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Concurrent 'coronoid foramen' with trifid mandibular canal in a live human: CBCT exploration of a unilateral variant

Nyer Firdoose C.S.

Riyadh Specialized Dental Center, Central Second Health Cluster, Ministry of Health, Ishbiliyah, 13226 Riyadh, Kingdom of Saudi Arabia

SUMMARY

The incidence of a coronoid foramen in a live human subject is rare and hence the scarcity of the literature. The knowledge of any such anatomical variation is important, as surgical procedures on the mandible are regularly performed by dental as well as oral and maxillofacial surgeons. The current script details anomalous morphology of an isolated coronoid foramen in the mandible of a 16-year-old female Saudi patient, which is a first ever documented case along with the presence of two separate accessory mandibular canals encountered during routine dental investigations. A high spatial resolution three-dimensional cone beam computed tomography (CBCT) was used as a diagnostic investigative method so as to allow an accurate three-dimensional analysis of mandibular coronoid foramen and accessory mandibular canal variations. These variations were documented and a detailed review of literature done. The script focuses on the variations themselves, and the clinical implications of the presence of such variations. A thorough understanding of anatomical variants in the mandible and their neurovascular contents always determines the success of any procedural anesthesia, the prevention of surgical misadventure and the etiology of pathologic processes.

Key words: Coronoid foramen – Unilateral variant – Trifid mandibular canal – Inferior alveolar nerve – Cone-beam computed tomography

INTRODUCTION

The mandibular canal is a single channel of inferior alveolar neurovascular bundle most of the times but occasionally have been reported with multiple smaller branches running parallel to the main branch attributing to its variations (Naitoh et al., 2009) such as bifid and trifid mandibular canals. The variations in the normal morphology of the mandible are considered to be mostly bilaterally symmetrical (Haas et al., 2016) with the presence of accessory foramina such as the accessory mental foramen, retromolar foramen, accessory mandibular foramen and lingual foramen, which are predominantly present on the posterior mandible, symphysis and the medial aspect of the ramus (Gupta et al., 2013; Haas et al., 2016; Haveman and Tebo, 1976).

With the advent of cone beam computed tomography (CBCT) the spectrum of anatomic variations is becoming identifiable in a live human helping the present clinicians to serve patients in a more appreciable way. The presence of a foramen in the coronoid process has been documented in only one case so far in the literature, and that was a bilaterally symmetrical finding, which emphasized

Corresponding author: Dr. Nyer Firdoose C. S. Riyadh Specialized Dental Center, Second Health Cluster, Ministry of Health, Department of Oral & Maxillofacial Surgery, Imam Saud Bin Abdulaziz Road, Ishbiliyah, 13226 Riyadh, Kingdom of Saudi Arabia.

E-mail: drnyeromfs@gmail.com

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Table 1. Classification of Mandibular bifid canal

Classification types		Subtypes
Type 1 (Retromolar canal type)		The retromolar canal, which bifurcates from the mandibular canal in the mandibular ramus region, courses forward at first, reaching the retromolar region
Type 2 (Dental canal type)		The dental canal, which bifurcates from the mandibular canal in the mandibular ramus region, courses forward, reaching the root of the molar
Type 3 (Forward canal type)	A	Forward canal without confluence: The forward canal, which bifurcates from the mandibular canal in the mandibular ramus region, courses forward to the second molar region
	B	Forward canal with confluence: The forward canal, which bifurcates from the mandibular canal in the mandibular ramus, courses anteriorly and then, joins the main mandibular canal
Type 4 (Buccolingual canal type)	A	Lingual canal: The lingual canal, which bifurcates from the mandibular canal in the mandibular ramus, courses lingually and then penetrates through the lingual cortical bone
	B	Buccal canal: The buccal canal, which bifurcates from the mandibular canal in the mandibular ramus, courses bucco-inferiorly
Type 5 (Trifid canal type)	A	Two accessory canals of the retromolar canal type
	B	Two accessory canals of one retromolar and one dental canal type
	C	Two accessory canals of the dental canal type
	D	Two accessory canals of one dental and one forward canal type
	E	Two accessory canals of the retromolar canal type with two mandibular foramina

the hypothesis of phylogenetic trait (Firdoose, 2018). The incidence of such coronoid foramen has never been documented in literature except in just one male patient until this date, making this case report the second of its kind, as it is a unilateral variant. Moreover, only four cases of the trifid mandibular canal were reported until 2012 (Mizbah et al., 2012), followed by seven cases of the trifid mandibular canal, in which they were classified into five subtypes (Oyuntugs et al., 2014). We hereby present the first-ever documented case of an isolated coronoid foramen and two separate accessory mandibular canals in the mandible of a 16-year-old female Saudi patient.

