Characteristics of Accessory Mental Foramina Observed on Limited Cone-beam Computed Tomography Images

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Abstract

In this retrospective study with limited cone-beam computed tomography (limited CBCT), we investigated the anatomic characteristics of the accessory mental foramina and accessory branches of the mandibular canal. The CBCT records of approximately 150 patients were evaluated, and 17 accessory mental foramina were found in 16 patients. The anatomic peculiarities of the mandibular canal that might be relevant to endodontic treatment were observed. Accessory mental foramina tended to exist in the apical area of the first molar and posterior or inferior area of the mental foramen. The accessory branches of the mandibular canal showed common characteristics in the course of gently sloping posterosuperior direction in the buccal surface area. Verification of the existence of accessory mental foramina would prevent accessory nerve injury during periapical surgery. In root canal treatment, the possibility of accessory mental foramina–related nerve paresthesia seems low unless the mental foramen and mandibular canal are injured. Limited CBCT is effective for presurgical 3-dimensional assessment of the neurovascular structures in dentoalveolar treatment. *(J Endod 2008; 34:1441–1445)*

Key Words

Accessory mental foramen, cone-beam CT, mandibular canal, mental foramen

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Confirmation of the mandibular canal course, which carries the inferior alveolar nerve, artery, and vein, is clinically important to avoid local injury to the nerve during surgical and endodontic procedures. Especially, it is crucial to identify the anatomic location of the mental foramen (MF) (1–3) and mandibular canal in relation to the root apices of the premolars and molars during root canal treatment. Labiomandibular paresthesia caused by endodontic overfilling involving the inferior alveolar nerve after root canal treatment is still a frequent complication despite the development of new endodontic technique (4–6).

On the other hand, the presence of small foramina identified as accessory mental foramina (AMF) in the surrounding area of the mental foramen has been discovered (7, 8). The reported frequency of occurrence of AMF has varied between less than 5% and about 30% (9–13). Concepcion et al. (14) encountered an accessory branch of mental nerve adjacent to the MF during flap reflection in a periapical surgery. Çağirankaya et al. (15) presented a case of AMF below the apex of the first molar demonstrated with intraoral radiographies for periodontal treatment.

The clinical significance of AMF remains a presumption. Toh et al. (16) described the distributions of accessory mental nerve emerging from the AMF to the mucous membrane and skin of the corner of mouth to the labial region. The group indicated the possible occurrence of pain caused by injury of the nerves emerging from the AMF by an injection via the mucous membrane. Boronat López et al. (17) mentioned the AMF as one of the factors implicated in regional anesthesia failure.

Recently, attention has been focused on anatomic variations in anterior jaw bone neurovascularization (18–20). The variation in the occurrence of the mandibular incisive canal has been revealed (21–24); however, an intraosseous path of the accessory branch of mandibular canal connected to the AMF has not been studied. Understanding the anatomic peculiarities of the mandibular canal could be relevant to periapical treatment and could contribute to the advancement of presurgical anatomic assessment (6, 25).

AMF can be rarely observed with intraoral and panoramic radiography because the size is generally less than 1.0 mm (16). Presurgical 3-dimensional (3-D) assessment with computed tomography (CT) made it possible to confirm the existence of AMF (26). However, observation of AMF smaller than the usual size and anatomic relationship among AMF, MF, and mandibular canal is difficult with the resolution of spiral CT. On the other hand, limited cone-beam CT (limited CBCT), which has been developed to produce high-resolution images for dental use (27–30), would be available for detection of the AMF and investigation of intraosseous course of the accessory branch of mandibular canal between the mandibular canal and AMF.

The objective of this study was to elucidate the anatomic characteristics of the AMF and accessory branch of the mandibular canal.

Materials and Methods

AMF was investigated on the limited CBCT images of mandibles taken for precise assessment between January 2005 and December 2007. Edentulous cases without stent indicative of each tooth position were excluded from the study. Informed consent for the study was obtained from all patients.

The limited CBCT PSR9000N (Asahi, Roentgen Ind Co, Ltd, Kyoto, Japan) was used. Cylindrical imaging area 41 mm in diameter and 40 mm in height in the dental CT mode was obtained with 400 axial images of 0.1-mm cubic voxel size. The exposure factors were 70–80 kV, 6–10 mA, and 13.3–6.7 seconds. The axial images were transmitted to the personal computer as the digital imaging and communications in medicine (DICOM) format and then reconstructed into multiplanar reconstruction (MPR) images by using the DICOM viewer (ExaVision SX Ver.1.13; Ziosoft, Tokyo, Japan).

