Detection of Simulated Vertical Root Fractures: Which Cone-beam Computed Tomographic System Is the Most Accurate?

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Abstract

Introduction: We aimed to compare the diagnostic accuracy of 5 cone-beam computed tomographic (CBCT) systems in detecting vertical root fractures (VRFs) and to assess whether fracture identification is affected by the presence of root canal filling. **Methods:** Eighty extracted posterior teeth were included in this study. They were grouped according to the presence/absence of VRFs and the presence/absence of endodontic treatment. The teeth were then inserted in 5 dry skull/mandible assemblies. CBCT scans were performed using 5 different commercially available systems. Two observers evaluated the resultant multiplanar images twice for VRFs using a 3-point scale. **Results:** i-CAT (Imaging Sciences International, Hatfield, PA) showed the highest diagnostic accuracy in the detection of VRFs among the 5 investigated CBCT systems. The presence of root canal filling did not significantly decrease the ability to detect VRFs by all the studied systems. In the detection of VRFs in endodontically treated teeth, i-CAT was the most accurate, whereas 3D Accuitomo (J. Morita, Kyoto, Japan) was the least. Interobserver agreement was moderate for the i-CAT and fair for the rest of the studied modalities, whereas intraobserver agreement was good for the Scanora 3D (Soredex, Tuusula, Finland) and moderate for images from the other CBCT machines. **Conclusions:** At the specified exposure parameters in the detection of VRFs in non–root canal–filled teeth, i-CAT showed the highest diagnostic accuracy followed by Planmeca Promax 3D (Planmeca, Helsinki, Finland), Scanora 3D, Accuitomo 3D, and Galileos 3D (Sirona Dental Systems, Bensheim, Germany), respectively. In the detection of VRFs in root canal–filled teeth, i-CAT showed the highest diagnostic accuracy followed by Planmeca Promax 3D, Scanora 3D, Galileos Comfort (Sirona Dental Systems), and Accuitomo 3D. *(J Endod 2016;42:972–977)*

Key Words

Cone-beam computed tomography, root canal therapy, root fracture, sensitivity, specificity

Root fractures are fractures involving the cementum, dentin, and pulp. Their incidence is approximately 1% within the permanent dentition with poor prognosis if not managed properly (1–3). Root fractures pose a challenge to dentists, especially when they are vertically oriented (4–15). Direct visualization of a hairline radiolucent fracture line on radiographs is the fundamental feature for detecting vertical root fractures (VRFs) (16). However, the superimposition of adjacent tissues, morphologic variations, surrounding bone density, x-ray angulations, radiographic contrast, and the array of radiolucencies around affected roots that may be caused by the fracture make radiographic interpretation of VRFs very difficult (17–19). Moreover, the presence of root canal filling (RCF) is another factor that might negatively affect the identification of VRFs (9, 11, 13).

Cone-beam computed tomographic (CBCT) imaging enables the clinician to view the tooth from multiple planes, which overcomes the limitations of 2-dimensional radiography in the detection of VRFs (20, 21). Several CBCT systems are currently on the market. Those systems vary in their image quality and performance, especially in highly demanding diagnostic tasks such as the detection of VRFs (22–27).

Figure 1. (*A* and *B*) Fixation of the 4 groups of teeth randomly in a maxilla/mandible assembly using dental wax.

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TABLE 1. Exposure Parameters Used in Each Machine According to the Manufacturers' Recommendations

Modality	kV	mA	Time (s)	Voxel size (mm)	FOV (cm)
i-CAT	120	5	7	0.125	8 × 8
Accuitomo 3D	90	6	9.4	0.2	10 × 8
Planmeca ProMax 3D	90	12	12.3	0.2	7.4 × 7.4
Scanora 3D	85	16	4.5	0.35	13 × 14.5
Galileos Comfort	85	21	6	0.2	15 × 15

In a very informative study, Hassan et al (20) compared 5 CBCT machines in the detection of VRFs. The CBCT systems were NewTom 3G (Quantitative Radiology, Verona, Italy), Next Generation i-CAT (Imaging Sciences International, Hatfield, PA), Galileos 3D (Sirona Dental Systems, Bensheim, Germany), Scanora 3D (Soredex, Tuusula, Finland), and 3D Accuitomo (J. Morita, Kyoto, Japan). They concluded that there was a large variation among the different CBCT systems in their ability to detect VRFs *ex vivo*.

