Proximity of the Mandibular Canal to Teeth and Cortical Bone

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Abstract

Introduction: The proximity of the inferior alveolar canal to the mandibular molar roots may pose a risk of injury during various dental surgeries. The purpose of this study was to evaluate age-related and gender-related changes by using cone-beam computed tomography images between the roots of the second molars, mandibular cortex, and the inferior alveolar canal. **Methods:** One hundred fifty-five patients (68 men, 87 women), 20 years and older, who had previous cone-beam computed tomography scans were enrolled in this study. The patients were subcategorized by gender and age (group I, <21 years; group II, 21–40 years; and group III, >40 years). Distance between the mandibular canal (MC) and the second molar distal root apex as well as the 3 mandibular cortical regions (inferior cortex, buccal cortex, and lingual cortex) were measured. **Results:** In men, the second molar root apex to the MC distance was significantly shorter in group I than in group III ($P < .01$). In women, the second molar root apex to the MC distance was significantly shorter in group I than in group II and group III ($P < .05$). In both men and women, the buccal cortex of the mandible to the MC distance was significantly shorter on the right side compared with the left side ($P < .01$). **Conclusions:** Our study shows that age, gender, and region have an influence on the location of the MC in the second molar area. *(J Endod 2016;42:221–224)*

Key Words

Inferior alveolar nerve, mandibular canal, mandibular cortex, mandibular second molar

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The inferior alveolar nerve (IAN) is located in the mandibular canal, which runs through the ramus of the mandible body to the mental foramen (1). The IAN supplies the mandibular molar and premolar teeth and adjacent parts of the gingiva. Its larger terminal branch emerges from the mental foramen as the mental nerve (2). Three nerve branches come out of the mental foramen. One innervates the skin of the mental area, and the other 2 proceed to the skin of the lower lip, mucous membranes, and the gingiva as far posteriorly as the second premolar (2). The IAN is the most commonly injured nerve (64.4%), followed by the lingual nerve (28.8%) (2). Most of the injury to the IAN is primarily iatrogenic (2). The proximity of the inferior alveolar canal (3) to the mandibular molar roots may pose a risk of IAN injuries during various dental interventions including dental implant placement (2–5), mandibular third molar extraction (6), and root canal treatment (7, 8) and may result in neuropathic pain or anesthesia. Injury to the IAN has been reported in up to 40% of the patients who had received dental implants (3, 4). Paresthesia can be seen as high as 13% in the posterior mandible from dental implant placement as a result of injury to the IAN (2). Endodontic therapy may also cause IAN injuries, which have been reported to occur in about 1% of mandibular premolar root canal treatment (8) and about 10% of mandibular second molar root canal treatment (9).

The mandibular second molar apices have been reported to be the closest to the mandibular canal compared with the premolars and the first molar (10, 11). Therefore, the dental procedures involving the mandibular second molar may have the highest risk to have IAN injury. Accurate determination of the location of the mandibular canal before dental procedures is crucial to avoid IAN injury.

Most of the information regarding mandibular second molar and the IAN are usually obtained from conventional periapical or panoramic radiographs. These 2-dimensional radiographs limit the ability to accurately perceive the relationship of the teeth and the neurovascular structures (9, 12, 13). The advent of 3-dimensional imaging such as cone-beam computed tomography (CBCT) has been crucial in understanding the anatomic relationship between teeth and the IAN (14, 15).

The purpose of this study was to evaluate age-related and gender-related changes by using CBCT images between the roots of the second molars, mandibular cortex, and the inferior alveolar canal.

Materials and Methods

All images in the study were obtained from the radiology database at Boston University Henry M. Goldman School of Dental Medicine, with appropriate approval from the Institutional Review Board at the outset of the project. Images were acquired by using i-CAT (Imaging Sciences International, Hatfield, PA) at 120 kVp and 4–7 mA with 14-bit gray scale resolution and voxel size of 0.125–0.3 millimeters. Measurements were made by using the i-CAT Vision software, and 155 patients' CBCT scans who underwent CBCT from April 2009 to September 2014 were enrolled (68 men, 87 women; mean age, 32.3 years) and randomly selected. The patients were subcategorized by gender and age (group I, <21 years, n = 51; group II, 21–40 years, n = 53; and group III, >40 years, n = 51). Inclusion criterion was existing second molar. Exclusion criteria were missing second molar, the second molar root apex was not formed,

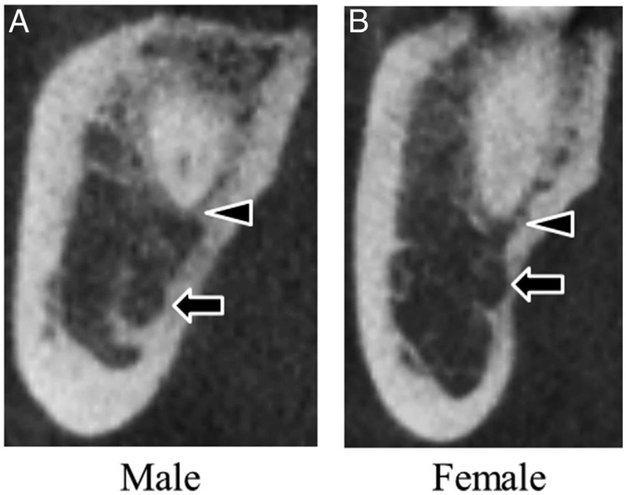

Figure 1. Cross-sectional CBCT images in both men (*A*) and women (*B*) showing location of mandibular canal (*arrows*) in relation to the apical of mandibular second molar distal root (*arrowheads*).

history of trauma, tumors, cysts, and periapical lesions presenting in the mandibular posterior region, and patients undergoing orthodontic treatment.

