Micro–Computed Tomography Analysis of the Root Canal Anatomy and Prevalence of Oval Canals in Mandibular Incisors

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Abstract

Introduction: This study aimed to describe the anatomy of the mandibular incisors by using micro–computed tomography. **Methods:** Mandibular incisors (n = 340) were scanned at 19-μm voxel size resolution, and the numbers of canals were classified according to Vertucci classification, as well as the major and minor diameters of the root and root canals, presence of oval canals, and three-dimensional analysis of the apical third were also measured. Data were presented in terms of median and range for each anatomic classification. **Results:** Overall, the specimens had 1 root canal (N = 257). The second most prevalent anatomy was Vertucci type III (N = 56). These anatomies represent 92% of the sample. The medians of the major diameter at the 1-, 2-, and 3-mm level of the most prevalent anatomies were 0.36, 0.39, and 0.47 mm for type I and 0.41, 0.51, and 0.66 mm for type III, respectively. The apical volume appears to be constant among these anatomies (0.63 and 0.59 mm^3). Oval canals were found at the 1-mm apical level, with a prevalence of 16.7% for Vertucci type I and 37.5% for Vertucci type III. The presence of oval canals increased at the 3-mm apical level to 32.4% and 76.2% for Vertucci type I and III classifications, respectively. **Conclusions:** Type I and III configurations represent 92% of the mandibular incisors studied. Within these anatomic configurations, oval-shaped canals in the apical third were not uncommon and more prevalent in the type III anatomy. *(J Endod 2013;39:1529–1533)*

Key Words

Dental anatomy, mandibular incisor, microcomputed tomography, oval canals

A detailed knowledge of the number of the root canal systems and cross-section morphology is required for successful root canal treatment (1). Failure to achieve complete cleaning of the main root canals and lateral anatomy can lead to the failure of the endodontic treatment because of the known infectious etiology of apical periodontitis.

The internal anatomy of the mandibular incisors has been described in several studies that used clearing or cross-sectional methods (1–9). The results of these studies show that mandibular incisors with single canals are the most common reported anatomy. The second most prevalent anatomic variation includes the presence of 2 canals that ends in a single foramen (Vertucci type III) (1, 5, 9). Despite the presence of single canals at the apical third of the mandibular incisors, the prevalence of oval canals is not uncommon (3).

Several studies have shown the difficulty to achieve efficient cleaning of the mandibular incisors with oval root canal anatomy by using hand or rotary instruments (10–13). In addition, the consequent unfilled spaces of this incomplete cleaning usually decrease the quality of several filling techniques in this anatomy (14). Despite the considerable number of studies describing the internal configuration of the mandibular incisors, only a few studies have reported the apical diameters and the prevalence of oval canals at the apical third (3, 8).

Micro–computed tomography (micro CT) has been intensively used in recent years to get an in-depth description of the root canal configuration of different teeth. Algorithms used in this method allow bidimensional and tridimensional analyses that are impossible to obtain by using clearing or cross-sectional techniques (15). Thus, the aim of this study was to describe the anatomy of the root canals of mandibular incisors according to Vertucci classification and to evaluate the apical diameter, volume, and root thickness at the apical level. In addition, the prevalence of oval canals at the apical third was also determined.

Materials and Methods

Three hundred forty mandibular incisors that were extracted for nonrestorable caries or periodontal disease from a Brazilian population were acquired after the ethics committee in human research approved the protocol (CEP 131/2010). The age and sex of the patients were unknown. Teeth with an open apex or with previous endodontic treatment were excluded. The samples were scanned by using a Skyscan 1174

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Supported by grants of CNPQ and FAPESP process (2010-16072-2), (2013-03695-0).
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0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2013.08.033

micro-CT system (Bruker-microCT, Kontich, Belgium). The parameters used were 50 kV, 800 mA, and a voxel size of 19.6 μm. The system includes a charge-coupled device camera (1304 × 1024 pixels). Radiographic images of each sample were reconstructed by using the NRecon software (Bruker-microCT). Three-dimensional models were reconstructed after the segmentation and binarization processes with CTAn v.1.12 software (Bruker-microCT). CTVol v.2.2.1 and data viewer softwares (Bruker-micro CT) were used for visualization and evaluation of the internal anatomy according to Vertucci classification (1). CTan software was also used to calculate the apical volume of the samples from the 1- to 3-mm apical level, and the results were expressed in mm^3.

For the two-dimensional analysis, cross sections of the apical portion of the teeth were selected. The cross sections selected from the "stack" were determined at 1, 2, and 3 mm from the apex. The more prevalent anatomies, Vertucci I and III, had their apical diameters measured from the 1-mm to the 3-mm apical level. The short and long diameters were obtained by measuring the mesiodistal and buccolingual distances of the root canal, and the results were expressed in millimeters. Other anatomic parameters such as the buccolingual and mesiodistal root thickness at the apical level were also measured (Fig. 1). These parameters were taken by using the measurement tool of the data viewer software (Bruker-microCT). The measurements were repeated twice to ensure reproducibility.