In this report, the buccal foramina, which were smaller than the MF and followed by accessory branch of the mandibular canal, were identified and labeled as AMF regardless of location. MF and AMF were observed on both the axial and cross-sectional images (coronal or sagittal image) constructed on the basis of the occlusal plane and dentition. The existence of the AMF was confirmed on preferred viewing conditions of the oral radiologist because the window level and width in the observation of the images cannot be standardized as a result of low reliable CT values of the limited CBCT. The size of MF and AMF was assessed on the basis of the maximum size of the horizontal and vertical directions. Furthermore, linear regression analysis on the size of MF and AMF was performed with the statistical software SPSS Ver. 15.0 (SPSS Inc, Chicago, IL).

The location of MF and AMF was determined according to each tooth area. If both existed in the missing teeth area, the location was determined by the surgical stent, which indicated each tooth position. The positional relationship between MF and AMF was investigated as well. The relative position of the AMF to MF was classified into the following 8 areas: posterosuperior, posterior, posteroinferior, superior, inferior, anterosuperior, anterior, and anteroinferior areas. The shortest distance between MF and AMF was measured in the horizontal and vertical directions on the axial and cross-sectional (coronal) images.

The accessory branch of the mandibular canal, which was identified as a canal connecting the mandibular canal and AMF, was observed with respect to its direction, branched position in the mandibular canal, and length. Its course was investigated on the axial and serial cross-sectional images, and the branched position was assessed on the basis of the horizontal distance from MF. The length of the branch was measured on reconstructed MPR images along its direction.

Results

Seventeen AMF were detected in 16 patients including 1 patient with double AMF. In 1 of the 16 patients, the imaging area of the limited CBCT had been also examined with panoramic (Fig. 1*C*) and intraoral radiography (Fig. 1*D*), which, however, could not detect AMF.

The median horizontal and vertical sizes of MF were 3.5 mm (range, 1.5–5.3 mm) and 2.6 mm (range, 1.3–3.8 mm), respectively, whereas those of AMF were 1.6 mm (range, 0.7–2.6 mm) and 1.2 mm (range, 0.5–2.2 mm). When comparing MF with AMF, there was no significant correlation on the horizontal ($r = -0.11$, $P = .66$) and

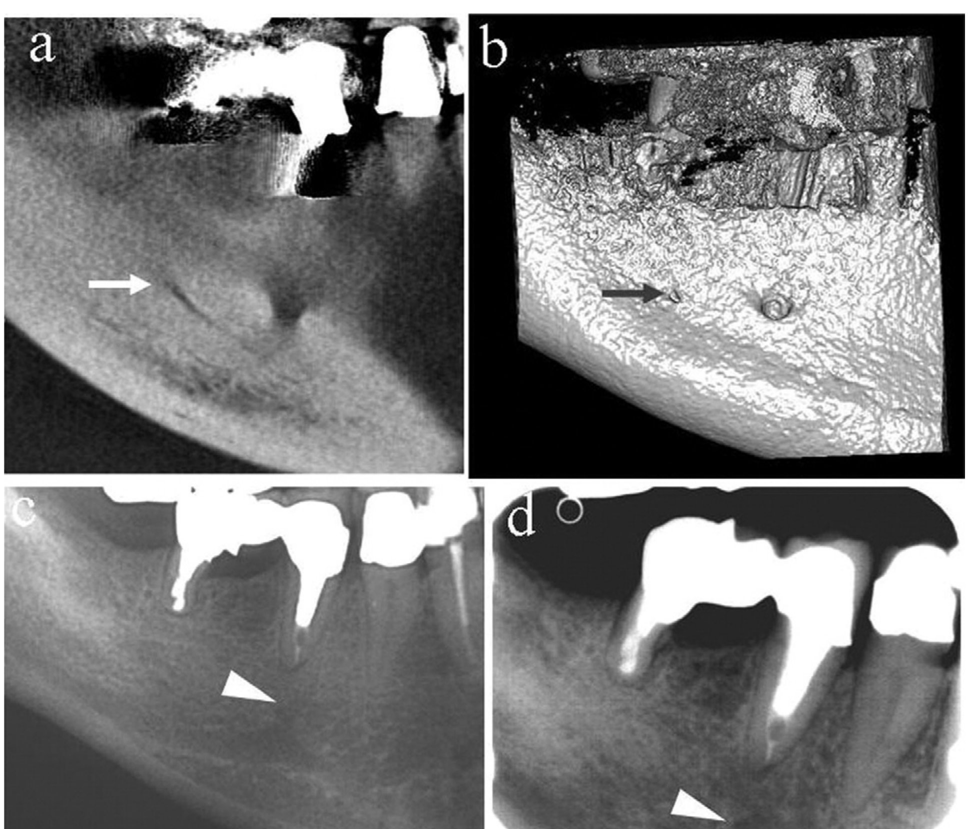

Figure 1. Comparison between limited CBCT images (*a, b*), panoramic (*c*), and intraoral radiograph (*d*) of the same patient's mandible. A sagittal MPR image (*a*) revealed the superoposterior course of the accessory branch of mandibular canal connecting to the AMF (arrow), and the AMF existing in the posterior area of the MF (arrow) can be observed in 3-D images (*b*). Only the MF (arrowheads) is described with the conventional radiography (*c, d*).

