ORIGINAL RESEARCH PAPER | Radiology

LOCALISATION OF BIFID MANDIBULAR CANALS BY USING CONE BEAM COMPUTED TOMOGRAPHY

KEY WORDS: Surgery; Anatomy; Mandible.

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ABSTRACT

The sample consisted of 300 CBCT examinations obtained with Classic I-Cat scanner operating at voxel of 0.25 mm and FOV of 13 x 17 cm. Of the 300 patients, 188 (62.7%) were female and 112 (37.3%) male, with age ranging from 13 to 87 years old. Of the 300 examinations assessed, bifurcations were found in 90 cases (30%), with 51 (56.7%) belonging to females and 39 (43.3%) to males. With regard to affected sides, 32.2% of the cases (n = 29) were on the right side and 24.5% (n = 22) on the left side, with 43.3% (n = 39) on both. According to the results of the present study, it was possible to conclude that the localisation of BMC was at the centre of the mandibular body, presenting a relatively short distance between CM1 and CM2.

INTRODUCTION

Mandibular canals (MC) are anatomical structures located in the body of mandible, extending from the mandibular foramen to the mental foramen, where they bifurcate to form the mental nerve and incisive nerve canal, which are hardly visible on radiographs. The inferior alveolar nerve, a third division branch of the trigeminal nerve, sends rami innervating lower teeth, interdental papillae, periodontium, bone tissue adjacent to teeth, mucosa and buccal gingiva of anterior teeth and lower lip, all being the main stage for the surgeon-dentist. Knowledge on anatomy has always been of extreme importance, being frequently target of a number studies in the most varied areas as a result of variations which may occur along the mandible.3[1,2,3]

The presence of anatomical variations in the mandibular canals is a reality, and many of these anatomical variations have been describe elsewhere. It is known that bifid mandible canals (BMC) represent the most important anatomical variation in mandibular canals and whose frequency is a controversial issue. Data discrepancy is due to the fact that the majority of studies on such structures used panoramic radiographs. Motamedi et al.[4] emphasised that assessments based on panoramic radiographs showed rates of BMC lower than those of studies using computed tomographs (CT) and cone beam compute tomographs (CBCT).

Dentistry is currently cruising an era of technological changes and these innovations range from the development of new forms of diagnosis to modalities of entirely novel treatments.[5] Therefore, with the emergence of new technologies such as CBCT, some studies have been questioned and consequently reviewed as this examination modality provides a better image quality, allowing for a more precise identification of structures. The incidences of BMC in the retromolar region range from 20%, according to Kuribayashi et al.[66] to 30%, according to Naitoh et al.[7] and Orhan et al.[8]

In view of the countless procedures performed in the mandible, it is extremely important to know these anatomical variations as this can bring many advantages to several areas of dentistry, such as anaesthesiology, surgery and implantation, since mandibular canal is the course of inferior alveolar nerve as well as of major blood vessels and arteries, thus avoiding possible complications.

In this way, we have assessed the localisation of bifid mandibular canals and their distance from bone cortices in the mandibular body, since it is clearly important to know them as well as their position in the mandible because this is a region of extreme complications in dentistry.

MATERIALS AND METHODS

The present non-experimental study has used a non-probabilistic convenience sample after being approved by the research ethics committee of the Post-Graduate Centre of São Leopoldo Mandic Faculty of Dentistry, Campinas, SP (protocol number 1367546). This study performed a descriptive analysis of patients who were exclusively submitted to dental treatment. A total of 500 CBCT images belonging to local department of radiology were initially used for diagnosis and treatment planning. Of these, 300 images were selected according to the following inclusion criteria: male and female patients aged between 18 and 87 years old who had been submitted to tomography. Patients who had been submitted to surgery in the posterior region of the mandible or suffered from trauma, fracture and pathological or syndromic lesions were excluded. By means of CBCT, we have sought to identify and locate bifurcations in the mandibular canal by measuring the distances from BMC to buccal and lingual cortices as well as to mandibular base and bone ridge.

