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Unilateral triple mandibular canal with double mandibular foramen: cone beam computed tomography findings of an unexpected anatomical variant

Running head: Accessory mandibular canals and foramen

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Abstract

The mandibular canal is a bony channel located within the spongiosa of the mandible. The main structure contained in the mandibular canal is the inferior alveolar nerve (IAN). The IAN is a very important structure that requires due consideration during dental or surgical procedures involving the mandible. Therefore, a detailed morphological analysis of the mandibular canal should be carried out before any surgical procedure in the mandibular region in order to avoid complications and to reduce the risk of inadequate local nerve blocking. The human mandible typically has a single mandibular canal on each side; however, accessory mandibular canals have been described previously in the literature. The most common variant of the mandibular canal is the bifid mandibular canal, which has a prevalence ranging from 10-66% on cone-beam computed tomography (CBCT) examinations. A rare variant of bifid mandibular canal is the trifid canal, accounting for less than 6% of all bifid canals. In some cases, the bifid and trifid mandibular canals are associated with a double mandibular foramen, which is a rare anatomical variant with a reported incidence of 1.35% on CBCT images. Herein, we present the interesting CBCT images of an unexpected anatomical variant characterized by unilateral triple mandibular canal with double mandibular foramen in a young Caucasian woman.

Key words: mandibular canal, anatomic variation, accessory mandibular canal, accessory mandibular foramen, mandible, cone beam computed tomography

INTRODUCTION

The mandibular canal is a bony channel located within the spongiosa of the mandible, typically close to the apices of the roots of the molars. The mandibular canal starts at the mandibular foramen (located on the lingual aspect of the mandibular ramus) and ends at the mental foramen (located on the buccal aspect of the mandibular body) [9]. It runs from the top to the bottom of the mandible, and forms an upward-facing curve.

The main structure contained in the mandibular canal is the inferior alveolar nerve (IAN). The IAN is the largest branch of the mandibular nerve, which is the third division of the fifth cranial nerve (*the trigeminal nerve*) [13]. Inside the mandibular canal, the IAN appears as a single large nerve bundle; however, it has been previously demonstrated that the IAN includes two distinct branches spirally twisted around each other [8]. Both nerves are wrapped in a layer of connective tissue (*the perineurium*). The larger branch corresponds to the mental nerve, whereas the smaller branch corresponds to the dental nerve [8, 13]. The mental nerve comes out at the level of the mental foramen, while the dental nerve continues its intra-mandibular course beyond the mental foramen within the incisive mandibular canal [13]

The IAN is a very important structure that requires due consideration during dental or surgical procedures involving the mandible, such as dental implant placement, endodontic treatment, mandibular molar extractions (especially of the third molars), and periapical and orthognathic surgeries [8]. Therefore, a detailed morphological analysis of the mandibular canal should be carried out before any surgical procedure in the mandibular region in order to avoid complications, such as neurosensory impairment, traumatic neuroma, or bleeding, and to reduce the risk of inadequate local nerve blocking.

In the interest of contributing a novel finding to the literature, this report presents interesting cone-beam computed tomography (CBCT) images of an unexpected anatomical variant characterized by a triple mandibular canal with double mandibular foramen in the same hemimandible in a young Caucasian woman.

CASE REPORT

During a retrospective search on the department radiology information system/picture archiving and communication system between January 2012 and December 2019, we came across interesting CBCT images of a young Caucasian woman who underwent a CBCT scan of the mandible as part of her routine dental examination. The patient was in good health, and no systemic disease or hereditary syndromes were reported. The examination was carried out with high-quality CBCT scanner (NewTom Cone Beam 3D Imaging, Verona, Italy) using the following parameters: tube

voltage, 90 kVp; tube current, 4 mA; and field of view, 10x8 cm. The CBCT acquisition data were reconstructed in the axial plane as thin-section images with a voxel size of 150 μ m.

Unexpectedly, the CBCT images revealed an extremely rare anatomical variant characterized by a triple mandibular canal on the left side of the mandible (Figs. 1, 2). On the same hemimandible, a double mandibular foramen (MF₁ and MF₂) was also observed (Figs. 1, 2). The maximum diameter of the left main mandibular canal (MC_{main}) was 2.6 mm, and the maximum diameters of the two accessory mandibular canals (AMC₁ and AMC₂) were 2 mm and 1.4 mm, respectively.

The intra-mandibular position of AMC₁ and AMC₂ was in close proximity to MC_{main} (Fig. 1).

AMC₁ originated from MC_{main} at the level of the second molar (Fig. 1). From its origin, AMC₁ ran forward in contact with the lingual cortex of the mandibular body, lingual to MC_{main} (Fig. 1). AMC₁ joined MC_{main} at the level of the mental foramen, continuing mesially into the incisive mandibular canal (Fig. 1). AMC₂ originated from a small accessory mandibular foramen (MF₂) located inferior to the main mandibular foramen (MF₁) (Fig. 2). From its origin, AMC₂ ran forward and inferior to MC_{main} (Figs. 1, 2). AMC₂ joined MC_{main} at the level of the second premolar (Fig. 1).

With respect to the distomesial course of the triple mandibular canal, while the intra-mandibular course of MC_{main} and AMC₂ formed an upward-facing curve (Fig. 2), the intra-mandibular course of AMC₁ showed a serpiginous shape in the anterior portion (Fig. 2).

