Cone-beam Computed Tomography: Anatomic Analysis of Maxillary Posterior Teeth—Impact on Endodontic Microsurgery

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Abstract

Introduction: It is imperative that the endodontic surgeon be knowledgeable of the anatomic dimensions of the surgical site. If cone-beam computed tomography is not available because of location/cost, it is prudent for the clinician to consult a knowledge base for the surgical site. An understanding of the root thickness of maxillary premolars and molars at the preferred level for root resection (3.0–3.6 mm), bone thickness over these roots, and the proximity of each root apex to the maxillary sinus will help the surgeon before and during the surgical procedure. Methods: Cone-beam computed tomography scans from 155 patients were used to evaluate measurements from 505 teeth and respective areas. Results: (1) Buccal bone was thinnest over the buccal root of the 2-rooted first premolar (0.66 mm) and the mesiobuccal (MB) root of the first molar (0.84 mm) and thickest over the MB root of the second molar (1.91 mm). (2) The palatal bone was thinnest over the palatal root of the maxillary first molar (1.24 mm) and thickest over the single-rooted second premolar (3.26 mm). (3) The longest distances to complete resection were found for the 2-rooted first and second premolars (8.81 mm and 9.14 mm, respectively) and the MB root of the second molar (7.40 mm). (4) The MB root of the second molar had the closest proximity to the sinus floor, with an average distance of 0.66 mm. Conclusions: An understanding of the maxillary posterior tooth anatomy for apical resection is beneficial to the endodontist. (J Endod 2016;42:890–895)

Key Words

CBCT, endodontic microsurgery, maxillary posterior teeth

Preservation of the dentition and maintenance of function are the dental profession’s ultimate goals. The trained practitioner should consider surgical endodontic therapy when more conservative treatments have not achieved complete healing or when nonsurgical techniques stand little chance of removing the etiology. Endodontic surgery has now evolved into endodontic microsurgery. By using state-of-the-art equipment, instruments, and materials that match biological concepts with clinical practice, microsurgical approaches produce predictable outcomes in the healing of lesions of endodontic origin (1).

Before surgery, it is imperative for the clinician to be familiar with the anatomic landmarks and structures adjacent to the surgery site as well as tooth dimensions and anatomy. The buccal and lingual bone thickness, the dimensions and inclination of roots, and the adjacent anatomic structures, especially nerve and sinus location, are all critical factors in planning and performing the osteotomy and the root-end resection/root-end filling procedure.

Radiographic information is often used as part of the surgical planning. Cone-beam computed tomography (CBCT) is one of the radiographic diagnostic tools that can help the practitioner obtain more accurate measurements for assessing the surgical site. CBCT allows for more accurate 3-dimensional reconstruction of the dentofacial structures in comparison with periapical and panoramic images, which can distort and magnify structures (2).

Previous studies have provided the endodontic surgeon with a knowledge base of the average anatomy of the maxillary premolar and molar regions. According to Kim et al (3), for most roots, a 3.0-mm resection eliminates 93% of apical ramifications and 98% of the lateral canals. However, DeGennaro and Bowles (4) examined the mesiobuccal (MB) roots of 153 first and second maxillary molars at ×8 magnification with a stereomicroscope after being embedded and sectioned at 1.0-mm thickness. Isthmus tissue increased greatly at 3.6 mm from the apex, suggesting optimal root resection at this level for the MB root.

Previous measurements of the thickness of buccal bone over the apices of the maxillary premolar teeth have found this dimension to average 1.63 mm over the first premolar and 3.16 mm over the second premolar (5). The thickness of the palatal plate over the palatal root of the first premolar has been reported to be 5.42 mm (5). In the maxillary molar region, Jin et al (6) studied a Chinese population by using CT images of 66 patients. In the maxillary molar buccal roots, the distances from the MB and distobuccal (DB) roots of the second molar to the buccal bone plate were the largest at 4.63 mm and 3.61 mm, respectively. In this study, the average thickness for palatal bone over the palatal at the level of the apex was found to be 3.15 mm for the first molar and 3.08 mm for the second molar (6).

