Relationship between Root Apices and the Mandibular Canal: A Cone-beam Computed Tomographic Comparison of 3 Populations

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Abstract

Introduction: This study aimed to investigate the difference in the location of the inferior alveolar nerve (IAN) in relation to the apices of mandibular molars in 3 different populations using cone-beam computed tomographic (CBCT) imaging and to assess the proportion of teeth in close proximity (a distance of 1 mm or less) to the IAN. **Methods:** Random CBCT images (N = 1224, Israel = 408, South Korea = 416, and India = 400) were examined. The shortest distance to the mandibular canal was measured by imaging software. **Results:** The mean distance was 4.81 $\pm$ 2.15 mm. The mean distances for Israel, South Korea, and India were 4.60 $\pm$ 2.37 mm, 5.45 $\pm$ 2.13 mm, and 4.35 $\pm$ 1.76 mm, respectively. The distance in samples obtained from South Korea was significantly larger than the distance in samples obtained from Israel and India (P < .05). Samples from Israel exhibited close proximity in 6.6% of samples versus 3% in samples from India and 0.7% of samples from South Korea, a statistically significant difference (P < .05). **Conclusions:** Although variation in tooth morphology in different populations was widely researched, the variation in the location of the IAN in relation to tooth apices of different populations was not addressed in the literature. Our study reveals that a difference in the distance of the apices to the IAN exists between populations as well as a difference in the proportion of teeth in close proximity to the IAN. *(J Endod 2018;■:1–4)*

Key Words

Cone-beam computed tomography, inferior alveolar nerve, nerve injury

Significance

Our study is the first to address the differences in the location of the IAN between different populations. The proportion of teeth in close proximity to the IAN is defined.

The mandibular canal runs from the mandibular foramen to the mental foramen and contains the inferior alveolar artery, vein, and nerve (1). Damage to the mandibular canal and the inferior alveolar nerve (IAN) can cause paresthesia or dysesthesia in the region of distribution of the nerve (2, 3). Therefore, particular attention is required during surgical procedures and endodontic treatment in the posterior mandible because of the close spatial relationship between the upper border of the canal and apices of the mandibular molars (4). The possibility of a low microarchitectural density within the bone may create an unimpeded pathway for mechanical or chemical insults from the root end to the IAN (5).

During nonsurgical root canal treatment, the IAN may be affected (6). Direct nerve damage may be caused by overinstrumentation or length determination (7), extrusion of irrigants (8), or root canal filling materials. All of these may cause temporary or permanent damage to the IAN (9, 10). Root canal sealers are neurotoxic during the setting time (11) with some materials being known for their destructive effect on periapical tissues (12). Intracanal dressing materials can also cause nerve damage (13). Additionally, gutta-percha and paper points are claimed to cause injury to the IAN by mechanical impingement. Thermal injury can occur when warm obturation techniques are used (14). Hence, any extrusion of materials in proximity to the IAN should be avoided.

Cone-beam computed tomographic (CBCT) imaging provides 3-dimensional (3D) images with a moderate radiation dose (15), and numerous studies have reported its value in diagnosing spatial relationships between anatomic structures (16, 17). However, few studies have thoroughly evaluated the spatial relationship between the IAN and tooth apices (18–20). Some anatomic variations are described in the literature as being linked to ethnic groups (21). These include C-shaped canals (22), radix entomolaris (23), dens invaginatus (24), talon cusps (25), and others (26). It is reasonable to assume that ethnic groups will show variation concerning other anatomic structures, such as the location of the IAN.

To our knowledge, no research has been conducted using CBCT imaging on the relationship between root apices and the IAN comparing different populations, so the purpose of this article was to investigate those relationships in 3 geographically and ethnically dissimilar populations.

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Figure 1. (*A*) A representative image of a tooth apex inside the mandibular canal. (*B*) A representative image of a tooth apex with close proximity to the IAN. (*C*) A representative image of a tooth apex not in proximity to the IAN.