DISCUSSION

The human mandible typically has a single mandibular canal on each side; however, accessory mandibular canals have been described previously in the literature [6, 10, 12, 14, 15]. The presence of accessory mandibular canals is likely due to the incomplete fusion of three distinct inferior alveolar nerves that merge to form the IAN during the prenatal period [3].

The most common variant of the mandibular canal is the bifid mandibular canal, which has a prevalence ranging from 10-66% on CBCT examinations [6, 10, 12, 14, 15]. It is detected in the posterior mandible or mandibular ramus [6, 10, 12, 14, 15]. The most common and clinically important type of bifid mandibular canal is the retromolar canal [6, 10, 12, 14, 15]. A rare variant of bifid mandibular canal is the trifid canal, accounting for less than 6% of all bifid canals [12, 14].

In some cases, the bifid and trifid mandibular canals are associated with a double mandibular foramen [12], which is a rare anatomical variant with a reported incidence of 1.35% on CBCT images [4].

To the best of our knowledge, the current report describes the CBCT findings of a novel anatomical variant characterized by the presence of a triple mandibular canal associated with a double

mandibular foramen; a variant that is not included in the classification systems of mandibular canal branching [2, 11], and that has not been reported previously.

Differently from bifid and trifid mandibular canals [12, 14] which are confined in the retromolar or molar region, our accessory mandibular canals (AMC_1 and AMC_2) ran forward and continued their intra-mandibular course beyond the posterior mandible by reaching the premolar region (Fig. 2).

AMC_1 joined MC_{main} at the level of the mental foramen, whereas AMC_2 joined MC_{main} at the level of the second premolar (Figs. 1, 2).

From a clinical point of view, accessory mandibular canals and foramina have relevant clinical implications because they can increase the risk of neurovascular complications and inadequate local anesthesia during mandibular surgical procedures. Therefore, preoperative radiological analysis of mandibular anatomical landmarks and their variations is of great importance to determine appropriate clinical management and reduce the occurrence of iatrogenic complications and IAN block failures.

In clinical practice, the presence of one or more accessory mandibular canals and/or foramina may be detected with different radiological techniques such as conventional X-rays, multidetector CT and CBCT. The main limitations of conventional X-rays (periapical and panoramic radiographs) include the two-dimensional nature of these radiographic examinations and the overlap of adjacent anatomical structures due to the lack of any cross-sectional information. Given these limitations, certain anatomical variants within mandible may be difficult to detect. In addition, the presence of these variants could sometimes be misinterpreted as osteolytic lesion on conventional X-rays.

Both multidetector CT and CBCT are usually adequate for radiological assessment of the mandible. However, it is well known that CBCT outperform multidetector CT in displaying fine anatomical details (such as canals and foramina). Therefore, CBCT is currently considered the most accurate radiological imaging technique to study of fine anatomical details of the mandible and its variants. With the introduction and broad availability of CBCT scanners in clinical practice, an increasing number of anatomical variants are being detected, especially in the mandibular region [7, 9]. The number of reports that describe unusual anatomical variants within the mandible is also steadily increasing [1, 4, 5]. Therefore, radiologists should be aware of the clinical importance of reporting the number, caliber and course of any accessory mandibular canals and any additional variants that are incidentally observed during CBCT examinations.

CONCLUSIONS

This report describes the novel presentation of a triple mandibular canal associated with double mandibular foramen in a living human subject. Given that the occurrence of critical anatomical

variants associated with an increased risk of iatrogenic injury of the IAN is becoming more frequent nowadays, a preoperative CBCT study of the mandible is recommended before any oral and dental procedures are carried out in the mandibular region. In addition, awareness about the presence of these critical anatomical variants can also help prevent future misdiagnosis and unnecessary radiological investigations.

CONFLICT OF INTEREST: The authors declare that they have no conflict of interest

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Figure 1. Cross-sectional CBCT images show the buccolingual position of the three mandibular canals (MC_{main} , AMC_1 , AMC_2) on the left hemimandible. AMC_1 (*black arrowheads*) originates from MC_{main} at the level of the second molar (*white wavy arrow*). AMC_1 joins MC_{main} at the level of the mental foramen (*white curved arrow*). AMC_2 (*black curved arrows*) originates from a small accessory mandibular foramen (MF_2) inferior to the main mandibular foramen (MF_1). AMC_2 joins MC_{main} at the level of the second premolar (*black wavy arrow*). *White arrows*, MC_{main} ; *white arrowheads*, mandibular incisive canal; *black arrows*, mental foramen

Figure 2. Panoramic CBCT images demonstrate the distomesial course of the three mandibular canals (MC_{main} , AMC_1 , AMC_2) within the left hemimandible. (a, c) The intra-mandibular course of MC_{main} (*circles*) and AMC_2 (*dots*) forms an upward-facing curve. AMC_2 joins MC_{main} at the level of the second premolar (*curved arrow*). (b) The intra-mandibular course of AMC_1 (*asterisks*) shows a serpiginous shape in its anterior portion. AMC_1 originated from MC_{main} at the level of the second molar. Double mandibular foramen is also shown (*arrowheads*). *Large black arrows*, mental foramen



