Root Canal Morphology Evaluation of Central and Lateral Mandibular Incisors Using Cone-beam Computed Tomography in an Israeli Population

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Abstract

Introduction: Central and lateral mandibular incisors usually have 1 root canal. The purpose of this study was to investigate the prevalence of additional root canals in central and lateral mandibular incisors and to investigate the prevalence of oval and long oval canals in the cervical, middle, and apical thirds of cases with 1 root canal. **Methods:** A total of 1016 Israeli patients' cone-beam computed tomography scans were screened and evaluated. A total of 1472 central mandibular incisors and 1508 lateral mandibular incisors were examined. The root canal morphology and cross-sectional shape were recorded and analyzed. **Results:** The overall prevalence of more than 1 root canal in mandibular central and mandibular lateral respectively was 40.5% and 37.9%. The bilateral incidence of more than 1 root canal in mandibular central and mandibular lateral respectively was 69.8% and 68.7%. The root canal separation in type II to type V central and lateral mandibular incisors was found in the middle third of the root in 81.5% and 79.0%, respectively. The septum was smaller than 1 mm in 37% of central mandibular incisors and one-third of lateral mandibular incisors. In central and lateral incisors with 1 root canal, long oval canals were found in the middle third of the root of central and lateral mandibular incisors in 36.8% and 48.9%, respectively. **Conclusion:** The occurrence of more than 1 root canal in central and lateral mandibular incisors is approximately 40% (type III was the predominant canal type). In central and lateral incisors with 1 root canal, long oval canals are common. *(J Endod 2017;■:1–5)*

Key Words

Central mandibular incisor, cone-beam CT, lateral mandibular incisor, root canal morphology

Significance

The occurrence of more than 1 root canal in central and lateral mandibular incisors in the Israeli population is approximately 40%. Long oval canals are common in central and lateral incisors with 1 root canal.

A thorough knowledge of tooth morphology is a prerequisite for successful endodontic treatment (1). Several studies investigated central and lateral mandibular incisors root canal morphology. Vertucci (2) described the complex canal system and identified 8 pulp space configurations. He found that a single canal with 1 foramen was identified in 70% of mandibular central incisors and in 75% of the mandibular lateral incisors. Miyashita et al (3) examined the root canal configuration of 1085 mandibular incisors. They found 87.6% of single canals from the pulp chamber to the apex. Green (4) found that 79% of 500 central and lateral mandibular incisors had 1 major canal with 1 apical foramen.

In addition to the number of canals in central and lateral mandibular incisors, another important property of root canals is their cross-sectional shape. Root canals have different cross-sectional shapes: round, long oval, and C-shaped. Wu et al (5) defined long oval canals as canals with a long diameter that is at least twice that of their short diameter. They discovered that long oval canals are relatively common, even in the apical 5 mm of root canals, and occur in at least 25% of teeth. In mandibular incisors, the percentage of long oval canals exceeded 50% at 2 to 5 mm from the apex (5). Jou et al (6) classified the cross-sectional root canal configurations as round, oval, long oval, flattened, or irregular. They defined oval as having a maximum diameter up to 2 times greater than the minimum diameter and long oval as having a maximum diameter 2 to 4 times greater than the minimum diameter (6).

Cone-beam computed tomography (CBCT) has become increasingly common in endodontic practice. CBCT has been found to be useful for the diagnosis of root canal morphology (7–9) and for identifying additional canals and roots (10–14). A search of the literature has not revealed any study based on CBCT that looked at the incidence or configurations of long oval canals and has not revealed any study of the anatomy of mandibular incisors in Israeli populations.

The first purpose of this study was to investigate the prevalence of second canals in central and lateral mandibular incisors in Israeli populations and to classify them using CBCT. The second purpose was to identify the length and width of the septum. The third purpose was to investigate the prevalence of oval and long oval canals in cases of 1 root canal.

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Materials and Methods

The study was approved by the Ethics Committee of Medical Corps, Israeli Defense Forces (IDF-1258). A total of 1016 patients' retrospective dental CBCT (Alioth series; Asahi Roentgen IND, Kyoto, Japan) records, which had already been recorded in a radiographic institute in Israel from 2009 to 2012, were examined.

The criterion for inclusion was the presence of at least 1 central or lateral mandibular incisor in the CBCT scan. All teeth that had previous endodontic treatments, canal obliteration, or artifact images that could prevent a correct analysis were excluded. The presence of artifacts can be due to full crown restorations, adjacent implants, or incorrect radiologist technique.

The patients (446 male and 570 female) were referred to this institute and required a tomography examination by CBCT as part of their dental examination, diagnosis, and treatment planning.

The CBCT images were taken using the Asahi Alioth CBCT device with a 360-degree X-ray tube head rotation. All CBCT scans were reformatted to the standard manufacturer's settings so that the exposure parameters of each scan were constant: tube voltage 85 kV, tube current6 mA, and field of view 80 × 80 mm, with an isotropic resolution of 0.155 mm. All CBCT exposures were performed with the minimum exposure necessary for adequate image quality.