There is a base of literature regarding the anatomy of the maxillary sinus and its proximity to root apices. Knowing the proximity of the root apices to the maxillary sinus is important for the endodontic surgeon to be able to recognize the risk of sinus perforation, provide adequate informed consent to the patient, and ultimately manage a sinus perforation if it should occur. According to Watzek et al (7), sinus perforation occurred in 28% of maxillary endodontic surgeries. In about 50% of the population, the sinus expands into the alveolar process, placing it in close relation to the roots of the
premolars and molars (8). In 1992, Eberhardt and Torabinejad (5) used CT images in vivo and in vitro to determine the distances between the apices of maxillary posterior teeth and the floor of the maxillary sinus as well as the thickness of the lateral bone covering these apices. There was no significant difference between in vivo and in vitro findings in their study. They reported that the apex of the MB root of maxillary second molar was closest to the sinus floor (mean, 1.97 mm) but farthest from the buccal bony surface (mean, 4.45 mm). The apex of the buccal root of the maxillary first premolar was closest to the buccal bony surface (mean, 1.63 mm) but farthest from the floor of the sinus (7.05 mm). On the basis of the thickness of bone, one could reason that the palatal roots of first and second molars should be approached from the palatal direction, whereas the maxillary root of first premolars should be approached from the buccal direction.

Although they provide useful information, some of these previous studies used older techniques such as tooth sectioning (4) or lower-resolution medical CT scans (5, 6), which may have introduced error. Furthermore, these studies did not include the measurement of root thicknesses in their methods. The combined dimensions of bone and root thickness along with root proximity to the maxillary sinus are important dimensions for the endodontic surgeon to understand. The objectives of this study were the following:

1. To measure the buccolingual (B-L) and mesiodistal (M-D) thickness of maxillary premolar and molar roots at the preferred level for root resection
2. To measure the buccal and palatal bone thickness at the optimal root resection level
3. To measure the distance to a complete root resection for each root (bone thickness plus root thickness)
4. To measure the proximity of each root apex to the maxillary sinus
5. To note whether sinus pathology or sinus thickening >3.0 mm was detected

**Materials and Methods**

The University's Institutional Review Board approved the present study. One hundred fifty-five CBCT scans that used the Next Generation i-CAT (Imaging Sciences, Hatfield, PA) were collected from the University's Oral and Maxillofacial Radiology. Twenty-two scans had a field of view (FOV) of 170 mm with 0.3-mm resolution, 34 had a FOV of 130 mm with 0.25-mm resolution, and 101 had a FOV of 60 mm with 0.2-mm resolution. The i-CAT Vision software was used to evaluate the maxillary premolars and molars and the adjacent anatomic structures. The scans were obtained from a database of images taken for diagnostic purposes or pre-surgical evaluation, which were unrelated to the present study.

Exclusion criteria for the study were the following:

1. More than 1 maxillary posterior tooth missing per side excluding third molars
2. Significant periodontal disease/bone loss
3. C-shape molar
4. Fused roots
5. Resorption of any maxillary tooth
6. Artifacts of any kind impeding identification of anatomic structures
7. Mixed or primary dentition

Patient, sex, date of birth, and date of the scan were recorded. Two examiners were calibrated for radiographic interpretation of the CBCT scans. To prevent eye fatigue, no more than 3 consecutive scans were completed by one examiner without a break period. The scans were viewed and evaluated on a Dell 24-inch non-glossy monitor with a Dell Optiplex 9010 WorkStation (Dell Inc, Round Rock, TX) by using the i-CAT Imaging System Software. The examiners had the ability to magnify the images and change the viewing settings such as density, contrast, and sharpness to enhance visibility and identification of the examined structures. Cross-sectional slices from the “implant screen” view mode were used to complete all the measurements at the radiographic apex of each maxillary first or second premolar or molar present, as well as the measurements of the maxillary sinus to apices. The software allowed recording of linear measurements of the CBCT slices, with a resolution range of 0.2–0.3 mm.

To perform the measurements at the optimal level of root-end resection from the apex, in the sagittal view, a line was drawn along the long axis of the root, extending from the radiographic apex to 3.6 mm for MB of first molar and 3.0 mm for the rest of the roots (Fig. 1). Because of limitations related to image resolution, when the line drawn from the apex could not be exactly 3.6 mm or 3.0 mm, the closest measurement was accepted. The range of the accepted measurements was between 3.0 mm and 3.9 mm. At this optimal resection level, M-D root thickness, B-L root thickness, buccal bone thickness (BT), and palatal bone thickness (PT) were measured in the axial view. For the root thickness, the largest M-D and B-L width was measured. BT was measured at the shortest distance between the outer surface of the buccal cortex (BC) to root surface (RS) on the buccal side of the root. PT was measured in the same manner at the palatal side of the root from the outer surface of the palatal cortex (PC) to the RS (Fig. 2). Because of low resolution of some of the scans when the buccal or palatal bone was too thin to be measured or the root appeared to be outside of the buccal or palatal plate, a measurement of 0 mm was recorded.

