Number of basis images effect on detection of root fractures in endodontically treated teeth using a cone beam computed tomography machine: an in vitro study

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Objectives. The objective of this study was to compare the accuracy of root fracture detection in endodontically treated teeth using scans acquired with a 180° rotation motion compared with a 360° after which the patient exposure and number of basis images are doubled.
Methods. Sixty-six roots were collected and decoronated. All were treated endodontically. One-half of the roots were fractured, resulting in 2 root fragments which were then glued together. The roots were placed randomly in 8 prepared beef rib fragments. Five reviewers independently reviewed the scans twice, at different times.
Results. The specificity of the 360° scan was significantly higher than the 180° scan; doubling the basis images leads to a significant decrease in false-positive rates. Accuracy and sensitivity were not significantly different.
Conclusions. Only the specificity is improved by the increased rotation and doubling of images. The accuracy and sensitivity are not improved. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;115:676-681)

Root fracture (RF) is a complication that often leads to teeth extraction.[1,2] RF is usually iatrogenic and can occur after the insertion of posts or screws in a root after an endodontic treatment. A common etiology of RF is the excessive occlusal force, especially in restored teeth that have undergone a root canal treatment. The teeth at highest risk for RF are endodontically treated and uncrowned posterior teeth.[3] Early detection of RF may prevent extensive damage to the periodontium.[2] Conventional and digital 2-dimensional intraoral radiography are still the diagnostic tools that are used most frequently in dental practices. Radiographic diagnosis of an RF is based on the presence of a radiolucent fracture line. In order to be able to see that line, the x-ray beam should pass directly along the fracture line or else the RF may not be diagnosed.[3,4]

Cone beam computed tomography (CBCT) had been introduced as one of the most accurate imaging modalities for dental diagnosis purposes.[5,6] Limited CBCT volumes were shown to be more accurate in diagnosing RFs.[7] Computerized tomography (CT) has also been found to perform better than intraoral techniques both in vivo[8] and in vitro[9] detection of RF. CBCT imaging is currently well known in dentistry and has replaced conventional tomography for dental diagnostic purposes.[10] Advantages of CBCT in clinical practice are easy image acquisition, accurate images, lower radiation doses compared with medical CT, faster scan times, and an enhanced cost-effectiveness.[11,12]

The time required for a scan or the angle at which the machine turns around the patient's maxillofacial complex is directly related to the patient's radiation dose and to the number of basis images acquired during the scan.[13] Higher scan times (or a greater angle) represent a higher radiation dose.[13] It had not been demonstrated clinically that a higher number of acquired basis images offers an enhanced diagnosis

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Statement of Clinical Relevance

Doubling the number of acquired basis images lead to a significant decrease of false-positive answers in detecting RFs in endodontically treated roots; the artifacts caused by gutta-percha were reduced when doubling the acquired number of basis images.

accuracy. The decision to acquire more basis images, leading to a higher patient radiation dose, should be assessed.

Presence of high-density material such as gutta-percha in root canals leads to significant artifacts which will decrease the RF detection accuracy.[14] Bechara et al.[14] have shown that 2 artifact reduction algorithms available in 2 different CBCT machines decreased the RF detection accuracy.

The number of basis images acquired can be varied for the same field of view (FOV). The Accuitomo 3D machine (Morita, Kyoto, Japan) offers a 180° and a 360° rotation motion around the patient's head for each FOV. The objective of this study was to compare the accuracy of RF detection in endodontically treated teeth using scans acquired with a 180° rotation motion compared with the 360° after which the number of acquired basis images and patients' exposure are doubled.

MATERIAL AND METHODS

Sixty-six human teeth were collected and decoronated. Single roots were prepared and filled with gutta-percha by the same operator using the same technique. Thirty-three roots, chosen randomly, were fractured with a tapered pin inserted vertically in the root canal and tapped gently with a hammer. The 2 root fragments were glued together with 1 layer of methyl methacrylate. The remainder of the roots (33) were kept intact. Eight bovine rib fragments were prepared to receive the roots (Figure 1). Two rib fragments contained 9 roots and the remainder contained 8 each. The roots were distributed randomly to the 8 bovine rib fragments. The fragments were numbered from 1 to 8. Roots were placed randomly within the assigned fragment. Wax was added around the roots placed in the bone sockets to fill the gap and keep them stable. The ribs were wrapped with 3 layers of wax to simulate soft tissues. They were scanned by groups: fragments 1 and 2 (group 1), 3 and 4 (group 2), 5 and 6 (group 3), 7 and 8 (group 4). Each group was scanned twice using the Accuitomo 3D machine: once using the 180° scan and the second time using the 360° scan while keeping the same position of the bone fragment. The fragments were set in a way that simulated an upper and a lower dental arch (Figure 2). Thus, 8 CBCT scans were made: 4 using the 180° scan and 4 using the 360° scan. The settings using the CBCT machine were 76 kV, 6 mA, and the voxel size was 0.125 mm. A 6 × 6 cm FOV was used.

The CBCT scans were exported with the viewer and each of 5 observers classified the presence of RFs using a 5-point scale: (1) definitely absent, (2) probably absent, (3) unsure, (4) probably present, and (5) definitely present. Due to the fact that observers were not located in the same geographical area, they were calibrated using a document that explained how a RF

Fig. 1. One of the 8 bone fragments.

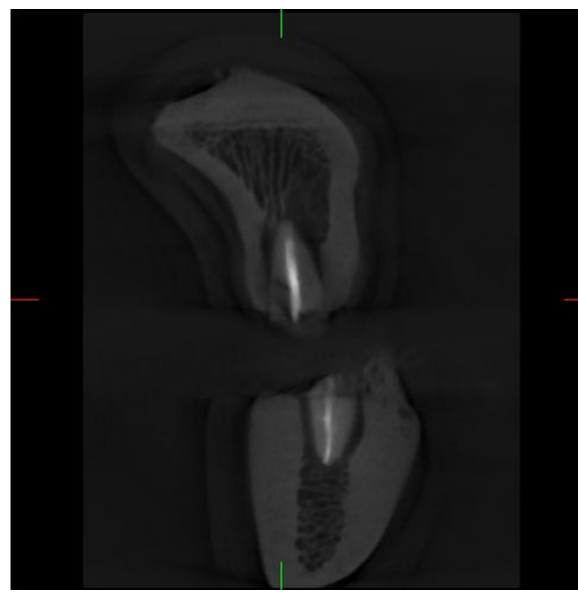

Fig. 2. Coronal CBCT image of fragments 1 and 2 (group 1).

appears on the screen by using descriptive terms and cropped photos of RFs. It was stated that the fracture can be at any level of the root. For the calibration of the monitors, reviewers were instructed in the same document to review the images under an indirect dimmed light and to calibrate the monitor using the same online tool. They were asked to modify their monitor contrast and brightness till they can see all the gray shades. After calibration, observers independently classified each of the images twice during 2 distinct viewing sessions separated by at least 14 days.

Statistical analyses

The κ statistic[15] was used to assess the inter- and intra-observers agreement. Area under the receiver operating characteristic (ROC) curve was used to assess the accuracy of assessment of presence or absence of an RF. Area