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Case Report

CBCT Finding of Double Bifid Inferior Alveolar Canals: Literature Review and Case Report

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Abstract

Objectives: The aim of this study is to describe a case of a right and left bifid mandibular canals identified using cone beam computerized tomography (CBCT) imaging techniques and to discuss how frequently this variation occurs.

Methods: A systematic review of the literature is presented and the study methods are discussed. A case of a double bifid mandibular canal discovered by cone beam CT is presented. They were identified during a bilateral pre-implant CBCT analyses.

Results: Mandibular canals can be detected on two dimensional radiographs. However, as confusion is possible when using these imaging modalities, it is only with tomographic imaging that some of these distinctive features can be identified. The case of left and right bifid mandibular canals revealed by CBCT is the only one reported in the literature to date using this means of identification.

Conclusions: The presence of bifid mandibular canals is very rare, yet it is important to recognize this anatomical variation in any surgical procedures involving the lower jaw and its presence can only be confirmed by volumetric imaging.

Keywords: *Mandibular canal; Cone beam CT*

Introduction

The mandibular canal is usually a unique channel, running in the mandibular bony tissue, forming an upward concave curve. It encloses the lower alveolar neurovascular bundle, it begins posteriorly at the level of the mandibular foramen, a part of it, while exiting at the level of the mental foramen situated in most cases between the two roots of the premolars, innervates the soft tissues the another part continues its way anteriorly to form the incisive canal.. When examined in section it can vary in shape, being sometimes oval, circular or pyriform [1,2].

In dental imaging, its appearance has been described as a radiolucent ribbon between two radio-opaque lines" [3] in certain cases, however, the presence of a second mandibular canal has been revealed. Although anatomy textbooks give few details about this type of variation, there are published case reports that provide further information about these anatomical configurations. Identifying these structures enables us to prevent potential complications that can sometimes have very serious consequences during surgical procedures in the mandibular region.

Review of the Literature

The numerous cases reported in the literature have been observed using different imaging methods: panoramic radiographs, panoramic images in association with lateral cephalometric radiographs and three dimensional imaging.

The first clear case is published in 1973 [4]. Duplication was unilateral and was identified on a panoramic radiograph. Due to the superimposition of the different structures, the authors did not rule out the possibility of a deep mylohyoid groove on the medial mandibular surface which can be confused with a second mandibular canal. In a retrospective study of 3612 panoramic radiographs, Nortje *et al*. [5] studied 33 cases of bifid mandibular canals, 20 bilateral and 13 unilateral, which were classified into three types, then into four when a new canal configuration was found [6]. Driscoll [7] and later Wyatt [8] reported two new unilateral cases based only on panoramic radiographs. Other cases have been published, but based on panoramic radiographs in association with lateral cephalometric radiographs to confirm observations.

A case of unilateral bifid mandibular canal was also published by Paterson in 1973 [9], where the separation into two branches occurred in the ramus and the body of the lower jaw. The authors identified two mental foramina. In order to confirm their findings, they carried out a lateral projection radiograph of the skull.

Mader and Konzelman [10] reported a unilateral case and, in their words, eliminated the possible presence of artifacts by taking a new panoramic image and a lateral skull view.

In 1988, Strider [11] added a bilateral case identified during an intraoral vertical ramus osteotomy where lateral oblique radiographs of the mandible showed an image of double mandibular canals.

Quattrone *et al*. [12] discovered a case of a double bilateral mandibular canal, but they present only axial tomodensitometric incidences that are not very demonstrative.

In 1993, Meoli *et al*. [13] published a more illustrative case of a double foramen mental is which was unilateral, but the division at the level of the mandibular canal occurred only in the region close to these foramina, hence along a very short course. Berberi *et al*. [14] and later Claeys *et al*. [15] published some very well illustrated cases using CT scans of double mandibular canals with two distinct mental foramina. In our opinion, these last two publications constitute the only established cases of this anomaly. In 2000, Kaufman *et al*. [16] for their part, presented images of bilateral accessory mandibular canals. In all probability, the term "accessory" was chosen by the authors to describe these canals because of their very short length (about 15 mm). Auluck *et al*. [17] have described the case of a triple mandibular canal in a 20-year-old patient, where the third branch perforated the lingual cortex in the retromolar area.