Personal details, including age and sex, of all patients were recorded. The CBCT images were displayed with OnDemand3D software (CyberMed, Irvine, CA) in a darkroom. All CBCT anonymized images were analyzed simultaneously by 2 graduate endodontic residents to reach a consensus for the interpretation of the radiographic findings. In cases of disagreement, a third definitive evaluation was conducted by an endodontist with 10 years of experience. All the evaluators were calibrated by analyzing 20 random cases of central and lateral mandibular incisors using slices of 3 planes (sagittal, axial, and coronal) based on the same criteria and variants.

All dental CBCTs recorded from 2009 to 2012 were evaluated. Inclusion criteria for CBCT images were the presence of mandibular incisors with fully formed apices. Exclusion criteria for CBCT images were the presence of root canal treatments, posts, or crowns.

The following information was recorded and analyzed:

1. The root canal classification for each root according to Vertucci (2) (except type VIII, which, in our study, includes all other different morphologies):
   - Type I: A single canal appears from the pulp chamber to the apex (Fig. 1).
   - Type II: Two separate canals leave the pulp chamber but merge into 1 to the apical foramen.
   - Type III: One canal leaves the pulp chamber, divides into 2 within the root, and then merges into 1 to the apical foramen.
   - Type IV: Two distinctly separate canals are present from the pulp chamber to the apex.
   - Type V: A single canal leaves the pulp chamber but divides into 2.
   - Type VI: Two separate canals leave the pulp chamber, join at the midpoint, and then divide again into 2 with 2 separate apical foramina.
   - Type VII: One canal leaves the pulp chamber, divides, and then rejoins within the root, and finally redivides into 2 separate canals with 2 separate apical foramina.
   - Type VIII: All other different morphologies.
2. The beginning and end points of the separation in cases with more than 1 single canal (type II–type VII).
3. The degree of ovality of single canals (type I): round, oval, or long oval (Fig. 1).

The Pearson χ^2 test was applied to examine any statistically significant difference between central and lateral mandibular incisors. A P value less than .05 was considered significant.

Results

A total of 1016 patients, 573 female and 447 male individuals, aged 13 to 89 years (average age 38.35 years) were included in this study.

A total of 1472 central mandibular incisors and 1508 lateral mandibular incisors were evaluated. The distribution of central and lateral mandibular incisors is shown in Table 1. In central mandibular incisors, type I was found in 875 teeth (59.5%) and type III was found in 497 teeth (33.7%) (Fig. 1).

In lateral mandibular incisors, type I was found in 941 teeth (62.1%), and type III was found in 484 teeth (31.9%) (Fig. 1). In both central and lateral incisors, types II, IV, V, and VIII were rare, and type VI and VII were not detected at all (Fig. 2).

No significant difference was found between central and lateral mandibular incisors ($P > .05$). The bilateral incidence of more than 1 root canal (type II–type VIII) in central and lateral mandibular incisors was 69.8% and 68.7%, respectively.

The root canal separation in type II to type V mandibular central incisors was found in the middle third of the root in 81.5% of cases and in the cervical third of the root in 15.6% of cases. In 37% of the cases, the septum was smaller than 1 mm. In 30.7% of the cases, the septum started in the middle third and ended in the apical third of the root.

The root canal separation in type II to type V mandibular lateral incisors was found in the middle third of the root in 79% of cases and in the cervical third of the root in 19.7% of cases. In one-third of the cases, the septum was smaller than 1 mm. In 31% of the cases, the septum started in the middle third and ended in the apical third of the root.

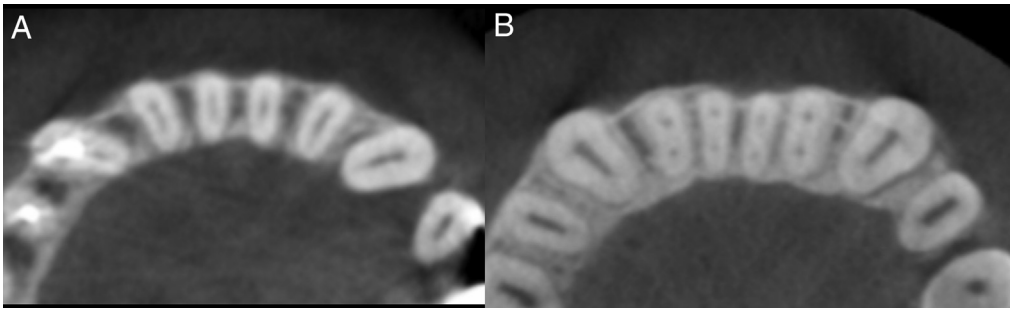

Figure 1. Cone-beam computed tomography images of central and lateral mandibular incisors: (*A*) long oval root canal and (*B*) 2 root canals.