# Detection of Vertical Root Fractures in the Presence of Intracanal Metallic Post: A Comparison between Periapical Radiography and Cone-beam Computed Tomography

*Rafael Binato Junqueira, MSc,* Francielle Silvestre Verner, MSc,* Celso Neiva Campos, PhD,† Karina Lopes Devito, PhD,† and Antônio Márcio Resende do Carmo, PhD†*

## Abstract

**Introduction:** This *in vitro* study compared cone-beam computed tomography (CBCT) exam with different voxel sizes with digital periapical radiography in the detection of vertical root fractures in teeth with and without intracanal metallic posts. **Methods:** Eighteen single-rooted human teeth were endodontically treated, prepared for cast metal posts, and artificially fractured. After positioning the teeth in dry mandibular sockets, the samples were subjected twice (with and without posts) to digital periapical radiography at 3 different angles and to CBCT examinations with 2 voxel sizes, 0.125 and 0.25 mm. The images were evaluated by 3 oral radiologists. Indices of sensitivity, specificity, and positive and negative predictive values, in addition to the areas under the receiver operating characteristic curves (accuracy), were calculated. Comparison of the accuracy of the imaging methods was assessed by using the $\chi^2$ test. Comparison of the accuracy between teeth with and without posts was determined by using the Fisher exact test. **Results:** The accuracy of the imaging methods showed no significant differences ($P = .08$). The comparison between teeth with and without posts in each examination revealed significant differences for CBCT with a voxel of 0.125 mm ($P = .04$) and for periapical radiography ($P = .04$). **Conclusions:** No significant differences were observed between CBCT and periapical radiography in the detection of vertical root fractures, except for teeth with metallic posts in images from CBCT with a voxel of 0.125 mm and in digital periapical radiography. Furthermore, voxel size did not significantly influence the diagnosis of vertical root fractures. *(J Endod 2013;39:1620–1624)*

## Key Words

Cone-beam computed tomography, diagnosis, digital periapical radiography, vertical root fracture

Correct diagnosis of vertical root fractures is a challenge for dental surgeons, and the early detection of these fractures would directly influence treatment planning. The diagnostic process should include a thorough analysis of the case history and a detailed clinical examination, as well as an evaluation of the bone and tooth structure. Therefore, it is essential to order complementary exams (1, 2).

Periapical radiography is still the most widely used complementary method for the diagnosis of vertical root fractures. However, it has limitations, such as the two-dimensional representation of the bone and tooth structures and the overlapping of different planes (2).

The advent of cone-beam computed tomography (CBCT), with its three-dimensional representation of maxillofacial structures, has led to major advances in diagnosing and planning in various areas of dentistry, with an emphasis on endodontics (1,3–6). Recent studies have demonstrated the superiority of CBCT's accuracy in detecting root fractures (7–11). Variation of the acquisition protocols in performing the exam by using voxels of different sizes is an alternative that can improve image quality (12, 13). However, in cases in which there are metallic objects associated with the involved teeth, such as intracanal posts, artifacts can appear on tomographic images, rendering the interpretation of the exam difficult in the diagnosis of root fracture. A limited number of studies assessing the influence of imaging artifacts on the diagnosis of root fractures can be found in the literature (14–16).

Considering the voxel size and the influence of metallic artifacts on the diagnostic ability of the CBCT images, this study aimed to compare CBCT with different voxel sizes with digital periapical radiography in the detection of vertical root fractures in the presence and absence of intracanal metallic posts.

## Materials and Methods

After approval by the Ethics Committee (protocol 122/2011), 18 healthy single-rooted anterior (incisors and canines) human teeth, extracted for therapeutic reasons, were selected. The teeth were inspected with a magnifying lens to confirm the absence of defects or root fractures. The crowns were removed at the cementoenamel junction. The root canals were treated by an endodontist who used Gates Glidden drills sizes 1, 2, and 3 (cervical preparation) and 15–35 Nitiflex files (apical preparation) (Dentsply Maillefer, Ballaigues, Switzerland). The filling was performed with gutta-percha points and zinc oxide-eugenol–based sealer (Dentsply Maillefer). Two-thirds of extent of the canal was cleared and modeled with chemically activated acrylic resin, and cast metal posts (CMPs) in a nickel-chromium alloy were obtained. These were fitted in the respective canals, but no luting material was used.

From the *School of Dentistry and †Department of Dental Clinics, School of Dentistry, Federal University of Juiz de Fora, Juiz de Fora, Minas Gerais, Brazil.
Rafael Binato Junqueira was supported by CAPES foundation.
Address requests for reprints to Dr Karina Lopes Devito, Department of Dental Clinics, School of Dentistry, Federal University of Juiz de Fora, Campus Universitário, s/n, CEP 36036-900 Juiz de Fora, Minas Gerais, Brazil. E-mail address: karina.devito@ufjf.edu.br
0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2013.08.031

Nine teeth were randomly selected and induced to vertical root fractures by using mechanical force applied to the tooth by means of a chisel and hammer (16). After total separation of the fragments, they were placed together, returning to their original position, to simulate the immediate post-trauma situation in which no edema or granulation tissue has displaced the fragments yet (14). The roots were uniformly covered with a 0.3-mm layer of utility wax (Epoxiglass, São Paulo, Brazil) to simulate the radiographic aspect of periodontal space and the alveolar cortical plate (17) and placed randomly into dry mandibular sockets.

The mandibles were placed into an acrylic box filled with water for the attenuation of x-ray beams, simulating the soft tissue of maxillofacial region (15).