The discovery of these anatomical particularities has led practitioners or researchers to study their frequency. All such research studies have been carried out on panoramic radiographs. Between 1977 and 2003, six publications were found where the frequency of the occurrence of double mandibular canals ranging between 0.08% and 8.3%. Given such a disparity in results, one must be skeptical as to the type of study used (Table 1).

From studies on a large number of occurrences on two dimensional imaging and especially the panoramic images, Nortje *et al*. [5] was able to classify the bifidity of the inferior alveolar canal by describing three configurations of these canals then a fourth type 6 was later added. This classification was later confirmed by Heasman [18]. In 1985, Langlais *et al*. [19] established a system of classification into four groups according to the anatomical parameters. They stressed that the mandibular canals could present small and as yet unlisted supplementary accessory canals.

Case Report

The case reported here was prescribed for pre-implant analyses. A 50-year-old male was referred to the maxillo-facial imaging department of the dental school at the Lebanese University for a pre-implant evaluation. The scan was performed using an Icat®CBCT scanner (Imaging sciences international-Hatfield, United States of America) operated at 120 kVp and 24 mA with a resolution of 0.4 voxel.

Reconstructed axial, coronal and sagittal cuts (MPR) were automatically reconstructed by the software (Icat vision®-Imaging sciences international) (Figure 1). A planning line, along the centerline of the mandibular jaw arch, was drawn on the axial cut that shows the major part of the inferior alveolar canal (Figure 2). A Panorex "panoramic reconstruction" was automatically generated by the software (Figure 3) and cross-sectional images (slice thickness 0.4 mm) were also reconstructed (Icat vision®-Imaging sciences international) (Figure 3 and 4).

Bilateral divisions of the mandibular canal were detected on the right and left-hand side at the level of the ramus. Thesebifurcations derive from the originaltruncus (Figure 3). The right branch ends in the bone trabeculaeat the level of the first molar region and the left one continues more anteriorly to the level of the second premolar (Figure 4). An accessory left mental foramen is also noted on a cross-sectional cut. This is due to the splitting of the primary inferior alveolar canal in two parts before exiting (Figure 5).

Year	Author	Number of Cases	Number/Type: Unilateral (U) Bilateral (B)	Means of Identification	Further Investigations	Super-Imposition of Mylohyoide Groove
1973	Kiersch	1	1/U	Panoramic	Non	Possible
1973	Paterson	1	1/U	Panoramic	Lateral projection	Not possible
1977	Nortje	33	13/U 20/B	Panoramic	Non	Possible
1981	Mader/ Konzelman	1	1/U	Panoramic	Panoramic + lateral projection	Not possible
1988	Strider	1	1/B	Lateral projection	Vertical ramus Osteotomy	Not possible
1989	Quattrone	1	2/B	Axial tomodensitometry		Possible
1996	Driscoll	2	2/U	Panoramic	Non	Possible
1996	Wyatt	2	2/U	Panoramic	Non	Possible
1993	Meoli	1	1/U near double mental foramen	Para-axial Tomography		Not possible
1994	Berbery/ Cleys	2	1/U near double mental foramen	Different Tomodensitometric cuts		Not possible
2000	Kauffman	1	1/short B	Panoramic		Possible
2005	Auluck	1	Triple	Panoramic		

Table1: *Classification of the founding of the bifidity of the Inferior alveolar canal.*