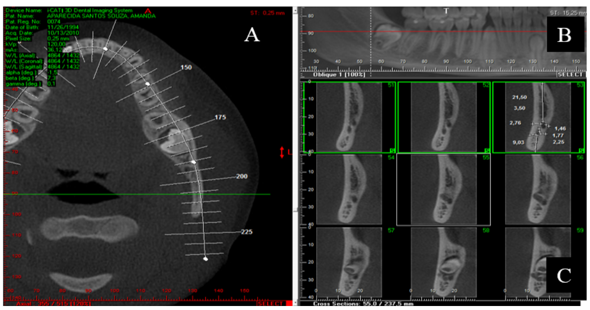
CBCT images were acquired with a Classic I-Cat scanner (Imaging Sciences International, Hatfield, USA) operating at voxel of 0.25 mm, FOV of 13 x 17 cm, acquisition time of 40 seconds at high

Volume-7 | Issue-2 | February-2018 | PRINT ISSN No - 2250-1991

resolution, and standard configurations of 120 kVp and 36.15 mAs. All the images were processed and manipulated with Xorancat® software (Xoran Technologies, Ann Arbor, USA) by making minor corrections in brightness and contrast in order to facilitate the visualisation of structures. The filter Angio-Sharpen-Low 3x3 was used for standardisation so that tomographic sections could present the same anatomical details, which enabled BMC to be identified. An own software's tool was used to standardise the measurements of BMC in millimetres.

CBCT images were processed by using the Xorancat® software to allow the mandibles to be visualised, with axial, coronal and sagittal planes being aligned on the screen for multiplanar re-construction (MPR). For axial images, the pterygoid processes of sphenoid bone were aligned with the coronal plane, thus maintaining the anterior nasal spine in parallel to the sagittal plane. For sagittal images, the maxillary plane was used as reference so that the plane between anterior and posterior nasal spines could be in parallel to horizontal or axial plane. Finally, in the coronal sections, the hard palate and nasal cavity floor were aligned with the horizon or axial plane as well. After this correction and with the axial section in hands, a panoramic curve was traced along the bone ridge of each patient. Next, panoramic re-construction was performed and the resulting cross-sections were standardised at 1.00 mm in thickness and at a distance of 1.00 mm between each other. In the panoramic re-construction, the section thickness was set to 10.25 mm in order to enhance the details of the mandibular canal (Figure 1).

Figure 1. Illustration of the methods used to assess CBCT images. A: Axial re-construction along the mandibular line for obtaining cross-sections; B: panoramic re-construction; C: cross-section re-construction. Source: Elaborated by the authors.



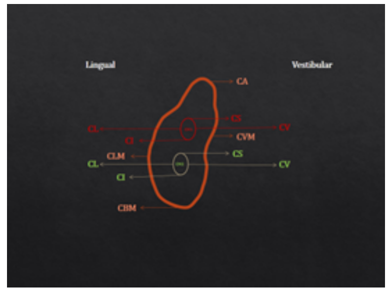
The images were selected according to their order of acquisition by the own software, enabling the visualisation of which cases presented changes in the mandibular canal. Tomographic images in the axial window were explored to confirm the presence of mandibular canal, with the tomographic volume being rotated and analysed in order to allow for observation of the whole extension of the mandibular canal in the sagittal window. The zoom tool was used to better visualise the images of bifurcations. In the cases in which the presence of BMC was observed, cross-sections were created to obtain images in the buccal-lingual sense. A specific section was selected to visualise the best image for measurements. Only BMC with diameter greater than 1.00 mm were included.

Demographic data on gender, age and affected side were obtained by means of relative values and descriptive analysis. By using the cross-sections according to the above-described protocol and the Xorancat® software's ruler tool, seven measurements were made in millimetres based on anatomical landmarks of BMC.

As shown in Figure 2, the following landmarks were used for identification of BMC:

- CM1: BMC closest to the alveolar ridge (CA);
- CM2: BMC closest to basal cortex in the mandible;
- CS: upper cortex of BMC;
- CI: lower cortex of BMC;
- CL: lingual cortex of BMC;
- CV: buccal cortex of BMC;
- CLM: lingual cortex of the mandible;
- CVM: buccal cortex of the mandible

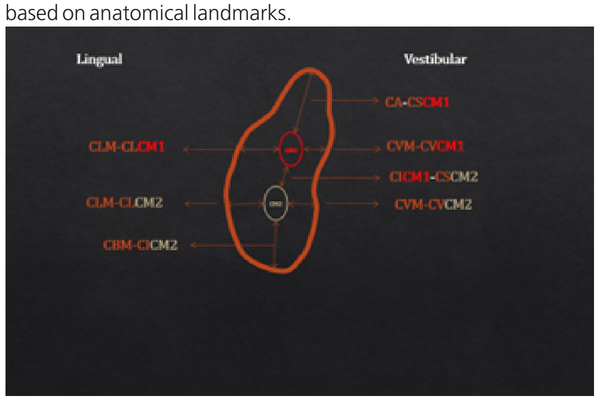
Figure 2. Schematic drawing illustrating the landmarks used as boundary point in the measurements made.



