

The Position of the Mandibular Canal between the Mandibular Cortical Plates: A Cone Beam Computed Tomographic Analysis

Chiriță Andrei Leonid

Faculty of Dental Medicine, DMD, PhD Student, Division of Anatomy, Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

Corresponding Author: Chiriță Andrei Leonid, University of Medicine and Pharmacy "Carol Davila" 8, Bd. Eroilor Sanitari, RO-76241 Bucharest, Romania. Phone: +40746100568, E-mail address: chirita.andrei45@gmail.com

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Abstract

Objective: As the mandibular canal can be located anywhere between the buccal, lingual and basilar plates, the present study tries to classify its position inside the mandibular body.

Methods: To clarify the position of the mandibular canal inside the mandibular body, 30 Cone Beam Computed Tomography scans were analyzed and the distances from the mandibular canal to the surrounding mandibular cortical plates were measured on 4 levels of sections corresponding to the mesial and distal roots of the first two mandibular molars.

Results: The distance from the mandibular canal to the external surface of the buccal plate ranged from 1.77 to 8.96, with an average 4.89 mm at the mesial root end of the first molar and 5.71 mm at the distal root end of the second molar. The distances from the mandibular canal to the lingual surface of the cortical bone ranged between 5.84 and 0.56 mm with an average of 2.48 mm at the mesial root end of the first molar and 2.42 mm at the distal root end of the second molar.

Conclusion: The mandibular canal was found to be located closer to the lingual cortical bone in all of the four levels of sections and therefore it is safe, if necessary, to extend the cortical osteotomy for bone harvesting on the cortical plate in the molar area.

Keywords: Mandibular canal, Cone beam computed tomography, Cancellous bone, Cortical thickness

Introduction

The Mandibular Canal (MC) is an anatomical structure that extends from the mandibular foramen situated on the medial aspect of the mandibular ramus and divides into two separate canals in the mandibular body near the apex of the second mandibular premolar [15]. The canal contains the inferior alveolar nerve and vessels which split into mental and incisive divisions to enter the canals with the same names [3]. The mental canal is the division of the mandibular canal which ends on the external surface of the mandibular body in the premolar area where the mental foramen is located [27,2], while the incisive canal continues the course of the mandibular canal through the mandibular body and usually ends before reaching the mandibular symphysis [18]. In infants, the MC is situated near the lower border of the mandibular body and as a consequence of the bone apposition on the lower border of the mandible, but in adults the canal is observed at approximately half way between the lower border and the alveolar crest [24]. The relation between the dental apices and the MC is dynamic during postnatal development. According to some studies [25], the distance between the MC and the dental apices increases once with dental eruption.

During oral surgery, different procedures, such as dental implants placement, bone harvesting from the retromolar region, apical surgery on mandibular molars and premolars, surgical removal of the teeth and cysts, might harm the inferior alveolar nerve and vessels by neglecting the course of the MC [14,1]. As a consequence, nerve injury might result in neurosensory disturbance [6,7].

To avoid any surgical complication that might occur, the dental practitioner should keep in mind that the MC can be located anywhere inside the mandibular body and, because the MC varies from individual to individual, Computed Tomography is mandatory prior to any surgical intervention in the vicinity of the MC. Studies [8,11] have

shown that Cone Beam Computed Tomography (CBCT) is a reliable and efficient technique when it comes to the evaluation of the course of the MC.