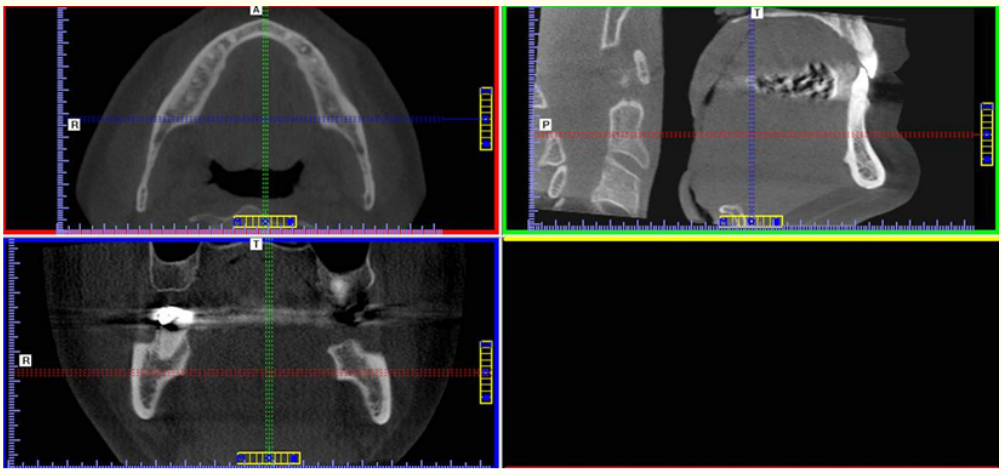

Figure 1: *Reconstructed axial, coronal and sagittal cuts (MPR).*

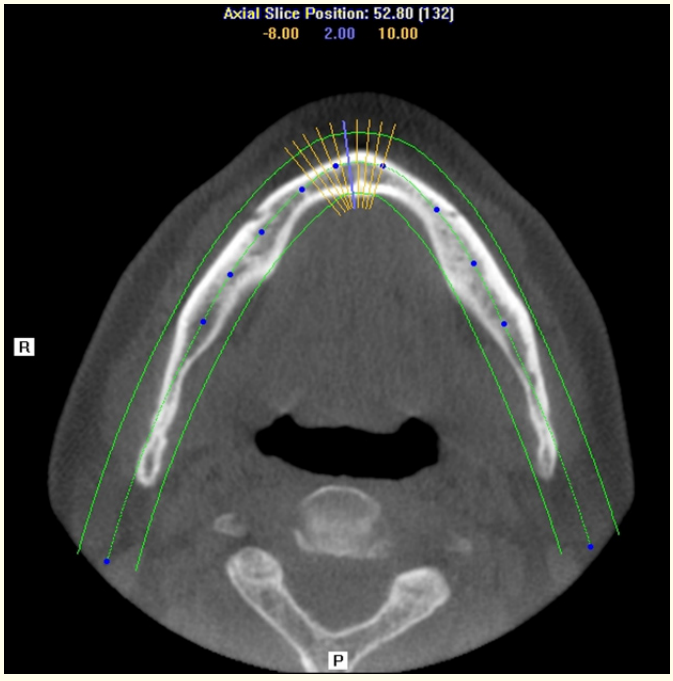

Figure 2: *Panorexplanning line on the axial cut.*

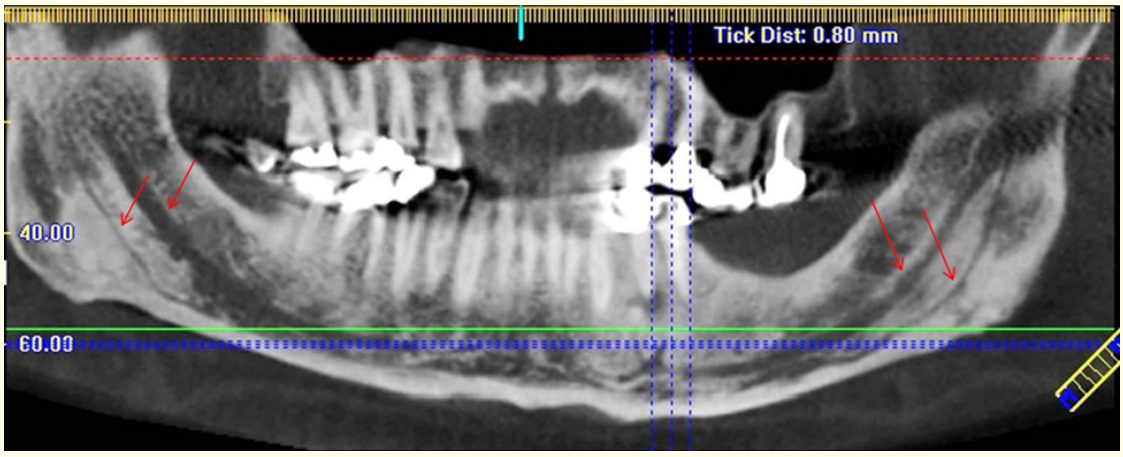

Figure 3: *Panorex reconstruction showing the two accessory canals.*