Studies comparing multiple CBCT systems regarding their capability to perform a definite assignment are very helpful to clinicians when deciding to buy a CBCT scanner. Because Planmeca ProMax 3D (Planmeca, Helsinki, Finland) was not ranked in Hassan et al's (20) study, we thought it worthwhile to compare the accuracy of 5 CBCT systems, including Planmeca ProMax 3D, in detecting VRFs and to assess whether root fracture identification is affected by the presence of RCF.

Materials and Methods

The study design was expedited from review by the faculty's research ethics committee. Eighty extracted posterior teeth with sound roots (40 premolars and 40 molars) were included in this study. The teeth were provided by the department of surgery. Teeth were grouped into 4 equal groups each comprising 20 teeth. They were distributed according to the presence/absence of VRFs and RCF as follows: F/F group (vertical root fractured/root canal filled), F/NF group (fractured/not filled), NF/F group (not fractured/filled) and NF/NF group (not fractured/not filled).

RCF

Teeth included in the F/F and NF/F groups were endodontically treated using ProTaper NiTi files (Dentsply Maillefer; Ballaigues, Switzerland). A well-fitting gutta-percha cone was inserted in each canal.

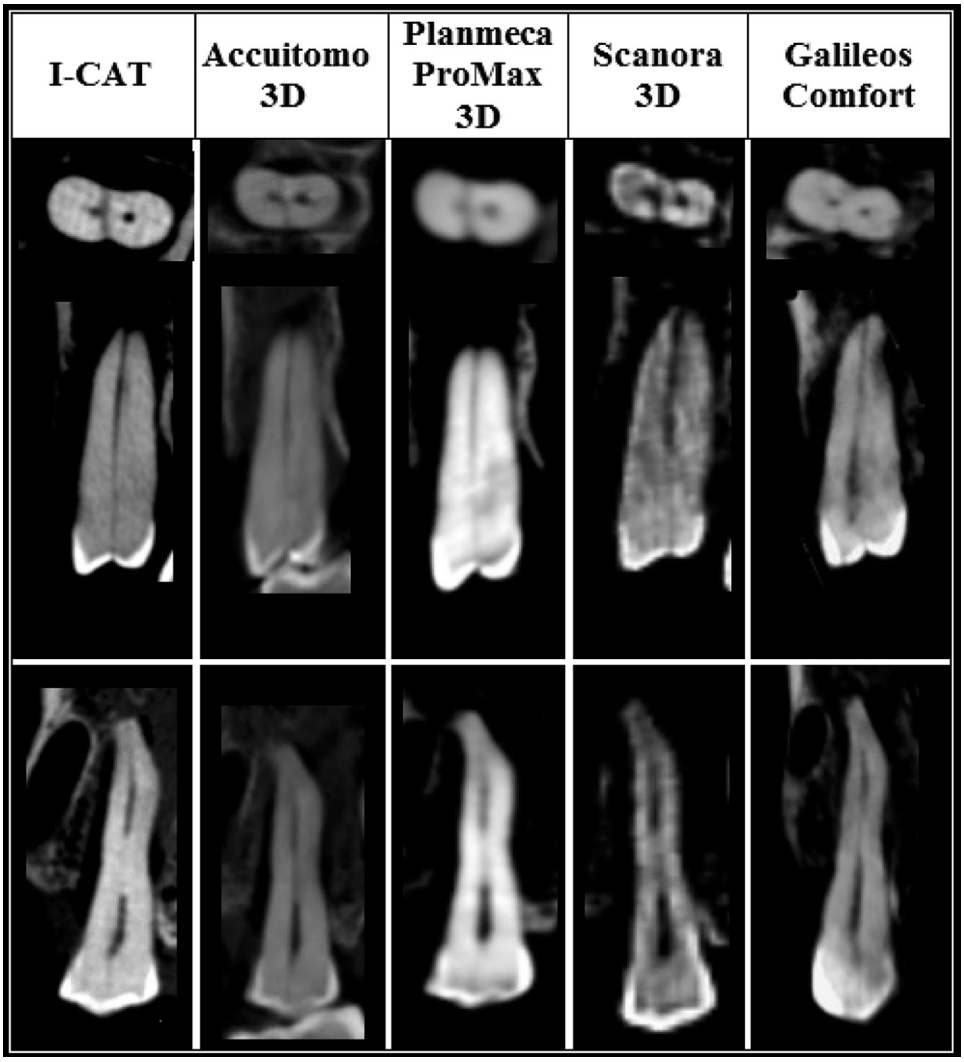

Figure 2. Axial, sagittal, and coronal views for a tooth from the fractured/not filled group imaged by the 5 CBCT systems under study.