As shown in Figure 3, seven measurements were made based on the identification of the following landmarks:

- **CA-CSCM1 –** measurement of the distance from alveolar ridge (CA) to upper cortex of mandibular canal 1 (CSCM1);
- **CBM-CICCM2** – measurement of the distance from mandibular basal cortex (CBM) to lower cortex of mandibular canal 2 (CICCM2)
- **CLM-CLCM1** –measurement of the distance from mandibular lingual cortex (CLM) to lingual cortex of mandibular canal 1 (CLCM1);
- **CVM-CVCM1** – measurement of the distance from mandibular buccal cortex (CVM) to buccal cortex of mandibular canal 1 (CVCM1);
- **CLM-CLCM2** – measurement of the distance from mandibular lingual cortex (CLM) to lingual cortex of mandibular canal 2 (CLCM2);
- **CVM-CLCM2** – measurement of the distance from CVM to buccal cortex of mandibular cabal 2 (CLCM2);
- **CICM1-CSCM2** – measurement of the distance between both mandibular canals, that is, from the lower cortex of mandibular canal 1 (CICM1) to the upper cortex of mandibular canal 2 (CSCM2).

Figure 3. Schematic drawing illustrating the measurements made based on anatomical landmarks.



All assessments and measurements were performed by two surgeon-dentists, both specialists in dental radiology and having a minimum 2-year experience with CBCT and imaging software.

Excel spreadsheets (Microsoft, Seattle, WA, USA) were used to gather data containing image identification number, presence of BMC, affected side, and age and gender of the patient.

Analysis of the 90 tomographs showing presence of BMC was performed for demographic data (i.e. gender and age) and localisation (i.e. right side, left side and bilateral). These data were obtained by using relative values and descriptive analysis. Intra-class correlation coefficient (ICC) was applied in order to determine whether there was reliability between raters in the measurements of the seven distances. Statistical calculations were performed by using SPSS (SPSS Inc., Chicago, IL, USA) and BioEstat 5.0 (Fundação Mamirauá, Belém, PA, Brazil) software at significance level of 5%.

RESULTS

Of the 90 tomographs showing presence of BMC, 39 cases (43.3%) were from males and 51 (56.7%) were from females. The patients were 18 to 77 years old at the moment of examination, with mean age of 51.1 year (Table 1).

Table 1 – Localisation of BMC by gender.

	MALE (n%)	FEMALE (n%)	TOTAL (n%)
RIGHT SIDE	16 (41.00)	13 (25.50)	29 (32.20)
LEFT SIDE	9 (23.10)	13 (25.50)	22 (24.50)
BILATERAL	14 (35.90)	25 (49.00)	39 (43.30)
TOTAL	39 (43.33)	51 (56.67)	90 (100.00)

By using ICC, it was found that there was excellent reliability between raters regarding the measurements of all distances assessed (Table 2).

Table 2 – Reliability between raters according to ICC.

Distance	Intra-rater reliability
CA-CSCM1	0.9998 (excellent)
CBM-CICCM2	0.9993 (excellent)
CLM-CLCM1	0.9355 (excellent)
CVM-CVCM1	0.9772 (excellent)
CLM- CLCM2	0.9976 (excellent)
CVM-CVCM2	0.9974 (excellent)
CICM1-CSCM2	0.9940 (excellent)

Source: Elaborated by the author.

Table 3 shows descriptive analysis of the data, represented by minimum and maximum values as well as by means and standard deviations of the seven distances measured. It was found that CA-CSVCM1 values were higher, indicating the distance between CA and CM1. On the other hand, the distances between CBM and CM2 showed the lowest values, emphasising the risk of complications due to this proximity.

Table 3 – Descriptive analysis of the distances measured in millimetres.