CASE REPORT

This case report describes an isolated unilateral coronoid foramen on the right side of the mandible along with two accessory mandibular canals branching out from the main mandibular canal, thereby making it a trifid mandibular canal. This was primarily identified on a routine panoramic radiograph of a 16-year-old Saudi female, moderately built, asymptomatic patient with no pathological conditions affecting her mandible. She was referred to the author in the Department of Oral & Maxillofacial surgery at a tertiary referral center for oral health treatment services requiring extraction of her maxillary and mandibular first premolars as part of her initial orthodontic treatment plan. The findings were then elaborated by using a high spatial resolution 3D CBCT.

The patient's medical history was non-significant. Extra-orally there was no obvious asymmetry of the face. On intra-oral examination, the patient had a congenitally missing maxillary right lateral incisor, the left maxillary lateral incisor was peg-shaped, and the maxillary and mandibular third molars had incomplete root formation as they were in their erupting stage, mandibular left first molar was root canal treated. Exodontia of the maxillary and mandibular first premolars was planned for correction of her proclined anterior teeth with increased overjet and increased overbite. There was no sign of deviation of jaw movements or limitation in her mouth opening.

The skeletal and dental assessment for orthodontic evaluation was done by a series of radiographs involving panoramic radiograph, lateral cephalogram and complete mouth series radiographs.

All initial investigations were performed as per the requirements for orthodontic evaluation. The 3D CBCT scans were performed in the department of Oral & Maxillofacial surgery for the evaluation of an unusual radiolucency on the right coronoid process of mandible.

Panoramic radiographic findings: Revealed an unusual radiolucency in the right coronoid process of mandible, which did not co-relate with the normal radiographic anatomical structure. There was also evidence of presence of accessory canals in the mandibular body. One of the canals was located posteriorly running downwards and the other canal located anteriorly just inferior to the erupting third molar (Fig. 1). These variations were further classified by Oyuntugs et al. (2014) as Type 5 subtype D, having two accessory canals of which one a dental type and one forward canal type. Thereby, emphasizing the need for further evaluation of mandible and the coronoid processes.

Fig 1. Panoramic radiograph revealed a well-defined unusual radiolucency on the right coronoid process (white circle) along with **c** condyle; **cp** coronoid process; **cf** coronoid foramen (white circle); **ph** pterygoid hamulus; **1** mandibular canal bilaterally; **2** & 3 accessory branches of mandibular canals on right side.

Three dimensional cone beam computed tomography (3D-CBCT). A 3D CBCT by Orthopantomograph OP300 scanner with technical parameters: image volume size 61 x 78 mm, tube current 15 mA, tube voltage 80 kV, scan time 16 s, exposure time 12 s pulsed X-ray. The software used was DICOM OnDemand3D from Cybermed, USA, for image acquisition was used.

Analysis by this scan confirmed the alteration in the normal anatomic structure of the mandible with presence of foramen / bony defect in the right coronoid process of the jaw along with two accessory mandibular canals (Figs. 2-5), which was not consistent with the normal morphology of the mandible or maxilla.

The scan confirmed the presence of a foramen on the coronoid process on the right side of the mandible, and also the presence of accessory mandibular canals along the medial aspect of the ramus (Fig. 2). The foramen on the coronoid process could be appreciated from both lateral and medial aspects of the mandible. The left side of the mandible did not show any signs of alteration in its

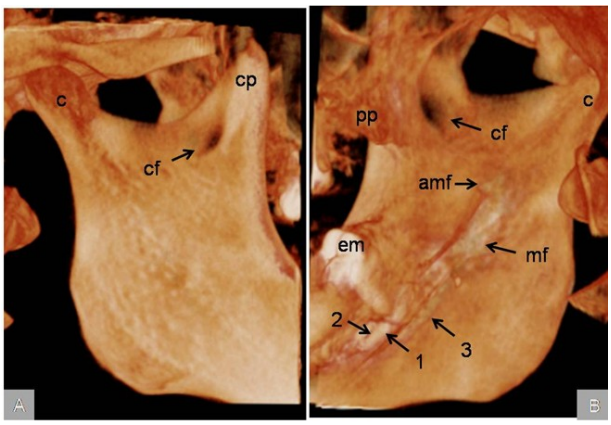

Fig 2. 3D CBCT scan image: **A**) right lateral aspect showing **c** condyle; **cp** coronoid process; **cf** coronoid foramen; **B**) right medial aspect aspect showing amf accessory mandibular foramen; mf mandibular foramen; **pp** pterygoid plate; **em** erupting third molar; **1** mandibular canal; **2 & 3** accessory mandibular canals.