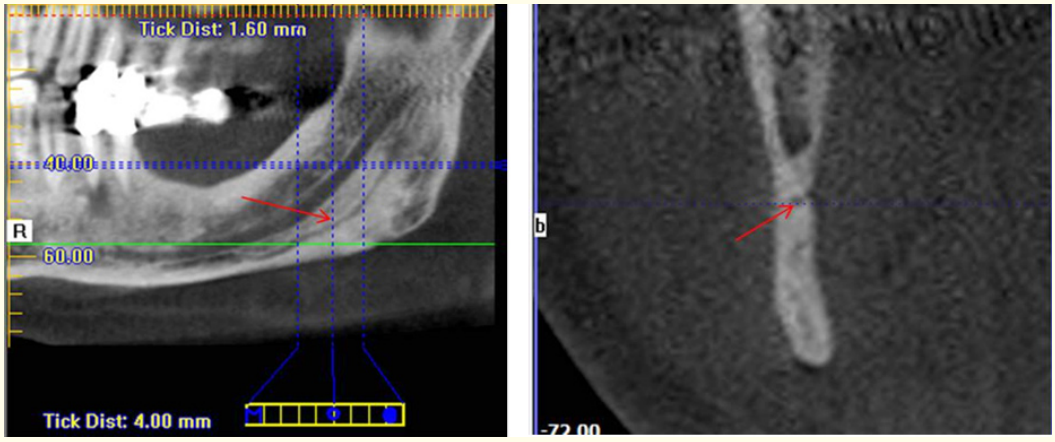

Figure 4a: *Cropped panorex and cross-sectional image showing the right accessory canal.*

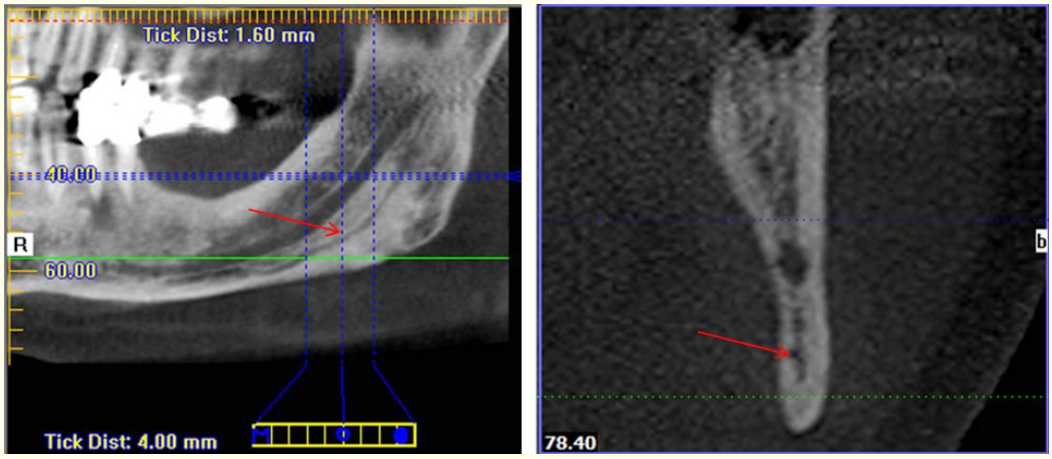

Figure 4b: *Cropped panorex and cross-sectional image showing the left accessory canal.*

