A Cone-beam Computed Tomographic Study of Apical Surgery–related Morphological Characteristics of the Distolingual Root in 3-rooted Mandibular First Molars in a Chinese Population

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Abstract

Introduction: Apical surgery on the separate distolingual (DL) root of a 3-rooted mandibular first molar is thought to be difficult because DL roots are always severely curved, small, and shorter than distobuccal (DB) roots, and they are located far from the buccal cortical bone. The purpose of this study was to use cone-beam computed tomographic images to investigate the apical surgery–related morphological characteristics of DL roots in a Chinese population. **Methods:** The screening process identified 83 subjects with 128 mandibular first molars with separate DL roots. The degree of root canal curvature was measured in the mesiodistal (MD) and buccolingual (BL) planes using the Schneider method. Distances were measured from the DL root apex to the buccal cortical bone, to the buccal cortical bone opposite the DB root apex, and to the buccal cortical bone opposite the mesiobuccal (MB) root apex. The lengths of the remaining DB, MB, and DL roots were measured after resection of 3 mm of the DL apical root. Angulations of the DL root canal were determined before and after DL apical root resection. **Results:** The teeth were classified into 3 types: type I, straight in the MD and BL planes; type II, straight in the MD plane and curved in the BL plane; and type III, curved in the MD and BL planes. Only 5 molars (3.9%) were classified as type I, whereas 52 (40.6%) molars were type II and 71 (55.5%) molars were type III. The type I DL root has a significantly shorter length and longer distance from the DL root apex to the buccal cortical bone than type II and III roots ($P < .05$). The distance from the DL root apex to the buccal cortical bone opposite the MB root apex is significantly longer than the distance to the buccal cortical bone opposite the DB root apex in types I and II ($P < .05$), whereas the distance is nearly equal for type III. The angulations for root-end preparation of types II and III DL roots vary from 57.5° to 129.1° and from 55.8° to 128.1°, respectively. **Conclusions:** A new classification was proposed for DL roots in 3-rooted mandibular first molars based on the root canal curvature. Type I is unsuitable for apical surgery. Access to the type II DL root apex should be through the DB root apex, whereas access to the type III DL root apex through the MB root apex is more feasible. Apical surgery on types II and III DL roots may be accomplished when the depth of the root-end preparation is reasonably reduced, and fine and personalized angulated ultrasonic retro tips are used. *(J Endod 2017;■:1–5)*

Key Words

Cone-beam computed tomography, distolingual root, endodontic microsurgery, mandibular first molar

Significance

We proposed a new classification for DL roots in 3-rooted mandibular first molars based on the root canal curvature. Apical microsurgery on types II and III DL roots may be accomplished using a modified protocol with different surgical access.

A thorough understanding of root and root canal morphology is crucial for nonsurgical and surgical endodontic treatment. In addition, the related morphological characteristics, such as the buccal bone thickness and the relationship to the mandibular canal or maxillary sinus floor, are also important, particularly for surgical treatment.

A third root, the separate distolingual (DL) root in the mandibular first molar, is considered to be a normal morphological variant among populations with Mongoloid and Eskimo traits, including Chinese, Korean, Native American Indian, and Eskimos, with a high incidence of 5%–40% (1–4).

Several *in vivo* and *in vitro* studies have revealed that separate DL roots of mandibular first molars are always severely curved, small, located far from the buccal cortical bone, and shorter than distobuccal (DB) roots (1, 2, 5–9). Therefore, surgical access to the DL root apex is hindered by thick buccal bone and DB roots. Because of these morphological characteristics, intentional replantation or extraction is usually chosen (instead of apical surgery) when surgical treatment of DL roots is necessary.

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However, DL roots are easily fractured during the extraction procedure of intentional replantation, even with the latest technique of atraumatic safe extraction (10). Undoubtedly, apical microsurgery *in situ* is the best option, if feasible. To date, in the literature, there has been only 1 case report (our own) of a 3-rooted mandibular first molar with a separate DL root being successfully treated using endodontic microsurgery (11). The purpose of this study was to use cone-beam computed tomographic (CBCT) images to investigate the apical surgery–related morphological characteristics of separate DL roots of mandibular first molars in a Chinese population.

Materials and Methods

Subjects

CBCT images of mandibular first permanent molars were collected from patients who visited the Qindu Hospital of Stomatology of the Fourth Military Medical University, Xi'an, China, between October 2013 and July 2014. We searched a database of 2452 limited-volume CBCT scans, and we evaluated 83 patients who met the following inclusion criteria:

1. Were between 12 and 75 years of age
2. Had scans containing the unilateral or bilateral 3-rooted mandibular first permanent molar
3. Had mandibular first permanent molars with fully formed apices and no root canal fillings, posts, or crown restorations

Radiographic Evaluation

The CBCT machine used for tooth identification (Galileos; Sirona Dental Systems GmbH, Bensheim, Germany) produced isotropic voxels sized 0.25 mm (85 kVp, 28–42 mA). The 3-dimensional images were reconstructed with GALAXIS 3D viewer software (Sirona Dental Systems GmbH).