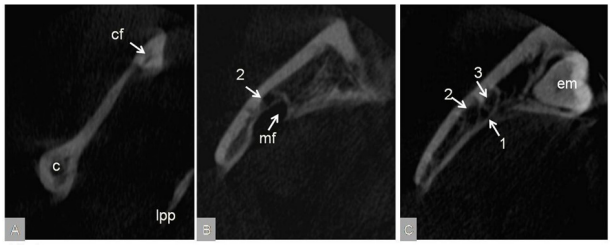

Fig 3. Axial Section of CBCT scan: **A**) showing **c** condyle; **cf** coronoid foramen; **lpp** lateral pterygoid plate. **B**) showing **mf** mandibular foramen; **2** accessory mandibular foramen. **C**) showing **1** mandibular canal; **2 & 3** accessory mandibular canals; **em** erupting third molar.

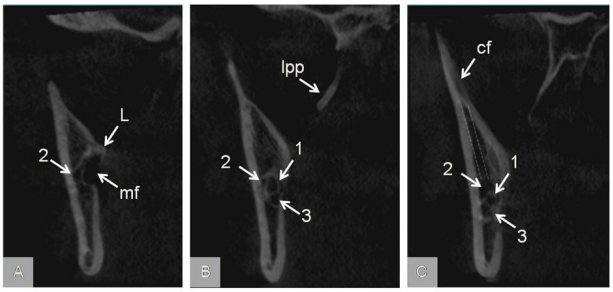

Fig 4. Coronal Section of CBCT scan: **A**) showing **L** linguala; **mf** mandibular foramen; **2** accessory mandibular canal. **B**) showing **lpp** lateral pterygoid plate; **1** mandibular canal; **2 & 3** accessory mandibular canals. **C**) showing cf coronoid foramen; **1** mandibular canal; **2 & 3** accessory mandibular canals; dotted lines the confluence of the coronoid foramen with the accessory mandibular canal.

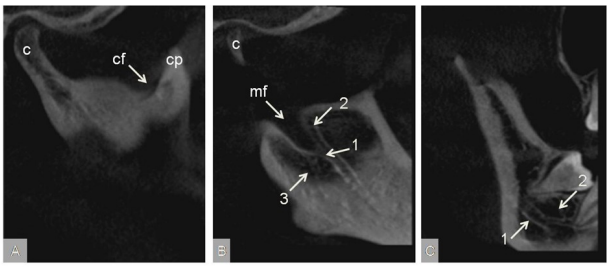

Fig 5. Sagittal Section of CBCT scan: **A**) showing c condyle; **cf** coronoid foramen; **cp** coronoid process. **B**) showing **c** condyle; **mf** mandibular foramen; **1** mandibular canal; **2 & 3** accessory mandibular canals. **C**) showing **1** mandibular canal; **2** accessory mandibular canal supplying the second molar.

normal anatomic morphology or the presence of any accessory foramina or canals. This finding thereby makes the present case study unique, with an isolated unilateral anatomic variant.

The axial section of the CBCT scan images of the right side mandible revealed the presence of a coronoid foramen and two accessory mandibular foramina that is the trifid mandibular canal (Fig. 3).

The coronal section of the CBCT scan images revealed further information on the above structural alterations. The presence of coronoid foramen was confirmed, which was in confluence with the larger of the two accessory mandibular foramina of the trifid mandibular canal. The large accessory foramen continued as a canal lateral to the mandibular canal. The smaller of the accessory foramina was continuous as a canal antero-medially beginning from the mandibular foramen continuing forward towards the lateral aspect of the ramus and becoming parallel and inferior to the larger accessory mandibular canal (Fig. 4). The two accessory mandibular canals ran parallel to the mandibular canal throughout their individual course without joining with each other until the level of the second molar region making the main mandibular canal a trifurcate.