In the sagittal view, the closest distance from the each root apex to sinus was measured (Fig. 1). In this view, if sinus thickening greater than 3.0 mm or any kind of sinus abnormality such as mucus retention cyst polyp or obliteration was detected, it was also recorded but not specified. The root apices in proximity to the sinus pathology and the presence or absence of apical pathology related to these roots were also recorded.

**Figure 1.** Measurements in the sagittal view. Red line is the line drawn along the long axis of the tooth, extending from the radiographic apex to 3.6 mm for MB of first molar and 3.0 mm for the rest of the roots. Blue line shows the distance from apex to sinus.
Results

CBCT scans (n = 155) were used in this study for evaluation of maxillary molars and associated areas in the maxilla. The demographic analysis revealed 109 of the study population (70%) were female (n = 109), and 46 (29%) were male (n = 46). The age of the study population ranged between 13 and 87 years old. There were 45 patients younger than the age of 35, 62 patients between the ages of 36 and 59, and 48 patients aged 60 and older.

Root Thickness

The data presented in the current study concerning B-L and M-D width at the resection level demonstrate that the single-rooted first and second premolars have the largest B-L widths (5.56 and 5.55 mm). The B-L widths of the buccal and lingual roots of each 2-rooted premolar are relatively similar, ranging from 2.97 mm (palatal of second premolar) to 3.28 mm (single-rooted second premolar).

In the molar region, the thickest B-L width belonged to MB root of first molar at 5.49 mm. The palatal root of the maxillary second molar had the smallest B-L thickness at 3.81 mm. The greatest M-D thickness belonged to palatal root of first molar (4.31 mm), and the smallest was DB root of maxillary second molar (2.87 mm) (Table 1).

Bone Thickness

The single-rooted and 2-rooted premolars were analyzed separately. In the premolar region, the average BT over the resection area ranged from 0.66 mm to 1.35 mm. First premolars had thinner buccal bone than second premolars. The palatal plate thickness over the premolar roots ranged from 2.52 to 3.26 mm.

In the molar region, at the resection level, the thinnest bone was found over the MB root of first molar (0.84 mm), and the thickest bone was over the MB root of the second molar (1.91 mm). The palatal plate thickness over the molar palatal roots ranged from 1.24 to 1.31 mm (Table 2).

Distance to Complete Resection

The data for the mean resection distance during root-end surgery were calculated by the addition of the BT and the B-L root diameter, or potentially the PT plus the B-L root diameter if a palatal surgical approach would be used. In 2-rooted premolars, this distance also included the space between the buccal and lingual roots because both roots are generally resected from the buccal approach. In the premolar region, it can be concluded that the largest resection distance is for the 2-rooted first and second premolars, averaging 8.81 mm for the first premolar and 9.14 mm for the second premolar. The single-rooted first premolar (6.43 mm) and single-rooted second premolar (6.9 mm) had similar resection distances (Fig. 3A).

In the molar region, the largest resection distance was for the MB root of the second molar, averaging 7.40 mm. The second largest average resection distance was for the MB root of the first molar at 6.35 mm. The total resection distances for the DB roots were considerably less at 5.52 mm for the second molar and 5.43 mm for the first molar (Fig. 3B). The palatal roots had the shortest resection distances from the PC, averaging 5.12 mm for the second molar and 5.28 mm for the first molar (Fig. 3C).

Proximity to Maxillary Sinus

For the maxillary premolars, the apices of the second premolar were closer to the sinus than those of the first premolar. The root closest to the sinus was the palatal root of the 2-rooted second premolar (2.16 mm), whereas the buccal root of the first premolar was the farthest from the sinus at distance of 7.08 mm. The buccal roots of the 2-rooted premolars were farther from the sinus than the palatal roots.