Serial axial, coronal, and sagittal CBCT images were continuously evaluated by moving the toolbar from the floor of the pulp chamber to the apex to measure the following data.

1. Root canal curvature: the degree of root canal curvature was measured in the mesiodistal (MD) and buccolingual (BL) planes using the Schneider method. A curvature of less than 10° was classified as straight, and a curvature of more than 10° was classified as curved (5, 12).
2. Apical root resection and root length: the length of the DL apical root resection (from A to B, A means DL root apex) is 3 mm. A virtual plane through point B, which is vertical to the long axis of the tooth, was obtained. The plane and the DB root canal intersect at point H, and the MB root canal intersects at point E. The distance from G (the DB root apex) to H indicates the length of the DB apical root resection when surgical access to the DL root apex is through the DB root apex, whereas the distance from D (the MB root apex) to E indicates the length of the MB apical root resection when surgical access to the DL root apex is through the MB root apex. The lengths of the DB and DL roots were measured from the lowest level of the distal furcation to the root apex, and the MB root length was measured from the lowest level of the buccal furcation to the root apex (ie, DL root = AB + BC, MB root = DE + EF, and DB root = GH + HI) (Fig. 1).
3. Distance: this includes the mean thickness of the buccal bone (line B, from the DL root apex to the buccal cortical bone plate), the DB access distance (line A, from the DL root apex to the buccal cortical bone plate opposite the DB root apex), and the MB access distance (line C, from the DL root apex to the buccal cortical bone plate opposite the MB root apex) (Fig. 2).
4. Angulations: the angulations for root-end preparation on the DL root canal (ie, the angle between the DL root canal and the horizontal line) before (α, from the root apex A) and after apical root resection (β, from the point B, 3 mm from the root apex) (Fig. 1).

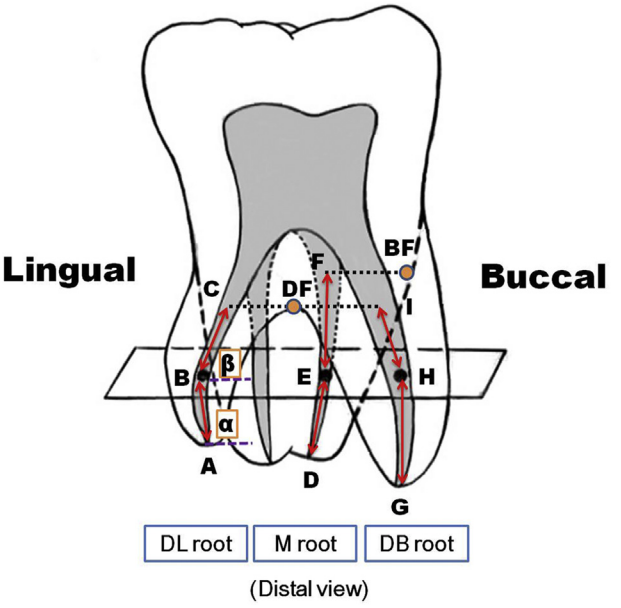

Figure 1. Apical root resection and root length.

Statistical Analysis

t tests were used to evaluate statistically significant differences with SPSS software for Windows (Version 16.0; SPSS, Inc, Chicago, IL). The level of statistical significance was set at $P < .05$.

Results

The study included 83 subjects (39 females and 44 males) with 3-rooted mandibular first molars with separate DL roots. A total of 45 subjects had bilateral 3-rooted mandibular first molars, and 38 subjects had unilateral 3-rooted mandibular first molars (128 molars in total).

The teeth were classified into 3 types based on the curvature of the DL root canal: type I, straight in the MD and BL planes; type II, straight in

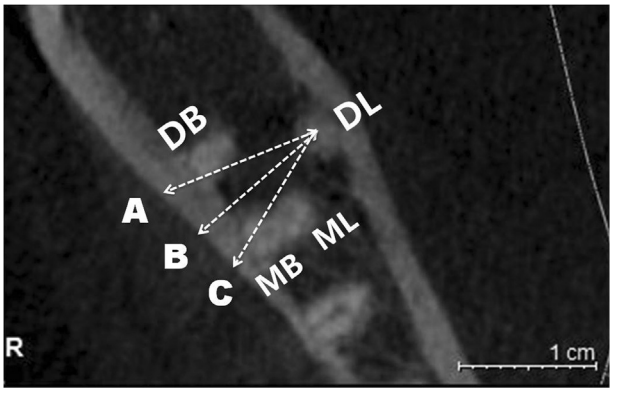

Figure 2. Distance from the DL apex to the buccal cortical bone.