Accuracy of Digital Periapical Radiography and Cone-beam Computed Tomography for Diagnosis of Natural and Simulated External Root Resorption

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Abstract

Introduction: The aim of this study was to compare the sensitivity and specificity of digital periapical radiography and cone-beam computed tomographic (CBCT) imaging in the detection of natural and simulated external root resorptions (ERRs) with micro–computed tomographic (micro-CT) imaging as the reference standard. **Methods:** One hundred twenty-six teeth were scanned using the SkyScan 1172 micro-CT scanner (Bruker microCT, Kontich, Belgium), and the images were evaluated using NRecon software (Bruker microCT). After micro-CT imaging, the teeth were divided into 3 groups: control, 42 teeth that did not present any ERR cavities; natural, 42 teeth that presented 1 or more ERR cavities; and artificial, 42 teeth without ERRs but perforations were created to simulate the cavities. Ortho-, mesio-, and distoradial digital periapical radiographs and CBCT images were obtained, and the images were evaluated by 2 double-blinded qualified radiologists. **Results:** The sensitivities and specificities for the radiographic and tomographic methods were 78.18% and 97.27% and 59.52% and 97.62%, respectively. Within the individual groups, both methods had lower sensitivity and specificity for natural and artificial resorptions, and the differences were statistically significant. **Conclusions:** CBCT imaging was the best method for the detection of ERRs. Only 74.5% of natural ERR gaps were observed on the digital periapical radiographs and 94.5% on CBCT imaging; in the artificial group, this number increased to 81.8% and 100%, respectively. The configuration of the natural ERR gaps is different from those artificially simulated and is much more difficult to observe. *(J Endod 2018;■:1–8)*

Key Words

Cone-beam computed tomography, digital periapical radiography, external root resorption, image diagnosis, microtomography

Significance

A natural root resorption has a different configuration (shape size) than an artificial root resorption. This is the first study that used a natural root resorption to test the accuracy of digital periapical radiography and cone-beam computed tomographic imaging with micro-CT imaging as the gold standard.

External root resorption (ERR) is the loss of dental tissue, cementum and dentin, as a result of the action of odontoclastic cells (1) caused by inflammation; it can occur in different situations such as dental trauma, apical infection, internal bleaching, periodontal treatment, ectopic eruption, and, most commonly, in the presence of orthodontic movement (2–4). The severity of ERR can lead to a compromised crown-to-root ratio and tooth functioning (5).

Because ERRs do not present clinical symptomatology (6, 7), they are almost always detected by x-ray examinations (2). Periapical radiography is the most commonly used method for diagnosing ERRs (8). The principal problem with diagnosing ERRs by periapical radiography is that the 3-dimensional anatomy of the region being radiographed is compressed into a 2-dimensional image (1), and its diagnostic accuracy is affected by anatomic superposition and the angle of the x-ray spectrum (9).

Cone-beam computed tomographic (CBCT) imaging can be used as an alternative method. The determination of the extension and location of ERRs will be facilitated by the various senses in the cutting planes, increasing their detection (2). Early diagnosis of ERR during orthodontic treatment is essential to identify teeth at risk of developing severe resorption (10). The high cost and radiation exposure make this modality generally unsuitable as the first choice for dental imaging (11) (eg, in case of root resorption [RR] and when using it as a diagnostic or control examination).

With the evolution of imaging technology, micro–computed tomographic (micro-CT) imaging has been widely used in dental research as a noninvasive diagnostic technique because it is a high-resolution method that provides comprehensive and accurate

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evaluation of dental tissues and periodontal disease in a 3-dimensional perspective (12). In addition, its high resolution allows the detection of tiny resorption craters before ERR is diagnosed (5).

Creanga et al (2) reported that ERR cavities created artificially in teeth *in vitro* did not exactly reproduce natural injury ERRs. Thus, the objective of this study was to compare the diagnostic value of CBCT imaging and digital periapical radiography in the detection of natural ERRs *in vitro* and to determine whether the ability to detect defects with these 2 modalities was influenced by the type of RR produced (ie, artificially made cavities or natural cavities) with micro-CT imaging as the reference standard.

Methods

This cross-sectional observational study included a sample of 126 *ex vivo* teeth (Ethics Committee CAAE: 50214515.0.0000.0020) from a previous study; this was the number sufficient to complete 9 jaws with 14 teeth each. The teeth were randomly selected from a tooth bank using a magnifying glass (3× magnification) and natural light until reaching the number determined for the study. The teeth were examined by 2 evaluators to confirm the anatomy and which tooth group each tooth belonged to and to verify the inclusion criteria.

The inclusion criteria were as follows: no root destruction, complete root formation, the absence of caries/abrasions in the cervical region, and no endodontic treatment. The presence/absence of ERRs in all teeth was determined by a micro-CT examination because it is known that between 7% and 10% of people who have never undergone orthodontic movement have some type of ERR (13, 14).