Table 1. Buccolingual (B-L) and Mesiodistal (M-D) Root Dimensions for Each Individual Tooth (mm)

<table>
<thead>
<tr>
<th>Tooth/root</th>
<th>B-L width</th>
<th>M-D width</th>
</tr>
</thead>
<tbody>
<tr>
<td>First premolar single root</td>
<td>Mean: 5.56</td>
<td>3.21</td>
</tr>
<tr>
<td>SD: 1.33</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>First premolar buccal</td>
<td>Mean: 3.14</td>
<td>3.31</td>
</tr>
<tr>
<td>SD: 0.83</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>First premolar palatal</td>
<td>Mean: 3.28</td>
<td>3.20</td>
</tr>
<tr>
<td>SD: 0.6</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>Second premolar single root</td>
<td>Mean: 5.55</td>
<td>3.43</td>
</tr>
<tr>
<td>SD: 4.94</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Second premolar buccal</td>
<td>Mean: 2.97</td>
<td>3.33</td>
</tr>
<tr>
<td>SD: 0.97</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Second premolar palatal</td>
<td>Mean: 3.27</td>
<td>3.23</td>
</tr>
<tr>
<td>SD: 1.03</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>First molar DB</td>
<td>Mean: 4.24</td>
<td>2.98</td>
</tr>
<tr>
<td>SD: 1.11</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>First molar MB</td>
<td>Mean: 5.49</td>
<td>3.22</td>
</tr>
<tr>
<td>SD: 1.19</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>First molar palatal</td>
<td>Mean: 4.04</td>
<td>4.31</td>
</tr>
<tr>
<td>SD: 0.97</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Second molar DB</td>
<td>Mean: 4.02</td>
<td>2.87</td>
</tr>
<tr>
<td>SD: 0.88</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>Second molar MB</td>
<td>Mean: 5.22</td>
<td>3.01</td>
</tr>
<tr>
<td>SD: 1.27</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Second molar palatal</td>
<td>Mean: 3.81</td>
<td>3.84</td>
</tr>
<tr>
<td>SD: 0.83</td>
<td>0.72</td>
<td></td>
</tr>
</tbody>
</table>

SD, standard deviation.
TABLE 2. Measurements of Buccal Cortex to Root Surface (BC-RS) and Palate Cortex to Root Surface (PC-RS) for Each Individual Tooth (mm)

<table>
<thead>
<tr>
<th>Tooth/root</th>
<th>BC-RS</th>
<th>SD</th>
<th>PC-RS</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>First premolar single root</td>
<td>0.87</td>
<td>0.91</td>
<td>3.22</td>
<td>1.46</td>
</tr>
<tr>
<td>Mean</td>
<td>0.85</td>
<td>0.90</td>
<td>2.52</td>
<td>1.42</td>
</tr>
<tr>
<td>SD</td>
<td>1.35</td>
<td>1.00</td>
<td>3.26</td>
<td>1.50</td>
</tr>
<tr>
<td>Mean</td>
<td>1.11</td>
<td>0.7</td>
<td>2.8</td>
<td>1.15</td>
</tr>
<tr>
<td>SD</td>
<td>1.12</td>
<td>0.7</td>
<td>2.8</td>
<td>1.15</td>
</tr>
<tr>
<td>Mean</td>
<td>0.84</td>
<td>1.99</td>
<td>1.24</td>
<td>0.99</td>
</tr>
<tr>
<td>SD</td>
<td>1.52</td>
<td>1.02</td>
<td>1.91</td>
<td>1.00</td>
</tr>
<tr>
<td>Mean</td>
<td>1.91</td>
<td>1.00</td>
<td>1.31</td>
<td>0.91</td>
</tr>
<tr>
<td>SD</td>
<td>1.35</td>
<td>1.42</td>
<td>3.22</td>
<td>1.46</td>
</tr>
<tr>
<td>Mean</td>
<td>0.87</td>
<td>0.91</td>
<td>3.22</td>
<td>1.46</td>
</tr>
<tr>
<td>SD</td>
<td>1.35</td>
<td>1.00</td>
<td>3.26</td>
<td>1.50</td>
</tr>
</tbody>
</table>

SD, standard deviation.

For the maxillary molars, the apices of the second molar were closer to the sinus than those of the first molar. The root closest to the sinus was the MB root of the second molar (0.66 mm), whereas the MB root of the first molar was the farthest from the sinus at a distance of 2.71 mm.

Sinus Pathology

In this study, sinus pathosis was noted in 57 teeth, or 36.8% of the time. The average thickening was 7.26 mm. In a total of 31 teeth, or 47% of the time, sinus pathology occurred adjacent to teeth with apical radiolucencies. Teeth with recorded apical radiolucencies adjacent to sinus pathology were 18 first molars (58.1%), 7 second molars (22.6%), 2 first premolars (6.4%), and 4 second premolars (12.9%).