Material and Methods

For this retrospective study, the scans of 30 patients, range between 26 and 47 years old, 9 males and 21 females, were selected. For this type of study formal consent is not required. The position of the MC inside the mandibular body was analyzed with the help of i Cat Vision software. Measurements were performed as follows: first, 4 different levels of section were set on coronal cut, on the mandibular body, on which the position of the MC was evaluated. Level A – The apex of the mesial root of the first mandibular molar, level B – The apex of the distal root of the first mandibular molar, level C – The apex of the mesial root of the second mandibular molar, level D – The apex of the distal root of the second mandibular molar (Figure 1). Then, on each level was measured: the upper distance (UD) – The distance from the upper border of the MC to the dental apex, the external vestibular distance (EVD) – The distance between the buccal lateral border of the MC and the external aspect of the buccal plate, the external basilar distance (EBD) – The distance between the lower border of the MC and the external aspect of the basilar plate, the external lingual distance (ELD) – The distance between the lingual lateral border of the MC and the external aspect of the lingual cortical plate, the internal vestibular distance (IVD) – The distance between the buccal lateral border of the MC and the internal aspect of the buccal plate, the internal basilar distance (IBD) – The distance between the lower border of the MC and the internal aspect of the basilar plate and the internal lingual distance (ILD) – The distance between the lingual lateral border of the MC and the internal aspect of the lingual plate (Figures 2,3 and 4).

The thickness of the cortical bone resulted after extracting the value of the internal distances from the value of the external distances.

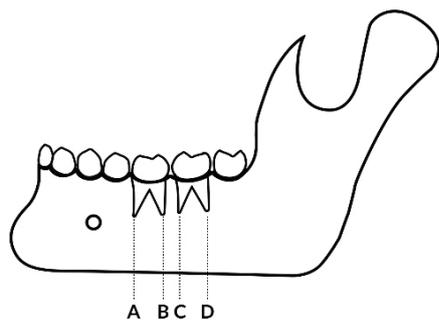


Figure 1: Illustration of the four different levels of sections; A – Level A – The mesial root of the first molar; B – Level B – The distal root of the first molar; C – Level C the mesial root of the second molar; D – Level D – The distal root of the second molar (Schematic representation made using Adobe Photoshop).

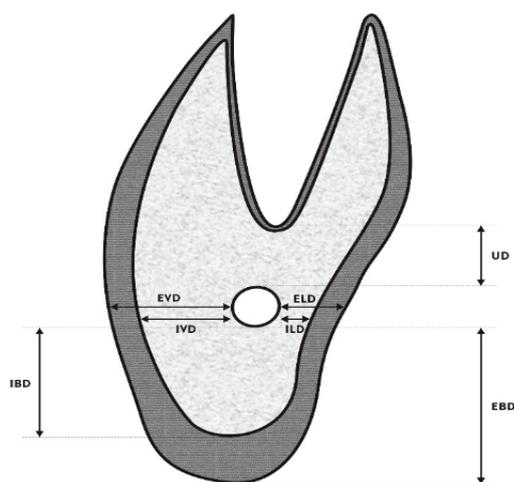


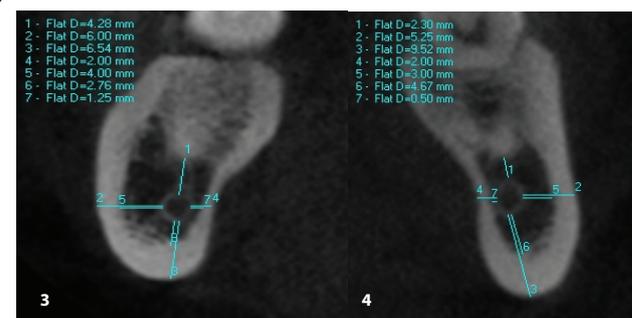
Figure 2: Illustration of the seven distances that were measured in the present study; UD - upper distance; EVD – External vestibular distance; EBD – External basilar distance; ELD – External lingual distance; IVD – Internal vestibular distance; IBD – Internal basilar distance; ILD – internal lingual distance (Schematic representation made using Adobe Photoshop).

Four subclasses were established in order to compare the thickness of the cancellous bone between the MC and the dental apices and between the MC and the internal surfaces of the mandibular cortical plates: Below 2 mm, b) between 2 and 4 mm, c) between 4 and 6 mm and d) above 6 mm.

Results

From the total of 1680 possible measurements on 30 patients, 1580 measurements (94%) could be made, and 100 (6%) measurements couldn't be made. The results on both the right and the left sides for the four levels of sections can be found in Table 1.

