5%, second premolars: 14.8%, first molars: 40.5%, second molars: 44.7%, $P < .001$). The apices of the mesiobuccal roots of the second molars were found frequently in group 1 (35.8%) and had the shortest mean vertical distance to the MSF (0.18 mm) and the thickest mean horizontal distance to the buccal cortical plate (4.99 mm) among buccal roots of 3-rooted molars ($P < .001$). The frequency of group 1 differed significantly by age ($P < .05$). No statistically significant difference was found in sex or side analysis. For the horizontal relationship between the molar roots and the MSF, most teeth were in group BP, in which the lowest point of the MSF was located centrally, relative to the roots (94.3% for first molars, 81.0% for second molars). For the first molars, no significant difference according to sex or side was found. However, the right side ($P = .003$) and males ($P = .005$) showed higher incidences for second molars. **Conclusions:** The data in this study highlight the close proximity between the root apex of maxillary posterior

teeth and the MSF and provide estimated distances from the root apex to the buccal cortical plate. Special care must be taken in treatment planning in the maxillary posterior region. (*J Endod* 2015;41:1839–1846)

Key Words

Buccal bone thickness, cone-beam computed tomography, Koreans, maxillary molars, maxillary premolars, maxillary sinus, root apex, sinus proximity

The maxillary sinus is an anatomic structure of primary concern during dental practice in the maxillary posterior region, especially in endodontic procedures, dental implantations, and extractions (1). The maxillary sinus floor (MSF) may extend between the roots, or sometimes the root apices of posterior maxillary teeth may penetrate into the sinus cavity (2). Because of the close proximity between the roots and the MSF, infection and sinusitis may result from the introduction of foreign bodies, such as endodontic instruments and root filling materials, into the sinus during root canal treatment (2–5).

In addition to close proximity to the MSF, buccal bone thickness may be a point of concern during surgical endodontic procedures of the maxillary posterior teeth because the operative access and the manipulation of surgical instruments are limited in a very confined space. The estimated distance from the apex to the buccal cortical plate may be useful information in treatment planning for apical surgery.

Conventional diagnostic aids, such as panoramic radiographs, should be used for careful planning and assessment of the close relationship between the root apex and the MSF. However, they may sometimes yield insufficient diagnostic information because they provide only 2-dimensional representations of a 3-dimensional (3D) structure (1, 6). Cone-beam computed tomographic (CBCT) imaging overcomes these limitations by providing precise 3D images and eliminating distortion and superimposition of anatomic structures with a reasonable radiation dose and cost. Many studies have suggested the benefits of CBCT analysis in investigating anatomic features associated with roots of maxillary posterior teeth (7–10). Although previous studies have evaluated the relationship between the maxillary teeth and the MSF (11), they focused on 3-rooted maxillary molars, and other possible root configurations were rarely taken into account. Additionally, few studies provided biometric measurements (7, 9, 10), and only 2 reported the horizontal relationship between the maxillary molar roots and the MSF (8, 12).

In this study, we included first premolars through to second molars and considered molars with various root configurations. Because a high incidence of anatomic variations other than 3-rooted teeth in maxillary molars was previously

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reported, providing relationships between those teeth and the MSF is useful for clinicians (13). To the best of our knowledge, this is the first study to evaluate biometric measurements of various root configurations other than 3-rooted molars. The aims of this study were to evaluate the vertical and horizontal relationships between the MSF and the root apices of maxillary posterior teeth with various root configurations and the distance from the root apex to the MSF and the buccal cortical plate.

Materials and Methods

Subjects

This study was approved by the ethics committee of Ewha Woman’s University Hospital, Seoul, Korea. CBCT images of the maxilla in a Korean population taken at Ewha Woman’s University Dental Hospital between March and November 2011 were evaluated retrospectively. The majority of the CBCT images were taken for the extraction of impacted teeth or orthodontic treatment. The criteria for taking CBCT images were insufficient information provided by conventional radiographs and the need for additional detailed radiographic information. This retrospective analysis of CBCT images required no additional radiation exposure to patients for the purposes of this study, so the as low as reasonably achievable (ALARA) principle was followed. The study subjects were selected according to the following criteria: patients had to be at least 21 years old, no cystic or traumatic lesion in the maxilla was present, and patients needed to have fully erupted bilateral maxillary first and second premolars and molars. Among the 500 CBCT scans, in total, 264 maxillary sinuses in 132 CBCT scans met the inclusion criteria. The study subjects were 66 men and 66 women whose ages ranged from 21–59 years (mean: 31 ± 9.01 years).