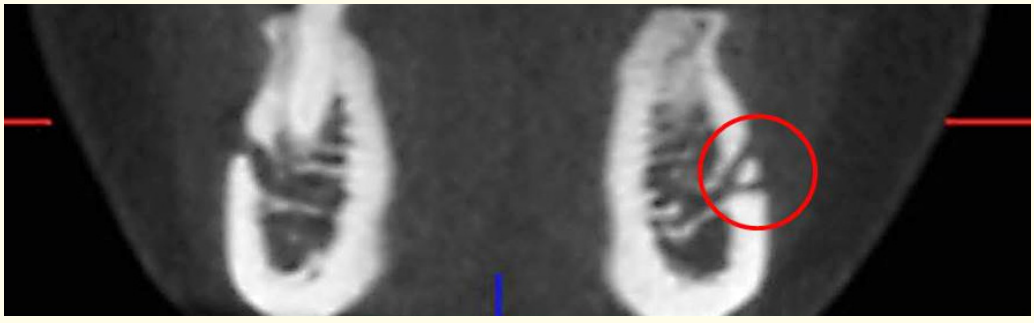

Figure 5: *Frontal cut showing the double left mental foramen.*

Discussion

The bifid mandibular canals have been variously described in the literature's "occasionally present", [5] "a variation", [6] "not a rare finding", [20] "not an infrequent occurrence", or "a fairly common anomaly" [21]. For other authors, it is an "abnormality", [7] an "anomaly", an "aberrancy" [11], or an "oddity" [10]. Studies based on volumetric imaging, however, are all in agreement in describing these cases as "rare", or even as "anomalies"[13,15].

The appearance of this bifidity can be explained by different causes. First we cannot dismiss a possible relationship with a general pathology, a case associated with Down's syndrome was observed in a 29-year old patient [10]. Second according to Chavez-Lomeli *et al*. [22] the inferior alveolar nerve is formed during embryonic development to innervate each of the three groups of mandibular teeth, and this development is followed by the fusing of the nerves. This hypothesis could explain the presence of a duplication of the mandibular canal or a triple mandibular canal as observed by Auluck *et al*. [17] after an incomplete fusion of the three nerves. The presence of a triplemandibular canal can also be explained if it is assumed to Bea third branch located on the mandibular ramus which does not emerge at a mental foramen [23].

According to the literature, the frequency of the bifid mandibular canals as seen on two-dimensional imaging appears to range from 0.08% [20] to 8.3% [8]. This suggests that there are major disparities in existing studies. All the studies of frequency are based on panoramic images which tend to overestimate the presence of these duplications in part due to the unreliability of panoramic radiographs for this type of findings and on the other part due to the variations in the appearance of the bifidity. The reason of the high frequency can also be attributed to the superimposition of different structures on 2D imaging. The presence of a deep mylohyoid groove can account for the characteristic images found on panoramic radiographs [4,9,24]. This possibility has been confirmed by Sanch is [25], who specifies that false double canals can be observed on two-dimensional radiographs due to the impression of the mylohyoid nerve on the medial surface of the mandible as it turns towards the floor of the mouth, or to the insertion of the mylohyoid muscle on the mandibularmedial surface on the mylohyoid line, all of which can generate images which imitate the presence of a bifurcation of the mandibular canal. Lastly, images of lingual vascular canals can also be confused with mandibular canals [26].

The reliability and precision of three dimensional imaging over two-dimensional ones have been emphasized in several studies including those by Klinge [27]. With the various images provided by the three dimensional imaging, there was sufficient information to identify the double mandibular canals. On the cross-sectional slices, they appeared as rounded radiolucent images edged by a narrow radio-opaque border, easily differentiated from the bone and any possible periapicallesion. In 2003, while conducting a study on 2012 panoramic radiographs, Sanch is [25] identified seven double mandibularcanals (0.35%), but after carrying out a tomodensitometricexamination he found only two cases of double canals. This confirms the potential for error inherent in reading panoramic images in particular, and two-dimensional images in general. In a study of 500 subjects based on periapical radiographs of themandibular zone of the mental foramen, Sweet [28] stated that "when doing work of this nature, there is a tendency to see that which does not exist" and "the mandibularcanal can be projected by the imagination into the radiographs unless one is very careful".

Conclusion

If bifid mandibular canals are not identified prior to an invasive act there is a possibility of nerve damaged, or hemorrhages that may impede the surgeon's visibility. There is also an increased potential for the formation of fibrous tissues in a site that is in contact with an implant. Non-identification may also account for certain failures in anesthesia.

In our opinion, retrospective studies of frequency based on panoramic radiographs have tended to overestimate the prevalence of these anatomical anomalies, as there is always a risk that one tends to see whatever one is looking for. A clinical study based on three-dimensional images Dentascan® or CBCT constitutes the only means of providing an irrefutable diagnosis as to the existence of double mandibular canals.

Our new case of a double bifid mandibular canal and a double left mental foramen confirm the very rare nature of these duplications.

By pinpointing these rare anatomical variations, it is possible to take the necessary precautions during implant surgery and avoid damaging these neurovascular structures.

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