The distances between the mandibular canal and the molar apices



Figures 3 and 4: Measurements made on Level A (The apex of the mesial root of the first mandibular molar) on the right and left side of the mandible. 1. UD – Upper distance (Distance between dental apex and mandibular canal); 2. EVD – External vestibular distance (Distance between the mandibular canal and the external aspect of the buccal plate); 3. EBD – External basilar distance (distance between mandibular canal and the external aspect of the basilar cortical bone); 4. ELD – External lingual distance (Distance between mandibular canal and the external aspect of the lingual plate); 5. IVD – internal vestibular distance (Distance between mandibular canal and the internal aspect of the vestibular plate); 6. IBD – Internal basilar distance (Distance between mandibular canal and the internal aspect of the basilar cortical bone); 7. ILD – Internal lingual distance (Distance between mandibular canal and the internal aspect of the lingual plate).

The UD was found to measure on level A, on average, 4.67 and 4.98 on the right and left side respectively. On level B, C and D the same distance measured was 4.59, 3.55, 3.33 for the right side and 4.89, 3.37, 3.26 for the left side. The UD range between 0 to 8.92 was with an incidence of 17% below 2 mm, 27% between 2 and 4, 36.5% between 4 and 6 and 19.5% above 6 mm.

The distances between the lateral border of the mandibular canal and the external surfaces of the buccal, basilar and lingual cortical plates

The EVD measured on average on the right side was 4.89, 5.72, 5.97, 5.71 mm and, on the left side, 4.69, 5.55, 5.94, 5.52 mm for level A, B, C and D respectively.

The EBD measured on average on the right side was 7.87, 7.55, 7.42, 7.73 mm and, on the left side, 7.82, 7.65, 7.99, 7.99 mm for the same levels.

The ELD measured on the right side was 2.48 (A), 2.25 (B), 2.30 (C), 2.42 (D) mm and, on the left side, 2.86 (A), 2.26 (B), 2.20 (C), 2.43 (D) mm.

The distances between the lateral border of the mandibular canal and the internal surfaces of the buccal, basilar and lingual cortical plates (the cancellous bone thickness)

The IVD measured on average on the right side was 2.50, 3.19, 3.40, 3.20 mm and 2.62, 3.30, 3.47, 3.10 mm for level A, B, C and D respectively.

The IVD ranged between 0 and 6.82 mm was with an incidence of 15.5% below 2 mm, 58.2% between 2 and 4 mm, 24.5% between 4 and 6 mm and 1.8% above 6 mm.

The IBD measured on average on the right side was 4.15, 3.90, 3.86, 4.17 mm and 4.00, 3.92, 4.17, 4.16 mm on the left side for the same levels, A, B, C and D.

The IBD ranged between 0 and 9.34 mm was with an incidence of 4.05% below 2 mm, 48.2% between 2 and 4 mm, 28.3% between 4 and 6 mm and 9.45% above 6 mm.

The ILD measured on average on the right side was 0.75 (A), 0.56 (B), 0.62 (C), 0.70 (D) mm and on the left side 0.93 (A), 0.68 (B), 0.54 (C), 0.78 (D) mm.

The ILD was found to range between 0 and 4.19 mm. In 89.8% ILD was below 2 mm and between 2 and 4 mm the incidence was 9.3%. Between 4 and 6 mm the incidence was only 0.9% and above 6 mm there was none.

The cortical bone thicknesses

The buccal cortical plate measured on average was 2.16, 2.52, 2.55, 2.51 on the right side and 2.06, 2.24, 2.47, 2.41 mm on the left side, for level A, B, C and D respectively.

For the lingual plate the values in mm were on level A: 1.74 (right) and 1.89 (left); on level B: 1.69 and 1.57; on level C: 1.72 and 1.66; on level D: 1.76 and 1.64.