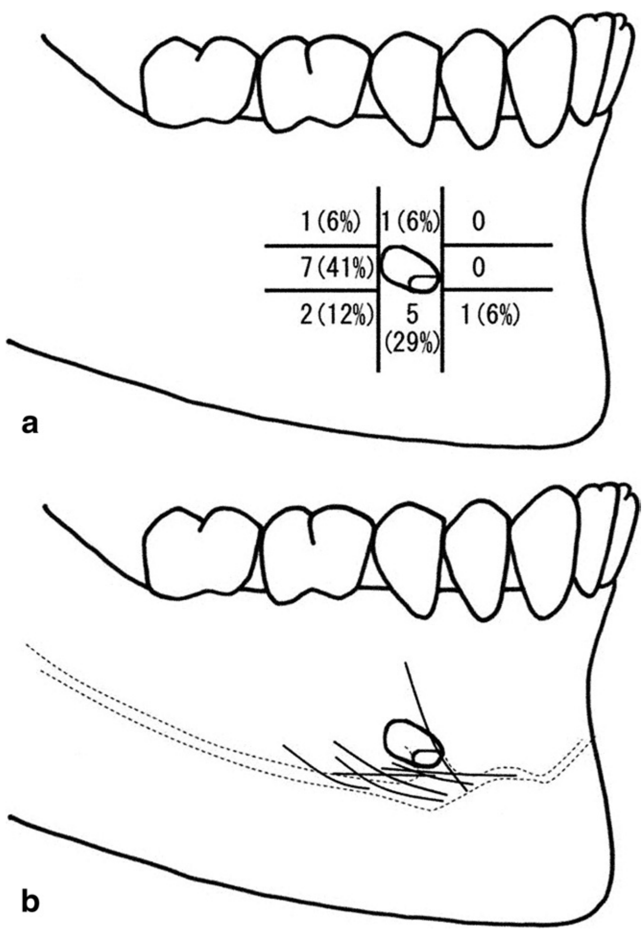

Figure 2. Positional relationship between the MF and AMF (*a*) and course of the accessory branch of mandibular canal (*b*). Gentle posterosuperior direction was common to all branches, and only 1 branch showed a steep slope to the root apex, which belonged to the patient with double AMF.

vertical (r = 0.15, P = .64) sizes. The appearance of AMF was concentrated in the apical area of the first molar, whereas MF was most frequently observed in the apical area of the second premolar. In any case, AMF was observed in the area between the first premolar and first molar.

As regards the positional relationship between MF and AMF, 10 of the 17 AMF (59%) were positioned in the posterior and 8 (47%) in the inferior area of MF (Fig. 2*A*). The median shortest distance between MF and AMF was 2.0 mm (range, 0–7.4 mm) in the horizontal direction and 0.5 mm (range, 0–3.58 mm) in the vertical direction. Almost always, the accessory branches coursed in the posterior or posterosuperior direction, with a gentle angled slope (Fig. 2*B*) in the buccal surface area. Only 1 accessory branch showed a steep slope to the root apex of the second premolar, which was one of the 2 branches in the patient with double AMF (Fig. 3). There was no accessory branch coursing in the anterior and inferior directions. Most accessory branches occurred from the mandibular canal in the area adjacent to the MF. The most anterior distant branch was seen from the anterior loop of the mandibular canal at 3.9 mm anterior to the MF, and the most posterior distant branch occurred from the main canal at 2.4 mm posterior to the MF. The median length of the accessory branch of mandibular canal was 4.4 mm (range, 1.7–10.6 mm).

Discussion

There are many osteologic studies on the frequency of occurrence of AMF (9–13); however, no study has demonstrated the distinction of AMF from other buccal foramina. A few studies reported the existence of a mental-incisive foramen complex, which was apparently similar to but distinct from the AMF in this respect that no intraosseous canals were found between the MF (31, 32).

Recently, the potential applications of advanced imaging modality that provided 3-D information have been discussed for endodontic and surgical treatment (33, 34). In this study, noninvasive 3-D observation of the course of fine accessory branch of mandibular canal was possible by using high-resolution limited CBCT images. A few buccal foramina were excluded from our definition of AMF because those connecting to the mandibular canal could not be identified.

In the osteologic and gross investigations, the diameter of MF ranged from 2.38–2.64 mm (35), whereas that of AMF ranged from 0.74–0.89 mm (16). In this study, most of the AMF were obviously smaller than MF; hence, discrimination between the two was not difficult. However, there were 2 AMF in which the sizes were relatively comparable to the MF.