The sagittal section of the CBCT scan images confirmed the presence of a coronoid foramen with two separate accessory mandibular canals, the larger being supero-anteriorly and the small canal running infero-posteriorly to the main mandibular canal. The coronoid foramen was confluent with the supero-anterior accessory mandibular canal which appeared to be supplying the second molar root (Fig. 5).

DISCUSSION

The location of the mandibular canal is on the medial aspect of the mandible, extending from the mandibular foramen postero-superiorly to the mental foramen anteriorly (Haas et al., 2016). It contains a neurovascular bundle responsible for somato-sensory innervations and nutrient supplement for mandibular hard and soft tissues (Eliades et al., 2015). The description of variations in the mandibular canal morphology pertaining to the bifid and trifid mandibular canals has been reported using different imaging modalities (Nortje et al., 1978).

The initial classification of bifid mandibular canals described mainly 4 types (Naitoh et al., 2009): Type 1: a retromolar canal observed on the surface of retromolar region, Type 2: a dental canal located at the end of the canal reaching the root apex of the second or third molar, Type 3: a forward canal arising from the superior wall of the mandibular canal and Type 4: a buccolingual canal arising from the buccal or lingual surface of the mandibular canal.

To the above classification a fifth type was added (Oyuntugs et al., 2014), which was a trifid canal type having further five subtypes, namely: Subtype A, which had two accessory canals of the retromolar canal type; Subtype B had two accessory canals of one retromolar and one dental canal type; Subtype C had two accessory canals of the dental canal type; Subtype D had two accessory canals of one dental and one forward canal type, and Subtype E, having two accessory canals of the retromolar canal type with two mandibular foramina.

Hypothesis: Synapomorphy-Phylogenetic trait of coronoid foramen

The coronoid foramen was seen to exist in paenungulates, including early genera such as: Seggeurius, Erithherium, Phosphatherium, Arsinoitherium and Prorastomus (Brocklehurst et al., 2016; Gupta et al., 2013). The presence of a coronoid foramen (or coronoid canal) was recovered as a paenungulate Synapomorphy (Gheerbrant et al., 2014).

Owing to its rarity of occurrence and lack of documentation, the author presents a case report of concurrence of anatomical variants such as incidental discovery of unilateral ‘coronoid foramen’ of mandible in a live human subject along with trifid mandibular canal, which is rarer than the bifid mandibular canals, making it an interesting case report which has never been documented in literature or in the human osteology studies.

Background of inferior alveolar nerve variations

Bifid mandibular canals were first reported in 1973 (Patterson and Funke, 1973). A study of 6000 panoramic radiographs over a period of 5 years (Grover and Lorton, 1983) showed an incidence of 0.08% bifid mandibular canal occurrence, and a similar study reported an incidence of 0.95% bifid mandibular canals and went on to describe 4 main patterns of canals (Langlais et al., 1985). While another study reported an incidence of 12.07% of bifid mandibular canals (Vallarelli, 2007), so the reported incidences using dry skull specimens and radiographic evaluations have varied between 0.08% and 12.07%.

Embryological evidence

Since bony canals are known to develop in prenatal life around the nerve paths, it was assumed that the canal pattern could reflect the pattern of innervations of the dentition (Gupta et al., 2013). In the embryologic course, three inferior dental nerves and smaller branches form to innervate each of the three groups of mandibular teeth. As age advances, gradual coalescence of all these branches occur and the bony canal develops around such nerve paths. Incomplete fusion of these nerves would explain the occurrence of accessory mandibular canals in some patients (Haveman and Tebo, 1976).

The patient in the present case report has an isolated coronoid foramen along with trifid mandibular canal, which was similar to a slightly modified version of the classification given by Naitoh et al. in 2009. The coronoid foramen discovery was only recent, which was a bilateral variant and was bigger compared to this study.

The presence of any such anatomic variations may be a cause of concern if not identified, leading to intra operative and post-operative complications during dental procedures (such as third molar extraction, osteotomy for bone graft and implant placement).

Clinical implications

Lack of profound anesthesia after routine administration of local anesthetic agents can be attributed to various factors, which may include, but are not limited to, faulty technique, inadequate anesthetic solution, local inflammatory state or presence of morphological variations (Iwanaga et al., 2019). It is not always immediately imperative that everyone shares a similar view of clinical significance about the rare findings in anatomic science that are interesting and yet important. The described unilateral anatomical variant combination has never been reported previously. Patients with these variations require a cautious pre-surgical planning, since they are at much greater risk of injury to neurovascular bundle, affecting blood supply to head and neck region and of iatrogenic complications if invasive procedures are undertaken without the knowledge of such variations beforehand.