The micro-CT images were acquired using the SkyScan 1172 microtomography scanner (Bruker microCT, Kontich, Belgium) at a resolution of 9 μm at 100 kV, milliamperage of 100 μA, and energy of 10 W. The raw images were reconstructed using NRecon software, version 1.4.4 (Bruker microCT). The reconstructed images of the scanned teeth were analyzed using CTvox software, version 3.1.1 (Bruker microCT), which enables visualization of the teeth in the axial, sagittal, and coronal planes to determine if ERR gaps exist in the apical, middle, and cervical thirds as well as the surface of the root (buccal, lingual, or proximal) where the gap occurred (Figs. 1 and 2*A*).

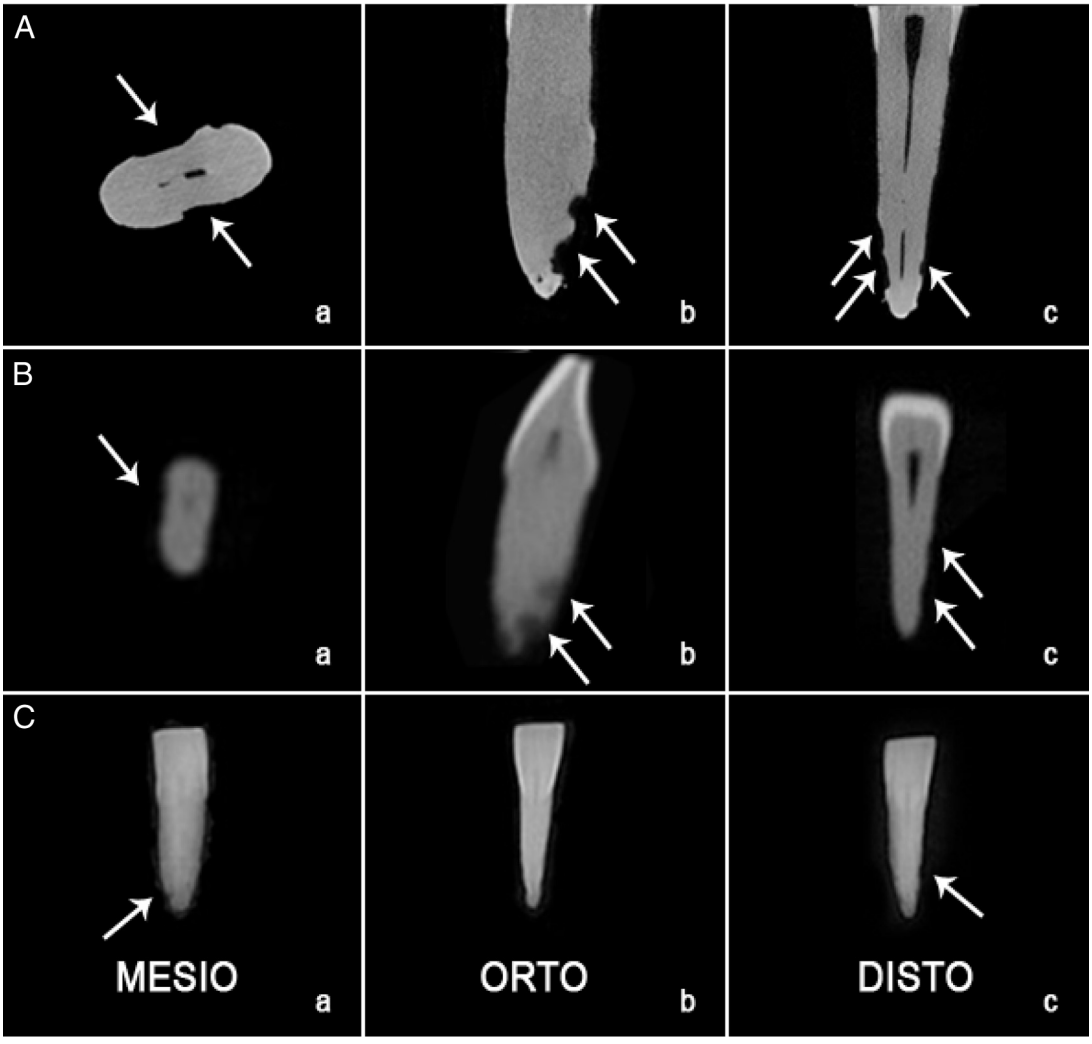

Figure 1. (*A*) Micro-CT imaging of a lower incisor (tooth number 12) with the marking of the root resorption area in the apical third as seen on the (*a*) axial, (*b*) sagittal, and (*c*) coronal cuts. (*B*) CBCT imaging of the same lower incisor as seen on the (*a*) axial, (*b*) sagittal, and (*c*) coronal cuts. (*C*) A periapical radiograph of the same lower incisor as seen on the (*a*) mesio-, (*b*) ortho-, and (*c*) distoradial views.