



The anatomy of bifid mandibular foramina: a comprehensive review

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Abstract

The pterygomandibular fossa is a fascial space that encloses vital structures including the inferior alveolar nerve (IAN), which is the largest branch of the mandibular division of the trigeminal nerve. The IAN enters the mandible through the mandibular foramen and provides sensory innervation to the teeth of the lower jaw.

Oral health professionals need to appreciate the anatomy of the pterygomandibular fossa in order to achieve successful inferior alveolar anesthesia during oral surgery as well as implant placement and third molar extraction. Anatomical variations of the pterygomandibular fossa can influence the success of mandibular or alveolar blocks leading to inadequate anesthesia. Bifid mandibular foramina are a common anatomical anomaly encountered in patients with failed inferior alveolar blocks. The incidence of bifid mandibular foramina has been estimated by many studies to vary from 0.05% to 65% in the general population. Bifid mandibular foramina can occur unilaterally or bilaterally on the mandible. The prevalence, clinical significance and anatomy of a bifid mandibular foramen will be reviewed in this article.

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Introduction

Understanding the anatomy of pterygomandibular fossa is crucial for dentists since it is one of the target spaces for inferior alveolar nerve blocks prior to dental treatment. Failure of achieving adequate anesthesia was reported in 20% of inferior alveolar blocks [1].

The sphenomandibular ligament and the interpterygoid fascia are integral structures that define this area [2]. The borders of pterygomandibular fossa are parotid glandular tissue posteriorly and pterygomandibular raphe anteriorly which is made by the union of buccinator and superior pharyngeal constrictor muscles. The lateral border is defined by the mandibular ramus and the medial border is formed by medial and lateral pterygoid muscles [3].

Nerves passing through the pterygomandibular fossa include: lingual nerve, inferior alveolar nerve, and nerve to the mylohyoid. The inferior alveolar nerve (IAN) is the largest branch of the mandibular division of the trigeminal nerve [4]. The mylohyoid nerve branches off the IAN just before it enters into the mandibular foramen. Towards the anterior end of the mandibular foramen; the IAN branches into two main sensory nerves: mental nerve emerging from the mental foramen and the incisive nerve continuing its course anteriorly. The

mental nerve supplies the skin of the chin and oral mucosa while the incisive nerve is responsible for providing sensory innervation for first premolar, canines and incisors.

The IAN is also accompanied with inferior alveolar artery and vein. Inferior alveolar artery is a branch of the maxillary artery, although it has been reported that it can branch off the external carotid artery [5]. The IAN was found to be anterior to inferior alveolar artery in the majority of cadavers [6].

When administering inferior alveolar block into the patient; there are many factors that should be taken into consideration including needle gauge, patient age and sex, as well as anatomical variation within the pterygomandibular fossa. Common anatomical variations that influence the success of mandibular anesthesia are: bifid mandibular foramina [7], accessory mylohyoid nerve, contralateral innervation of the anterior incisors and retromolar foramen [8]. The scope of this review is to focus on the anatomy, prevalence and relevance of bifid mandibular foramina.

Bifid mandibular canals in radiological studies

A considerable amount of literature discusses anatomical variations in pterygomandibular fossa, affecting the IAN. Variants of the IAN are classified into extra-osseous and intra-

Table 1. Studies of the incidence of bifid mandibular canals.

Investigators	Reported rates of bifid mandibular canals	Age	Population (Location of the study)	Methods
de Oliveira-Santos et al. 2012 [18]	19% of patients from 100 patients (200 hemi-mandibles)	(17 patients) ≤ 20 years (27 patients) 21–40 (34 patients) 41–60 (22 patients) >60	98 Caucasians, two non-Caucasians	CBCT
Romanos et al. 2012 [19]	9% of the scans (total of 299 images)	13–93 Mean age 45.36	Germany	CBCT
Orhan et al. 2011 [20]	46.5% of hemi-mandibles, 242 patient out of a total of 484	17–83 Mean age 36.7	Turkey	CT
Kuribayashi et al. 2010 [13]	15.6% of research subjects, 252 patients (301 mandible sides)	18–74 Mean age is 33	Japan	CBCT
Naitoh et al. 2009 [14]	64.8% of patient population 43% of hemi-mandibles	17–78 Mean age is 50.8	Japan	CBCT
Rouas et al. 2007 [21]	0.05% (3 out of 6000 scans)	Not specified	France	Mandibular CT scans and CBCT image
Sanchis et al. 2003 [22]	0.35% of canals were bifid from a total of 2012 patients	Mean age 40.4	Spain	Extra-oral panoramic radiographs and mandibular computed tomography
Langlais et al. 1985 [23]	0.95% (57 out of 6000 radiographs)	11–81	US	Panoramic radiographs
Grover and Lorton, 1983 [24]	0.08% (4 out of 5000 radiographs)	17–26	US army recruits	Panoramic radiographs
Nortjé et al. 1977 [12]	0.9% of research subjects	0–60	South Africa	3612 panoramic radiographs of patients