The thickness in mm of the cortical bone in the basilar segment was 3.75, 3.77, 3.60, 3.61 on the right side and 3.82, 3.72, 3.76, 3.83 on the left side for the levels A, B, C and D respectively.

Discussions

The distances between the mandibular canal and the dental apices

I found that the distances between the MC and the radicular ends of the first and second molars is decreasing from anterior to posterior which is a constant finding in other studies [21,5]. Similar to my findings, Littner et al [15] found that the shortest distance between the MC and the dental apices was at the distal root end of the second molar and that this distance increases gradually mesially, but, unlike me, who I used CBCT, he used orthoradial and eccentric radiographs and got different results, generally larger distances.

Sato et al., [21] used panoramic radiographs and CT scans to measure the distances between the MC and the radicular apices of the first and second molars and, although he found smaller distances (Ranging from 0.7-1.6 mm) than me (ranging from 3.2-4.9 mm), the same pattern of increasing distance mesially, from the distal root of the second molar towards the mesial root of the first molar, was seen.

Due to the close disposition of the dental apices of the second molar to the MC, there is a risk of damage of the inferior alveolar nerve during endodontic procedures [26]. Studies have shown that the mandibular second molar is the most frequent teeth involved in

inferior alveolar nerve injury during endodontic treatment, resulting in hypoesthesia or paresthesia of the lower lip and chin area [19,22].

The distances between the mandibular canal and the cortical plates

This study demonstrates a clear disposition of the MC near the lingual cortical plate on both the first and second molars sites.

Studies that evaluated the whole length of the mandibular canal, between the mandibular foramen and the mental foramen demonstrate that the course of the MC is near the lingual plate in the posterior segment and turns near the buccal plate as it approaches the mental foramen [16,15,4,20].

Levine et al., [13] measured the distance between the buccal margin of the MC and the external surface of the buccal cortical plate at the level of the first mandibular molar furcation and found the distance to be 4.9 mm (Range 1.3-7.8 mm).

Ylikontiola et al., [29] evaluated the distance between the MC and the external cortical plates at the reference point between the first and second mandibular molar. His results showed an average distance of 6.2 mm to the buccal cortical plate and 2.3 mm to the lingual plate, demonstrating a clear disposition, at this point, of the MC in the lingual side of the mandibular body.

Ylikontiola et al., [29] also evaluated the cancellous bone thickness between the MC and the cortical plates. On the same reference point (between the first and second molar) he found buccally 2.9 mm and lingually 0.3 mm of cancellous bone thickness. This study shows similar results: 3.1 mm of cancellous bone and on the buccal side and 0.5 mm on the lingual side (on level B – the distal root end of the first molar).

In a similar study Sekerci [23] evaluated the position of the MC inside the mandibular body on three reference points: a) Between the first and second mandibular molars; b) Between the second and third mandibular molar; c) Just distal to the third mandibular molar. Between the first and second molars the MC was at 6.4 mm from the buccal plate and at 2.3 mm from the lingual plate, and between the second and third molars 5.7 mm from the buccal plate and 3.3 from the lingual plate. In the third section, the distal to the third molar the MC was located 4.0 mm from the buccal plate and 2.6 from the lingual plate. Based on a similar reference point (level B as compared to the point between the first and second molars), this study is showing similar results. At level B, the distance between the MC and the buccal plate was 5.7 mm and the distance between the MC and the lingual plate was 2.2 mm.

Massey et al., [16] conducted a study on mandibular sections and measured the distances between the MC and the buccal surface, the lingual surface and the basilar surface of the mandibular body. The

Table 1: The average distances on right and left sides.