Materials and Methods

The study was approved by the Ethics Committee of Medical Corps, Israeli Defense Forces (IDF-1258). Two thousand five hundred anonymous CBCT scans were obtained from imaging centers in Israel, India, and South Korea. From those, a total of 1224 scans were selected at random as follows: 408 scans from Israel, 416 from South Korea, and 400 from India. Images from Israel were obtained using an Asahi Alioth apparatus (Asahi Roentgen Ind Co Ltd, Kyoto, Japan), images from South Korea were obtained using a PaX-Zenith 3D apparatus (Vatech Co, Hwaseong, Korea), and images from India were obtained using a ProMax 3D Mid apparatus (Planmeca OY, Helsinki, Finland).

Patient confidentiality was strictly respected, and no personal information was divulged. The CBCT scans were rendered anonymous using software to remove all of the patients' personal details, including name, age, sex, and the reason(s) for performing the scans. Scans were excluded if the posterior mandible was not included in the field of view, if any of the mandibular molars had been extracted, or if a periapical lesion or root resorption was associated with a mandibular molar. CBCT images were analyzed with OnDemand3D software (CyberMed, Irvine, CA) in a darkroom using a 21.3-inch flat-panel color active-matrix thin-film transistor medical display (MultiSync MD215MG; NEC, Munchen, Germany). The contrast and brightness of the images were adjusted using the image processing tool of the software to ensure optimal visualization. CBCT images were evaluated by 2 graduate endodontic residents who were calibrated based on the criteria and variants established before their evaluation. CBCT images were analyzed simultaneously to reach a consensus regarding the interpretation of the radiographic findings. In the case of disagreement, a third, definitive evaluation was conducted by an endodontist with 10 years of experience based on the same criteria and variants.

First and second mandibular molars were analyzed using 3 planes (sagittal, axial, and coronal) slices. Measurements were made from the closest point of the apices of the first and second molar (both distal and mesial roots) to the nearest point of the superior border of the mandibular canal that could be identified (Fig. 1). After normal distribution of data was confirmed by a Shapiro-Wilk test, an analysis of variance test with a Tukey B post hoc was performed. A P value <.05 was considered significant. A distance of 1 mm or less was defined as "close proximity."

Results

The average distance for all measurements was 4.81 mm (95% confidence interval [CI], 4.69–4.93). The average distance was 4.60 mm (95% CI, 4.37–4.83), 5.45 mm (95% CI, 5.25–5.66), and 4.35 mm (95% CI, 4.18–4.52) for Israel, South Korea, and India, respectively, with a statistically significant difference between measurements taken from South Korea and those taken from Israel and India ($P < .05$). No statistically significant difference was found between measurements from Israel and India ($P > .05$).

The average distance for the first molar was 6.18 mm (95% CI, 5.95–6.41) and 5.54 mm (95% CI, 5.33–5.75) for the mesial and distal roots, respectively, whereas the measurements for the second molar were 4.09 mm (95% CI, 3.89–4.30) and 3.42 mm (95% CI, 3.23–3.62) for the mesial and distal roots, respectively, revealing a statistically significant difference between mesial and distal roots and between the first and second molars ($P < .05$).

Close proximity was found in 3.4% of the samples. We discovered that the origin of the sample correlates with close proximity. A Pearson correlation analysis revealed that measurements from Israel were strongly ($R = 0.81$) associated with measurements of less than

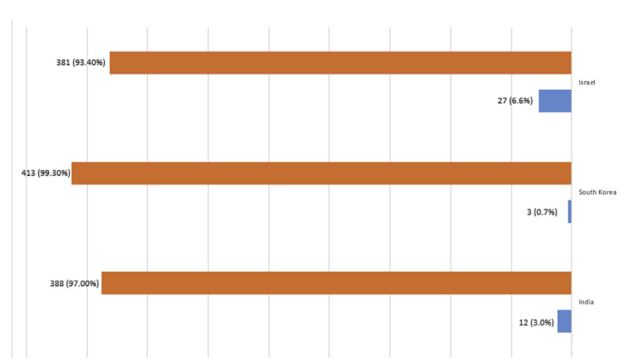

Figure 2. The number (percentage) of teeth with a distance of more and less than 1 mm from the mandibular canal according to the country of origin.