Discussion

The purpose of this study was to determine the dimensions of the root apices of the maxillary premolar and molar teeth, the BT and PT at the optimal root resection level, and the relationship of the apices in reference to the maxillary sinus. CBCT was used to avoid disadvantages such as superposition of anatomic structures and horizontal and vertical magnification that are associated with panoramic radiographs and periapical radiographs.

Root Thickness

The root thickness data presented in Table 1 are meant to provide the clinician with a reference when performing apical surgery. Obviously these averages should be used in conjunction with measurements from CBCT scans and radiographs of the region of interest and staining and magnification of the area during the surgical procedure.

Bone Thickness and Distance to Complete Resection

The thickness of the buccal or palatal plate is an important factor in apical surgery and can affect visualization, surgical access, and whether a buccal or palatal approach is chosen. There have been few reports on the thickness of the buccal and palatal plates. In 1992, Eberhardt and Torabinejad (5) reported that the thickness of the buccal bone over the first premolar was 1.63 mm and the second premolar was 3.16 mm. The measurements in the present study were similar for the first premolar (0.87–1.66 mm) but smaller for the second premolar (1.12–1.35 mm). More recently, Jin et al (6) used CT to examine cortical plate thickness over maxillary teeth in an Asian population. The premolars were analyzed separately as 1 and 2-rooted, similar to the current study. The buccal plate over the first and second single-rooted premolars was found to have a greater width than that over the 2-rooted premolars (2.19 versus 1.68 mm for the first premolar and 3.38 versus 1.99 mm for the second premolar). This is similar to the present study where the buccal plate over the single-rooted first premolar was 0.87 mm, and over the 2-rooted first premolar it was 0.66 mm. The same pattern was found in the second premolar where the thickness over the single-rooted second premolar was 1.35 mm, and over the 2-rooted premolar the thickness was 1.12 mm. The measurements of the current study are smaller on average than those found by Jin et al. The difference in cortical plate thicknesses between the 2 studies may be explained by the measuring techniques, because Jin et al measured thicknesses at the root apex and the present study measured bone and root thickness at the resection level.

When combining B-L root thickness and bone thickness in the premolar region, results from this study found that the complete resection distance is greatest for the 2-rooted first and second premolars, averaging 8.81 mm for the first premolar and 9.14 mm for the second premolar. The resection distance is similar among the single-rooted first premolar (6.43 mm) and the single-rooted second premolar (6.9 mm).

Eberhardt and Torabinejad (5) determined that the palatal plate thickness (5.52 mm) over the first premolar is significantly greater than the buccal plate thickness (1.63 mm). From this information, it was reasoned that the surgical access for both roots should be from the buccal approach. The palatal plate depth found in the current study measured 2.52 mm, which was much less than the 5.52 mm observed in the study by Eberhardt and Torabinejad. If the palatal root of the first premolar was the sole root demonstrating pathosis, the resection distance from buccal was 8.81 mm, and the distance from the palatal direction was 5.80 mm. Therefore, in a situation where the clinician desired only to resect the palatal root, it may be more easily accessed through the palatal plate than previously thought. However, if both roots demonstrate pathosis, the buccal approach is more efficient, because the buccal plate depth over first premolars with 2 roots is 0.66 mm.

In the molar region, Eberhardt and Torabinejad (5) found the BC to be thickest at the apex of MB root of second molar (4.25 mm), which confirms our finding of the thickest bone over MB root of second molar at the resection level (4.91 mm). In accordance with Jin et al (6), the thickness of the buccal bone over the MB and DB roots of the second molar was thicker than the bone over the buccal roots of the first molar. Our data demonstrate that the thickness of buccal cortex over the MB root of first molar was 0.84 mm versus 1.91 mm over the MB root of the second molar. For the DB root the bone thickness was 1.19 mm over the first molar and 1.52 mm for the second molar. Jin et al also found the average thickness for PC of first molar at the level of the apex was 3.15 mm, and this thickness for second molar was 3.08 mm. In our study, the PC at 3.0-mm resection level was...
1.24 mm for the first molar and 1.31 mm for the second molar. When comparing the data from the present study with the dimensions found by Jin et al, it appears that bone thickness at the apex is relatively greater than at the resection level.