Radiographic Evaluation

The CBCT images were obtained using a Dinnova system (Willmed, Gwangmyeong, Korea). Operating parameters were 9.0 mA, 80 kVp, 10-cm scan field of view, and 0.167-mm voxel size. CBCT images were reconstructed using OnDemand3D software (Cybermed, Seoul, Korea). Reconstruction was performed according to the operating parameters, and the evaluation was done on a voxel size of 0.167 mm. Serial axial, coronal, sagittal, and paraxial images were examined by 2 endodontists. Also, 50 CBCT images were examined twice at an interval of 1 week, and the kappa values were analyzed to assess reliability between the examiners. The kappa values were 0.820 (intraobserver) and 0.763 (interobserver). After intra- and interobserver calibration, the study subjects were examined independently, and any disagreement was resolved by discussion between the 2 examiners.

The vertical relationships between the MSF and the root apices of maxillary premolars and molars were classified as follows: group 1, the root apex was protruding into the sinus cavity; group 2a, the root apex was in contact with the MSF with a small elevation (<0.1 mm) produced on the sinus floor; group 2b, the root apex was in close contact with the MSF; and group 3, the root apex was below the MSF (Fig. 1A–H). For groups 1 and 3, the shortest vertical distances from the root apices of posterior maxillary roots to the closest border of the MSF were measured. If the root apex extended above the sinus floor, a negative value was assigned.

The horizontal relationships between the MSF and the roots of maxillary molars were classified as follows: group B, the lowest point of the MSF was located more toward the buccal side than the buccal root; group BP, the lowest point of the MSF was located centrally, relative to the roots; and group P, the lowest point of the MSF was located more toward the palatal side than the palatal root (Fig. 2A–F).

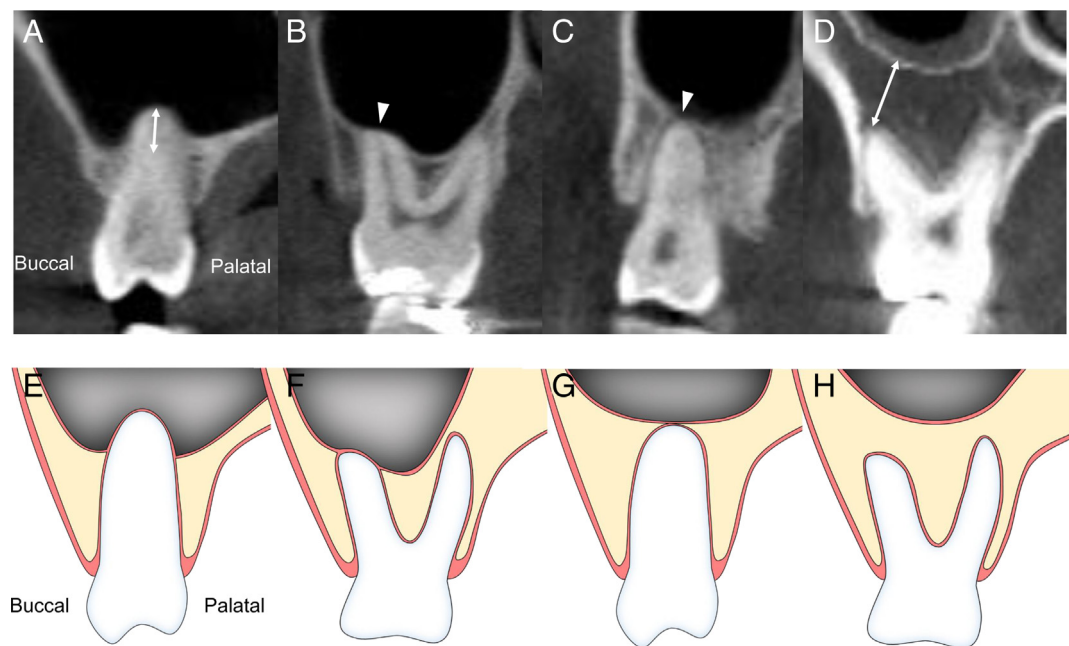


Figure 1. Maxillary CBCT images for the classification of the vertical relationship between the root apex of the maxillary posterior teeth and the MSF. (A) Group 1: the root apex protruded into the maxillary sinus, and the distance (arrow) from the root apex to the MSF was assigned a negative value. (B) Group 2a: the root apex was in contact with the MSF, producing a small elevation on the floor (arrowhead, a root in which the distance is 0). (C) Group 2b: the root apex was in close contact with the MSF (arrowhead, a root in which the distance is 0). (D) Group 3: the root apex was below the MSF, and a positive value was given for the distance (arrow) between the apex and the MSF. Schematic illustrations of the vertical classification for (E) group 1, (F) group 2a, (G) group 2b, and (H) group 3.

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