Table 2. Classification of bifid mandibular canal variants according to Nortjé et al. 1977 [12].

Types of bifid canals	Anatomical Features of bifid mandibular canal variants [12]
Type 1	Two canals bifurcating from one foramen. The lower canal was slightly narrower
Type 2	The upper canal extending only to third or second molar tooth
Type 3	Two equal in size mandibular foramina fusing at the body of mandibular region

osseous branches [4]. The IAN may branch before it enters into the mandibular foramen into extra-osseous branches that may have accessory foramina in the mandible.

The incidence of bifid mandibular canals in some patients has been mentioned in several studies (Table 1). Trifid mandibular

canals were also described in some case studies [9,10]. Bifid mandibular canals are not considered a rare variation and special attention is needed when dealing with patients with this variant. Mizbah et al. 2010 [11] had reported that bifid

Table 3. Classification of bifid mandibular canal variants according to Naitoh et al. 2009 [14].

Type	Anatomical Features of bifid mandibular canal [14]
1	Retromolar canal: observed on the bone surface of the retromolar region
2	Dental canal: located at the end of the canal reached to the root apex of the second or third molar
3	Forward canal: arising from the superior wall of the mandibular canal
4	Buccolingual canal: arising from the buccal or lingual wall of the mandibular canal

mandibular canals may occur in 0.08% to 65% of cases, this wide range could be attributed to different genetic pools of patients participating in the study and the methodology of the study. Bifid mandibular canals can be unilateral or bilateral [12].

Many studies employed the use of cone beam computerized tomography (CBCT) and computed tomography (CT) scans. Some authors agreed that bifid mandibular foramina are observed more when using CBCT scans [13,14] and found it more accurate than multislice CT (MSCT) [15]. There is a possibility of the false presence of bifid mandibular canals in panoramic radiographs [16]. The presence of multiple mandibular canals in radiological images is reinforced with stereoscopic and histological sections in one study [17].

Classifications of bifid mandibular canals

There are two methods of classifying bifid mandibular canals. The first one, suggested by Nortjé et al. 1977 [12] classifies bifid mandibular foramina into three types described in Table 2; which is based on the location of the nerve. The second and more recent classification was suggested by Naitoh et al. 2009 [14]; and divided bifid mandibular canals into four types described in Table 3.

The presence of variant branches of the IAN might contribute to failure of inferior alveolar blocks and subsequently repeating anesthesia. Buch [25] reported the presence of a recurrent variant branch of the IAN that supplies the upper

head of the lateral pterygoid muscle in Indian cadavers. This nerve was present in 44.4% of Indian cadavers that were examined in a later study by Buch and Agnihotri [26].

The presence of multiple mandibular foramina might contribute to the failure of inferior alveolar blocks. In most cases of bifid mandibular canals more anesthetic injections are needed leaving a higher chance of increased anesthetic neurotoxicity and/or injuring the inferior alveolar neurovascular bundles. Thus, the presence of bifid mandibular canals should be considered as a risk factor for inferior alveolar paresthesia and should be taken into consideration in third molar extraction, mandibular surgery, and implant placement [27].

Conclusion

Knowledge of the anatomical relationships and variations of structures of pterygomandibular fossa is essential for oral health providers. Bifid mandibular foramina are considered a frequently encountered anomaly that can be uncovered using CBCT, CT and panoramic scan. Success of dental anesthesia, implant placement, third molar extraction and oral surgery is influenced by the presence of bifid canals and should be taken into consideration.

Conflict of interest

The author declares that she has no conflict of interest.

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