Commonly, 3 branches of the mental nerve emerge from the MF (36, 37). One of them innervates the skin of the mental area, whereas the others spread to the skin of the lower lip, oral mucosa, and gingiva as far posterior as the second premolar. Hu et al. (38) categorized the mental nerve into 4 terminal branches as angular, medial inferior labial, lateral inferior labial, and mental branches, which originated from 3 or 2 main branches emerging from the MF.

On the other hand, descriptions of the area being supplied by the nerve leaving the AMF are few. Toh et al. (16) investigated the nerves emerging from the AMF in 3 cadavers and confirmed the distribution to the oral mucosa extending from the corner of the mouth to the labial region. They identified them as the accessory branch of the mental nerve and suggested the possible relation of the position of the AMF to the differences in areas of distribution. Thus, disturbance of the accessory branch of mental nerve as a result of surgical invasions is possible to occur, with low risk of serious sensory complication.

The 3-D radiologic observation indicated the common characteristics in the course of the accessory branch of the mandibular canal connected to the AMF, particularly the posterosuperior direction with the gentle angled slope in the buccal surface area. These findings correspond with the reported morphology of the mental nerve that the most frequent path of its emergence was the posterior direction (31). Our results also suggested that the AMF are presumed to be the result of branching of the mental nerve before its exit from the MF (32).

In this study, it was confirmed that the position of the AMF was influenced by the branched site and length of the accessory branch. The variance of the relative position of the AMF to MF was greater in the horizontal direction than in the vertical direction. Actually, all AMF were positioned similarly or just inferior to the level of the MF except for 1 patient with double AMF. It was thus considered that the accessory branch of the mandibular canal connecting the mandibular canal to the AMF is rarely injured because both the MF and mandibular canal are noted to prevent surgical injury. However, the risk of involvement in endodontic-related sensory disturbance, such as pain and paresthesia, could not be denied (39).

In conclusion, confirmation of the existence of the AMF could avoid nerve injury during periapical surgery. The possibility of AMF-related sensory disturbance is low during root canal treatment unless

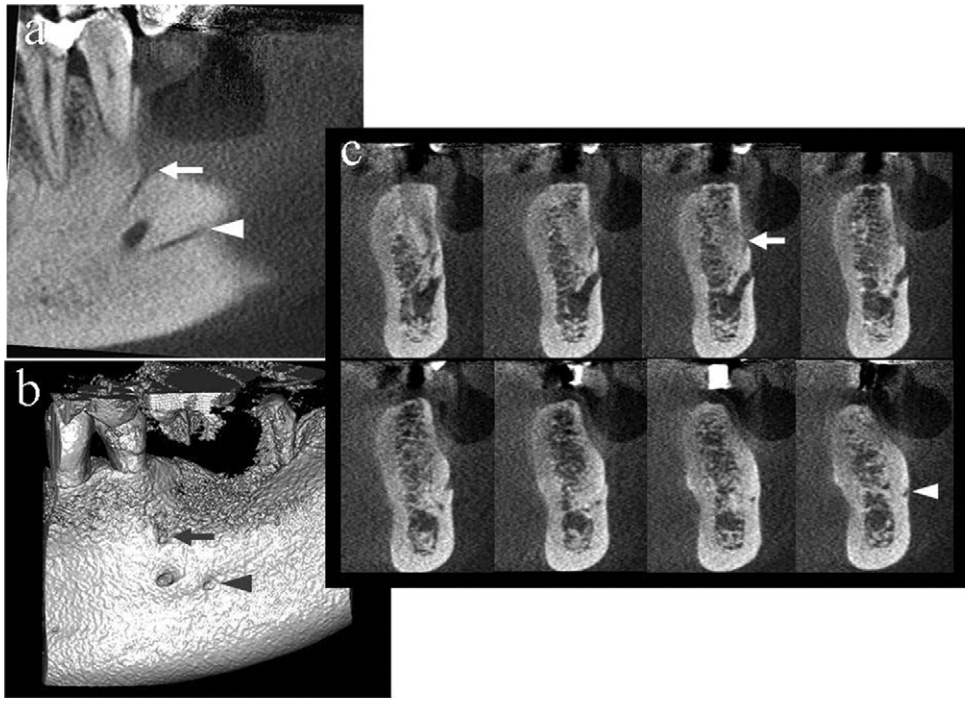

Figure 3. Observation of the double AMF on the sagittal (*A*), 3-D (*B*), and serial cross-sectional images to the distal direction (*C*). One AMF was observed in the apical site superior to the MF (arrow), and the other one was positioned distal and just inferior to the MF (arrowhead).

the MF and mandibular canal are injured. In dentoalveolar treatment, limited CBCT is effective as presurgical 3-D assessment of the neurovascular structures.

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