Initially, all the CMPs were placed in the root canals of the 18 teeth and were submitted to radiographic periapical exams at 3 different angles and CBCT exams. Luting procedures for the posts were not performed to avoid leakage of material through the fracture lines, which could have interfered with the evaluation of images. In the second step, the CMPs were removed, and the teeth were subjected again to the same imaging tests, thus forming 4 groups (n = 9): group 1, with CMP and without fracture; group 2, with CMP and with fracture; group 3, without CMP and without fracture; and group 4, without CMP and with fracture. The choice to use the same teeth in 2 conditions (with and without CMPs) was undertaken to ensure more accurate comparisons between groups.

All of the digital radiographs were obtained by using the Gendex Expert DC (Gendex, Des Plaines, IL) periapical x-ray unit, operating at 7 mA and 65 kVp and using an intraoral solid-state digital sensor CCD system (Visualix eHD; Gendex). The exposure time was 0.4 second, which was maintained constantly at all exposures. The sensor-focus distance was

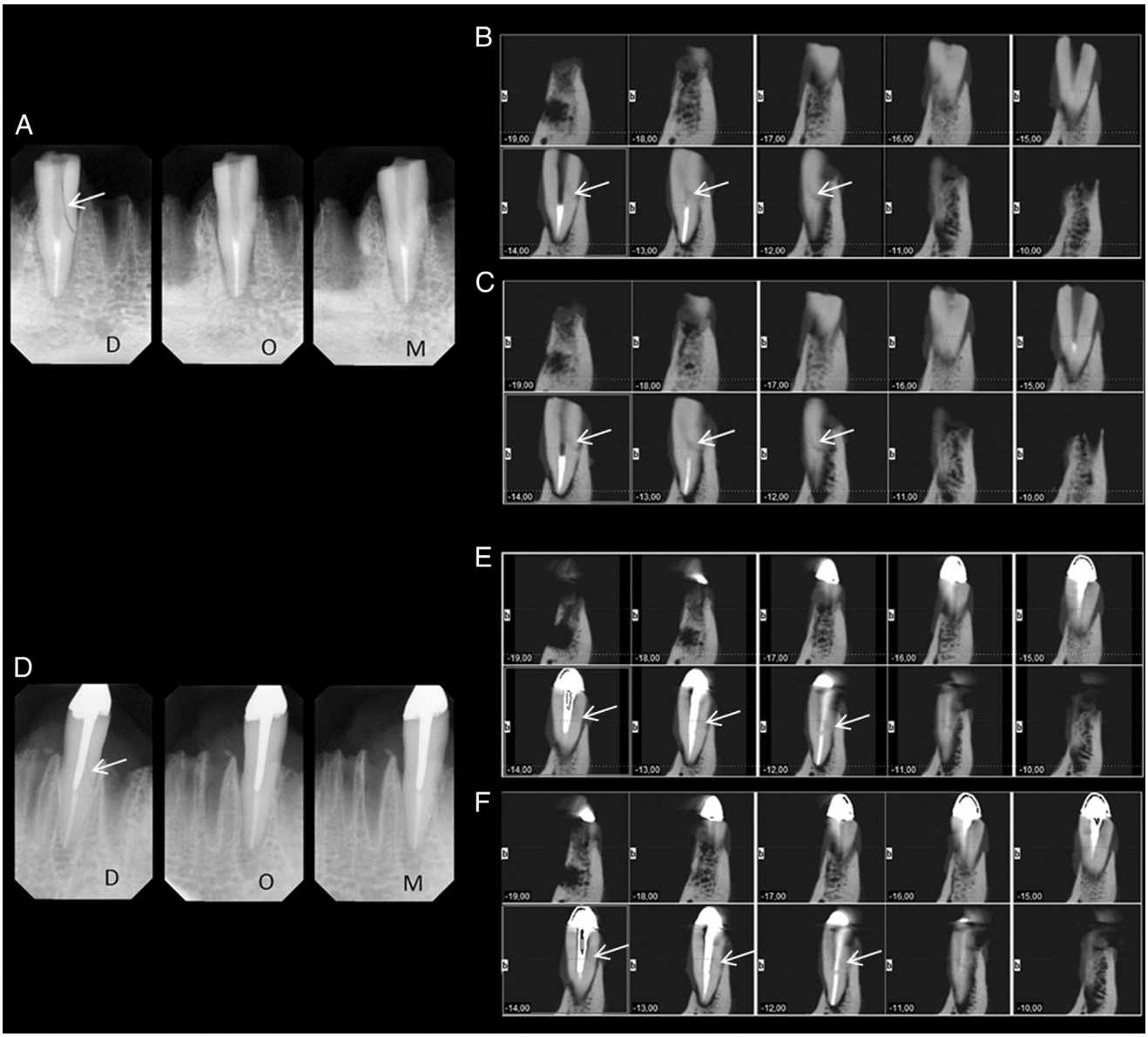


**Figure 1.** Images from periapical radiography and CBCT of single fractured tooth without (*A–C*) and with (*D–F*) CMP. (*A*) Periapical radiographs with variations of horizontal angulation. (*B*) Parasagittal slices from CBCT with 0.125-mm voxel. (*C*) Parasagittal slices from CBCT with 0.25-mm voxel. (*D*) Periapical radiographs with variations of horizontal angulation. (*E*) Parasagittal sections from CBCT with 0.125-mm voxel. (*F*) Parasagittal sections from CBCT with 0.25-mm voxel. *Arrows* show the fracture line. D, distoradial; M, mesioradial; O, orthoradial.