Conclusion

It is peremptory for all surgeons to have an understanding of anatomical variations, as they may potentially thwart a clinician from achieving successful treatment objectives. The performance of thorough diagnostic and pre-surgical evaluations of the region will not only help to assess any anatomical variants present, but also influences the outcome of surgical procedures related to that particular region along with preventing any sort of iatrogenic injuries to these variant structures postoperatively.

Ethical approval: All the findings were incidental and not planned procedural study. The patient and her guardians were informed about the peculiar findings in her, and an informed signed consent was taken with permission to use her data for research publication purposes.

REFERENCES

BROCKLEHURST RJ, CRUMPTON N, BUTTON E, ASHER RJ (2016) Jaw anatomy of Potamogale velox (Tenrecidae, Afrotheria) with a focus on cranial arteries and the coronoid canal in mammals. Peer J, 4: e1906.

ELIADES NA, MANTA KH, TSIRLIS AT (2015) Neurovascular content of the mandibular canal and its clinical relevance: A literature review of the related anatomical and radiological studies. Balkan J Dent Med, 18(3): 124-132.

FIRDOOSE CSN (2018) Bilateral 'coronoid foramina' with accessory foramina on the 'lateral aspect of ramus' of mandible: an unseen variance discovery in humans. Surg Radiol Anat, 40(6): 641-646.

GHEERBRANT E, AMAGHZAZ M, BOUYA B, GOUSSARD F, LETENNEUR C (2014) Ocepeia (Middle Paleocene of Morocco): The oldest skull of an Afrotherian mammal. PLoS ONE, 9(2): e89739.

GROVER PS, LORTON L (1983) Bifid mandibular nerve as a possible cause of inadequate anesthesia in the mandible. J Oral Maxillofac Surg, 41: 177-179.

GUPTA S, SINGH P, SONI A (2013) Morphological study of accessory foramina in mandible and its clinical implication. Ind J Oral Sci, 4(1): 12-16.

HAAS LF, DUTRA K, PORPORATTI AL, MEZZOMO LA, DE LUCA CANTO G, FLORES MC, CORREA M (2016) Anatomical variations of mandibular canal detected by panoramic radiography and CT: A systematic review and meta-analysis. Dento Maxillofac Rad, 45: 2.

HAVEMAN CW, TEBO HG (1976) Posterior accessory foramina of the human mandible. J Prosth Dent, 35(4): 462-468.

IWANAGA J, KIKUTA S, TANAKA T, KAMURA Y, TUBBS RS (2019) Review of risk assessment of major anatomical variations in clinical dentistry. Part I: Accessory foramina of the mandible. Clin Anat, 32(2): 672-677.

LANGLAIS RP, BROADUS R, GLASS BJ (1985) Bifid mandibular canals in panoramic radiographs. J Am Dent Assoc, 110: 923-926.

MIZBAH K, GERLACH N, MAAL TJ, BERGÉ SJ, MEIJER GJ (2012) The clinical relevance of bifid and trifid mandibular canals. Oral Maxillofac Surg, 16: 147-151.

NAITOH M, HIRAIWA Y, AIMIYA H, ARIJI E (2009) Observation of bifid mandibular canal using cone-beam computerized tomography. Int J Oral Maxillofac Implants, 24: 155-159.

NORTJE CJ, FARMAN AG, GROTEPASS FW (1978)

Variation in the normal anatomy of the inferior dental (mandibular) canal: A retrospective study of panoramic radiographs from 3612 routine dental patients. Br J Oral Surg, 15: 55-63.

OYUNTUGS R, JIN WC, WON JH, EUN KK (2014) Assessment of bifid and trifid mandibular canals using cone-beam computed tomography. Imaging Sci Dent, 44(3): 229-236.

PATTERSON JE, FUNKE FW (1973) Bifid inferior alveolar canal. Oral Surg Oral Med Oral Pathol, 36: 287-288.

VALLARELLI TP (2007) Radiographic interpretation of the mandibular canal in panoramic radiographs. Rev Aca Tir Odo, 7: 432-449.