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ORIGINAL ARTICLE

The best radiographic method for determining root canal morphology in mandibular first premolars: A study of Chinese descendants in Taiwan

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diagnostic accuracy

Abstract *Background/purpose:* There is large variation in root canal morphology and undetected canals and incomplete instrumentation are reasons for root canal treatment failure. The purpose of this study was to determine the best radiographic method for determining root canal morphology in mandibular first premolars in Chinese descendants in Taiwan.
Materials and methods: Mandibular first premolars extracted due to caries, periodontal diseases, trauma, or for orthodontic reasons were used. Four indices were examined: (1) root canal bifurcation observed in the buccolingual view; (2) root canal continuity in the buccolingual view; (3) double root outline in the buccolingual view; and (4) Vertucci canal classification in the mesiodistal view.
Results: A total of 82 left and right mandibular first premolars were included, a complicated root canal was confirmed in 38 (46.3%) by cross-sectional imaging and a single root canal was found in 44 (53.7%). Bifurcation identified on the mesiodistal view exhibited the highest sensitivity (94.7%) and second highest specificity (88.6%) for identifying a complicated root canal; however, this view is not possible to obtain clinically. Canal bifurcation on the buccolingual view was the most specific (93.2%), but had the lowest sensitivity (73.7%). Canal continuity on the buccolingual view had a sensitivity of 94.7%, and specificity of 70.5%.

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Conclusion: Combined X-ray analyses, such as performing the buccolingual view for identification of canal bifurcation and canal continuity, may increase the accuracy of identifying complex root canal morphology.

Introduction

Root canal treatment depends on complete canal debridement and filling of the root canal system. Undetected canals and incomplete instrumentation are reasons for root canal treatment failure.[1] Variation in root canal anatomy is common, and has been shown to be associated with race and gender.[2–4] To this end, knowledge of the morphology and variations of root canals is essential for successful endodontic treatment.

Canal anatomy of mandibular premolars has been shown to vary greatly. Studies have shown that mandibular first premolars with two or more canals occur in 13.7% of Caucasians in the United States and 46% of Chinese individuals.[2,5] Another study has shown that the incidence of three canals in mandibular first premolars ranges from 0.4% to 2%.[6,7] Furthermore, Fan et al[8,9] reported that 24% or more of mandibular first premolars have C-shaped root canals.

Cone-beam computed tomography (CBCT) and micro-CT are commonly used in dentistry,[10] and can accurately determine root canal morphology.[11–16] However, CBCT and micro-CT are not available in all parts of the world, especially underdeveloped and developing countries, and due to the cost and dose of radiation periapical X-rays are still the most widely used method for determining root canal morphology prior to endodontic treatment.[10] Accurate detection of complex canal morphology on X-ray is necessary to avoid missing root canals during treatment, but this can be difficult. Thus, the purpose of this study was to determine the best radiographic method for determining root canal morphology of mandibular first premolars.

Materials and methods

This study utilized mandibular first premolars extracted due to caries, periodontal disease, trauma, and other reasons at the Department of Oral and Maxillofacial Surgery of Taipei-Veteran General Hospital. Only first premolars with a mature and intact root structure and devoid of fractures were used. The details of the collection, preparation, and anatomical examination of the teeth have been previously published.[5] This study was approved by the Institutional Review Board of the hospital, and all patients had previously provided informed consent for the dental procedures performed.

Both buccolingual and mesiodistal parallel radiographs were obtained for each tooth using a Size 2, E speed radiograph cassette (CEA AB, Strangnas, Sweden), and a Heliodent DS X-ray system (Sirona Dental Company, Bensheim, Germany). The source—object distance was 55 mm, and other parameters were 7 mA, 60 kVp, and a 0.12-second exposure time. Radiographs were developed with an automatic X-ray film processor (Dent-X 810 Basic Auto Film Processor; Dentx Visionary Imaging, Elmsford, NY, USA) and mounted. Each radiograph was examined independently by two endodontists, each with $>$ 10 years' experience, using a 2 $\times$ magnifying viewer (JS Dental Manufacturing, Inc., Ridgefield, CT, USA) with a bright view box (King bright box, 5000 D $\times$ 10 W $\times$ 2; Asanuma & Co., Ltd., Hamamatsu, Shizuoka, Japan). The final analysis and findings of the radiographs were reached by consensus of the two reviewers.

Four indices were examined for their ability to identify complex root canal morphology: (1) root canal bifurcation observed in the buccolingual view; (2) root canal continuity in the buccolingual view; (3) double root outline in the buccolingual view; and (4) Vertucci canal classification in the mesiodistal view.[17]

Root canal continuity was classified as previously described.[18] Briefly, the classifications were as follows: (A) large canal becoming less obvious, and may logically determine there is a bifurcation; (B) large canal becoming thinner and deviating towards one side, there may be one small and one large canal or furcated roots, and may logically determine that there is a bifurcation; (C) medium root canal, gradual tapering, cannot logically determine that there are two canals but proximal view may display a second root canal; and (D) buccolingual view shows a direct bifurcation.

Statistical analysis

Counts and percentages were calculated for the X-ray characteristics of the root canal configuration and outline of the root in both the bucco-lingual and mesio-distal views. To test the efficacy of the four indices, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, and positive and negative likelihood ratios (LRs) with 95% confidence intervals were calculated using the findings of standard of cross-sectional imaging as the gold standard. The indices were calculated by the following formulas.

Sensitivity (true positive rate) = (number of positive results / total number of complicated canals) $\times$ 100.

Specificity (true negative rate) = (number of negative results / total number of single canals) $\times$ 100.