The presence of oval canals at the 1- to 3-mm apical level was determined in the more prevalent anatomies, Vertucci types I and III classifications, by using the ratio of the long and short diameters according to Wu et al (3). This value represents the degree of circularity of the root canal. The higher the value is, the more oval the canal is. The Vertucci classification evaluation was made descriptively. The volume and apical diameter at the 1- to 3-mm level were expressed as the median and range values. The presence of oval canals was expressed in terms of percentages.

Results

The tridimensional evaluation of 340 root canal systems showed that 324 teeth were plausible for classification according to Vertucci classification (1) (Table 1). The most prevalent anatomies were type I (75%)

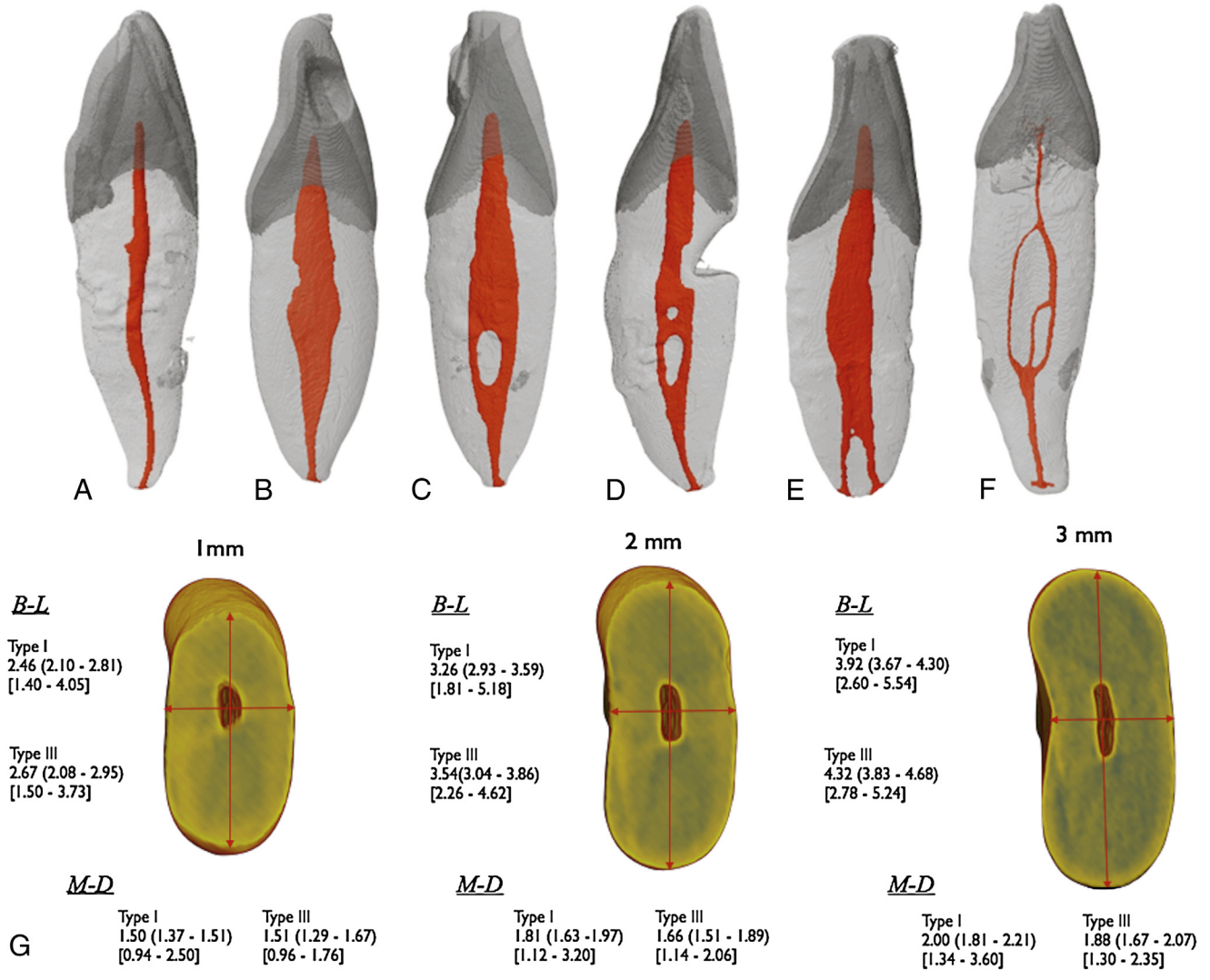

Figure 1. Representative tridimensional reconstructions of mandibular incisors showing different Vertucci classifications. (*A*) Type I, (*B*) type I oval canal, (*C*) type III, (*E*) type V, and 2 new classifications, (*D*) I-II-I-II-I and (*F*) I-II-III-I. The buccolingual (B-L) and mesiodistal diameters (M-D) of the root thickness of Vertucci type I and III variations are shown in (*G*). The values represent median, 25%–75% percentiles, and range of the root thickness at 3 different levels (1–3 mm). The values are expressed in mm.