When combining B-L root thickness and bone thickness in the molar region, the largest complete resection distance was for the MB root of the second molar, averaging 7.40 mm. The second largest average resection distance was for the MB root of the first molar, at 6.33 mm. Although these broad depths do not mean that resection on these roots should be avoided or approached from a different direction, they do give the clinician some reference of just how deep they will need to cut to completely resect these roots. The thickness of these resections highlights the need for magnification and illumination in these areas.

**Proximity to Maxillary Sinus**

Historically, premolars have received less focus than molars regarding proximity to the sinus floor. In the current study, 0.88% of first premolars and 9.3% of second premolars were found to have root tips protruding into the sinus. Our findings support the observations of previous authors that the root apices of premolars are on average farther away from the sinus floor than molars but may be in close proximity in certain patients (9–11). Eberhardt and Torabinejad (5) used CT and found the mean distance between the maxillary posterior teeth and the maxillary sinus floor was 1.97 mm from the sinus. Specifically, the buccal and lingual roots of the first premolar were 6.18 mm and 7.05 mm from the sinus, and the second premolar was 2.86 mm from the sinus. These results are similar to the present study where the buccal and lingual roots of the first premolar were 7.08 mm and 5.97 mm from the sinus floor, and the single-rooted second premolar was 3.78 mm from the sinus.

The finding by Eberhardt and Torabinejad (5) that MB of maxillary second molar is closest to the sinus also agrees with our findings for the same tooth. In a review article, Freedman and Horowitz (12) addressed maxillary sinus perforation associated with apicoectomy in maxillary posterior teeth. A review of 472 such procedures showed an occurrence of 10.4% (23% in molars, 13% in second premolars, and 2% in first premolars). This low incidence, coupled with no recorded cases of postoperative sinusitis, favors root-end resection over extraction even in areas of likely sinus perforation but demands meticulous surgical technique and appropriate postoperative care.

The method of measurement has been suggested to affect the data. Von Arx et al (13) found that measuring only in the coronal slices may overestimate distances and not yield the true shortest distance between the root apex and sinus floor. Similar to past studies, this study measured only in coronal slices, possibly explaining why the results were higher than those of the study by von Arx et al but similar to other studies measuring only in the coronal views.

![Figure 3](image-url)
Sinus Pathosis

In the present study, sinus pathology was found in 36.8% of scans. Of all of those teeth that were next to the area of sinus pathology, 18 (58.1%) were first molars, and 7 (22.6%) were second molars. These findings confirm the findings of Maillet et al. (14) that teeth involved in sinus pathology were mostly first and second molars.

In the present study, an association between teeth and sinus pathology was not made because of a lack of information regarding clinical symptoms. However, previous studies that did analyze clinical symptoms found that between 10% and 50% of sinus pathology is related to odontogenic infections (14, 15). Maillet et al. (14) examined CBCT scans that radiologists had previously identified as showing sinusitis and determined that 51.8% were associated with periapical pathology. The present study found that 26% of sinus pathology occurred adjacent to teeth with periapical radiolucencies, which is a relatively high number considering the scans in the current study were selected from the general population and not preselected with sinus pathology.

Conclusion

Limitations of the present study include the voxel size, which was 0.2–0.3 mm. The voxel size varied on the FOV of the scan. Because this was a retrospective study that used scans taken for clinical reasons, the FOV and voxel size of the scan were based on the clinical situation and could not be standardized or altered for the purposes of this study. The voxel size of the images used was significantly larger than that of limited field CBCT scans, which offer voxel sizes as low as 0.76 μm. The larger voxel size made it difficult, on occasion, to provide an exact measurement of root/bone thicknesses because the operator was forced to round measurements to the nearest 0.2–0.3 mm. In addition, in some instances the iCAT software made it difficult to measure the root and cortical plate thickness at a 90° angle to the long axis of the root. As a result, some of the measurements were made in diagonal direction instead of perpendicular to the long axis and may have increased the dimensions compared with the true measurements.

Understanding the maxillary premolar and molar root thicknesses for apical resection, the relative position of the apices to the maxillary sinus floor, as well as the buccal and palatal cortical bone thickness over the roots at the surgical resection level is beneficial to the endodontist. In contrast to previous authors who evaluated the buccal and palatal plate distance from the apex, this study was the first to evaluate the root and bone thickness at the surgical resection level (3.0 or 3.6 mm). The clinician should be aware of these respective distances and use this knowledge for treatment planning and executing surgical procedures.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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