Right	Level A	Level B	Level C	Level D	< 2 mm	2-4 mm	4-6 mm	> 6	Level A	Level B	Level C	Level D	Left
UD	4.67	4.59	3.55	3.33	17%	27%	36.50%	19.50%	4.98	4.89	3.37	3.26	UD
EVD	4.89	5.72	5.97	5.71					4.69	5.55	5.94	5.52	EVD
EBD	7.87	7.55	7.42	7.73					7.82	7.65	7.99	7.99	EBD
ELD	2.48	2.25	2.3	2.42					2.86	2.26	2.2	2.43	ELD
IVD	2.5	3.19	3.4	3.2	15.50%	58.20%	24.50%	1.80%	2.62	3.3	3.47	3.1	IVD
IBD	4.15	3.9	3.86	4.17	4.05%	48.20%	28.30%	9.45%	4	3.92	4.17	4.16	IBD
ILD	0.75	0.56	0.62	0.7	89.80%	9.30%	0.90%	0%	0.93	0.68	0.54	0.78	ILD
Buccal	2.16	2.52	2.55	2.51					2.06	2.24	2.47	2.41	Buccal
Basilar	3.75	3.77	3.6	3.61					3.82	3.72	3.76	3.83	Basilar
Lingual	1.74	1.69	1.72	1.76					1.89	1.57	1.66	1.64	Lingual

sections were made distal to the third molar, between the third and second molar, between the second and first molars, between the first molar and second premolar and between the premolars. His results on the distance between the MC and the buccal surface were, from posterior to anterior, 3.43, 4.71, 5.74, 4.62, 3.43 mm, with the higher distance in section 3, between the first and second molars. Between the MC and the lingual cortex the results were 2.47, 2.82, 2.47, 2.56, 3.02 mm, with the higher distance between the mandibular premolars.

The distance between the MC and the buccal plate, at the level of the first and second molars, is relevant during bone harvesting from the external buccal plate [17]. Studies [12] have shown that the distance between the MC and the external buccal cortical bone is greater in the molar region than in the ramus region. Also, it was shown in a study [28] that cancellous' bone thickness between the MC and the internal surface of the buccal cortical plate has the highest values at the furcation of the first mandibular molar (4.05 mm), followed by the furcation of the second mandibular molar. The least thickness of cancellous bone between the internal surface of the buccal cortical bone and the MC was found at the distal half of the third mandibular molar where it measured 1.7 mm. In this study I found the cancellous component to be the thickest on level C (3.40 mm) and D (3.20 mm) on the right side and C (3.47 mm) and B (3.30 mm) on the left side.

The distance between mandibular canal and the lower border of mandibular body

Massey [16] evaluated the distance between the MC and the lower border of the mandible on 5 different points: between the premolars (9.10 mm), between the first molar and second premolar (7.58 mm), between the second and first molar (6.60 mm), between the third and second molar (7.47 mm) and just distal to the third molar (10.23 mm). Khorshidi et al., [9] found between the lower border of the MC to the lower border of the mandible a distance ranging from 4.8 to 14.5 with an average of 8.5 mm. For the same distance Kilic et al., [10] reported a mean distance of 10.52 mm with a range between 6.6 and 17.4 mm. I found smaller distances than Kilic, but similar results to Khorshidi, with an average on the right side of 7.87 mm on level A, which was the highest and 7.42 mm on level C, which was the lowest and on the left side the highest point was on levels C and D with an equal distance of 7.99 mm and the lowest on level B, 7.65 mm.

The cortical bone thicknesses

Sekerci [23] evaluated the thickness of the basilar cortical bone in three separate locations, between the first and second mandibular molars, between the second and third mandibular molars and just distal to the third mandibular molar and his results were, 3.3, 3.1, 2.8 mm, from anterior to posterior. In this study the values were higher, but the same pattern of decreasing from anterior to posterior was seen. On level A and B the distance were 3.75 mm and 3.77 mm and distally, on level C and D the results were 3.60 mm and 3.61 mm respectively.

In his study, Ylikontiola [29] measured the thickness of the buccal and lingual cortical bone at the reference point between the first and second mandibular molars and found, on average, 2.5 mm for the buccal plate and 1.6 mm for the lingual site. On our level B and C the cortical bone measured 2.52 and 2.55 for the buccal plate. For the lingual plate the results were also similar, 1.69 mm for level B and 1.72 for level C.

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Conflict of interest

None

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