Distance	Mean	Minimum	Maximum	Standard deviation
CA-CSCM1	10.22	1.50	21.50	4.49
CBM-CICCM2	5.52	2.32	9.32	1.88
CLM-CLCM1	4.50	2.77	6.98	0.98
CVM-CVCM1	3.64	1.46	7.52	1.25
CLM- CLCM2	3.87	1.99	6.76	1.04
CVM-CVCM2	3.14	1.01	6.02	1.07
CICM1-CSCM2	1.96	0.61	4.46	0.79

Source: Elaborated by the author.

DISCUSSION

There is a consensus that knowledge of the localisation and anatomical variations of mandibular canals are indispensable for a successful clinical practice, mainly in surgical procedures involving the mandible, such as extraction of third molars and placement of implants in this region.[2,3,8]

Mandible canal is generally unique, but there is a series of reports in the literature[2,3,9] demonstrating by means of different types of examination the presence of bifurcations which may be bifid or even trifid. Fukami et al.[10] and Kuribayashi et al.[6] emphasise that anatomical variations of mandibular canals can be identified on panoramic radiographs, but the overlapping of structures and distortion of radiographic images may lead to misinterpretations. It is believed that due to the two-dimensionality and overlapping of anatomical structures, these radiographs are not adequate for detection of variations of the mandibular canal

These findings on BMC have become more frequent since the emergence of CBCT, with a prevalence ranging from 15.6% to 65%, as reported by Kuribayashi et al.[6] and Orhan et al.[9] It is known that CBCT examination provides a high three-dimensional resolution, which can detect accessory canals as well as their direction and diameter. Therefore, CBCT is the most adequate imaging technique for a better visualisation of the pathway of BMC. According to Rashsuren et al.[11] the use of CBCT in different spatial planes (i.e. axial, coronal and sagittal) and cross-sections enables the identification of BMCs, which is in accordance with the methodology used in this study.

We have found that the prevalence of BMC was 30%, which is in accordance with Freitas et al.[12] but below the 65% reported by Naitoh et al.[9] On the other hand, Kuribayashi et al.[6] found a 15-percent prevalence of BMC by using CBCT, which is far below that of our study. This prevalence variation may be due to ethnical, geographic and methodological differences as well as to sample size and type of imaging technique used for assessment.

With regard to the affected side, we have found that 32% of the cases of BMC were on the right side, whereas the left side had 24.5%. These data are in accordance with studies by Ohran et al.[9] Correr et al.[13] and Freitas et al.[12] who also found a higher prevalence of BMC on the right side, ranging from 32.2% to 62.5% of the cases. With regard to bilaterality, 43% (n = 39) of the cases involved BMC, which differs from findings by Langland et al.[14] and Sanchis et al.[15] who reported approximately 10% of the cases.

As emphasised by Freitas et al.[12] we have found no statistically significant difference in the gender predisposition for BMC. However, Sanchis et al.[15] Orhan et al.[9] and Oliveira-Santos et al.[16] reported that BMC was more prevalent in women.

With regard to patient age group, we have found that the mean age of emergence of BMC was 48.4 years old, which is in accordance with the study by Correr et al.[13] who found 48.2 years old. It is believed that this age-group similarity may be related to the number of patients who seek the same type of treatment between the fourth and fifth decade of life rather than to an age coincidence only.[17,18,19] In fact, because this anatomical variation occurs in the structure formation process, that is, even in younger or older patients, BMC will emerge in the same percentage.[20,21,22]

Bifid mandibular canals are closely related to mandibular canals, with a mean distance of 1.96 mm, which makes it difficult to carry out treatments in this region because of the risk of complications during manipulation.[23,24] On the other hand, the proximity between mandibular canal and bone ridge is greater, with a mean distance of 10.22 mm, which favours oral implantology planning.[25,26] Nevertheless, lower values were observed between mandibular canal and base of mandible, with mean of 5.52 mm.[27,28] The distances from CLM to CICM1 and CICM2 were 4.50 mm and 3.14 mm, respectively, whereas the distances from CVM to CVCM1 and CVCM2 were 3.64 mm and 3.14 mm, respectively, demonstrating that mandibular canals are relatively at the centre of mandibular ridge.

In view of this, the identification of mandibular canals and their anatomical variations are extremely important for successfully performing procedures in the mandible, thus avoiding complications during surgical Procedures.[29] In fact, CBCT is a very valuable tool for thorough investigation as it allows all these anatomical variations to be identified and confirmed.[30]

CONCLUSION

According to the results found in the present study, it was possible to conclude that BMC is located at the centre of the body of the mandible, presenting a relatively short distance between CM1 and Cm2.

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