Measurement

All images were evaluated retrospectively by 2 calibrated examiners, and measurements were obtained independently. The observers were previously calibrated oral and maxillofacial radiologists with at least 5–15 years of experience in CBCT interpretation. The calibration consisted of both written and verbal instructions about CBCT image interpretation and the usage of the software. Distance between the mandibular canal and the second molar distal root apex as well as the 3 mandibular cortical regions (inferior cortex, buccal cortex, and lingual cortex) was measured on cross-sectional images (Fig. 1) as follows:

1. The mandibular second molar distal root apex (A) to superior cortical bone of the mandibular canal (MC): A-MC
2. The inferior cortical border of the mandible to the inferior cortex to the MC: I-MC
3. The lingual cortical border of the mandible to the MC: L-MC
4. The buccal cortical border of the mandible to the MC: B-MC

The distance from buccal cortex and lingual cortex to the mandibular canal was measured parallel to the occlusal plane. The distance from the second molar distal root apex to the mandibular canal and from the inferior cortex to the mandibular canal was measured vertical to the occlusal plane. The root apex that was below the mandibular canal was recorded as minus. All of the measurements were done on the 3-dimensional rendering software Invivo 5 (Anatomage, San Jose, CA) on a Dell UltraSharp (Dell, Round Rock, TX) 2408WFP 24-inch LCD monitor at a pixel resolution of 1920 × 1200.

After interval of 2 weeks, the distances of 4 locations in 12 patients were reevaluated for intraobserver and interobserver reliability.

Statistical Analysis

The data were recorded in Microsoft Excel (Microsoft Corp, Redmond, WA) and analyzed by using the statistical software added into the Microsoft Excel. Mann-Whitney *U* test and Steel-Dwass test were used to compare sex differences and age differences. *P* values less than .05 were considered statistically significant. Pearson product moment correlation coefficient was used to verify the intraobserver and interobserver reliability.

Results

Intraobserver and Interobserver Reliability

Intraexaminer and interexaminer reliability was assessed to determine the validity of measurements taken in this study. By using kappa statistics, the correlation coefficient ranged between 78% and 100%.

Age-related Changes

In men, A-MC distance was significantly shorter in group I (n = 26) (range, −2.40 to 8.99 mm; mean, 2.40 mm; standard deviation [SD], 2.69) than in group III (n = 21) (range, −1.16 to 8.36 mm; mean, 4.01 mm; SD, 2.27) (P < .01) (Table 1). In women, A-MC distance was significantly shorter in group I (n = 25) (range, −1.84 to 6.28 mm; mean, 1.40 mm; SD, 1.69) than in group II (n = 32) (range, −1.74 to 7.89 mm; mean, 2.58 mm; SD, 2.21) and group III (n = 30)

TABLE 1. Age-related Changes of the Distance to the Mandibular Canal from the Apex of the Second Molar and Inferior Cortex, Lingual Cortex, and Buccal Cortex of the Mandible

	Male, *n* = 68			
	Group I, *n* = 26 (mean ± SD)	Group II, *n* = 21 (mean ± SD)	Group III, *n* = 21 (mean ± SD)	*P* value
Apex to MC (mm)	2.40 ± 2.69**	3.42 ± 2.53	4.01 ± 2.27**	**<.01
Inferior cortex to MC (mm)	7.19 ± 2.06	7.53 ± 2.18	7.19 ± 1.74	
Lingual cortex to MC (mm)	2.40 ± 1.40	2.13 ± 1.17	1.94 ± 0.94	
Buccal cortex to MC (mm)	5.81 ± 1.69	5.96 ± 1.78	5.38 ± 1.27	
	Female, *n* = 87			
	Group I, *n* = 25 (mean ± SD)	Group II, *n* = 32 (mean ± SD)	Group III, *n* = 30 (mean ± SD)	*P* value
Apex to MC (mm)	1.40 ± 1.69*,**	2.58 ± 2.21*	3.36 ± 2.97**	*<.05 **<.01
Inferior cortex to MC (mm)	6.62 ± 1.73	7.32 ± 2.61	6.98 ± 1.80	
Lingual cortex to MC (mm)	3.00 ± 1.11	2.52 ± 1.00	2.72 ± 1.24	
Buccal cortex to MC (mm)	6.26 ± 1.51	6.04 ± 1.35	5.83 ± 1.38	

In male subjects, the distance between A-MC was significantly shorter in group I than in group III (**P < .01). In female subjects, the distance between A-MC was significantly shorter in group I than in group II and in group III (group I vs group II, *P < .05; group I vs group III, **P < .01).