

Morphological and morphometric study of the mental foramen using cone-beam CT in dentate adult patients

Cabanillas Padilla, Juan *, Quea Cahuana, Eduardo **

Abstract

Objective. To study the morphology and morphometry of the mental foramen using cone-beam CT in dentate adult patients. **Methods.** Transversal descriptive study in which 180 cone beam CTs were studied to analyze the distance between the upper and lower cortical areas of the mental foramen to the alveolar crest and the mandibular basal bone respectively, as well as the location, shape, size and presence of accessory holes. **Results.** It was found that the mean of the upper cortical area in relation to the alveolar crest was 15.00 mm and the mean of the lower cortical area to the mandibular basal bone was 13.75 mm. The most frequent location was the longitudinal axis of the second premolar (44.4% right side and 47.2% left side). The predominant shape was oval and the size was in the range of 2.00 mm to 2.99 mm. Accessory holes were present in 55.5% of cases. **Conclusion.** Knowing the exact location of the mental foramen and its variations helps to properly plan surgical procedures and to administer anesthesia effectively without damaging the neurovascular bundle.

Keywords: Mental foramen, Cone-Beam, Computerized tomography.

* Professor at Facultad de Odontología, Universidad de San Martín de Porres (USMP), Lima, Perú. Dental Surgeon

** Professor at Facultad de Odontología, Universidad de San Martín de Porres (USMP), Lima, Perú. Dental Surgeon

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Introduction

The mandible stems from the first branchial arch, has mixed types of ossification and runs downwards and forward, as it develops from the condyle (1, 2).

Mandibular growth modifies the direction of the mental foramen. At birth, the neurovascular bundle runs forward through the hole, and in adults it runs backwards (3).

The mental foramen is an opening on the lateral part of the mandible. It is here that the inferior alveolar nerve branches into the mental nerve and the incisive nerve. These are terminal branches which supply sensory innervation to soft tissues in the vestibular area, the lower lip and the chin, up to the mandibular midline. The location of the mental foramen varies according to age. In children, before tooth eruption, it is located closer to the alveolar crest, whereas in adults it is, on average, between 13 mm and 15 mm above the inferior mandibular border. In individuals with bone resorption it is located closer to the alveolar crest, and it can even be found over it. Thus, this must be considered when preparing full prosthetics, as the set may press on the mental nerve loop (1, 4, 5, 7, 18).

Cone-beam CT enables us to accurately determine the location, shape, and size of the mental foramen, as well as the presence of accessory holes. This allows for an accurate morphometric analysis, which enables us to develop a suitable treatment plan and to administer anesthesia effectively, thus we can conduct invasive procedures without damaging the mental foramen (6, 24). This technology also provides life-size images where precise lines and measurements can be made, as it works with isotropic voxels. Additionally, it provides images in all three planes (8, 9, 10).

Materials and methods:

180 CTs of dentate adult patients of both sexes ranging between 20 and 50 years of age were analyzed (74 men and 106 women). They were taken at Centro de Diagnóstico por Imágenes, Lima, Perú. The tomographies were taken using Vatech equipment, Picasso Master model, with Easy Dent software, a field of view (FOV) of 20 x 19 mm, 70 Kv, 8 Ma, exposure time of 25 seconds and a focus point of 0.5 mm. The variables were studied on the transaxial plane through 1-mm cuts and 0.5-mm intervals.

The morphological and morphometric analysis of the mental foramen was conducted on both sides. The tomographies evaluated included all the teeth and a preserved alveolar crest. Tomographies with the following elements were excluded: periapical lesions, supernumerary teeth, orthodontics patients and bilateral absence of mental foramen.

The distances from the upper and lower cortical areas of the mental foramen to the alveolar crest and the mandibular basal bone respectively were analyzed, as well as the size of the hole on the transaxial cut. There we considered the distance between the upper and lower cortical areas of the structure, and the measurements were classified into ranges (Figures 1 and 2).

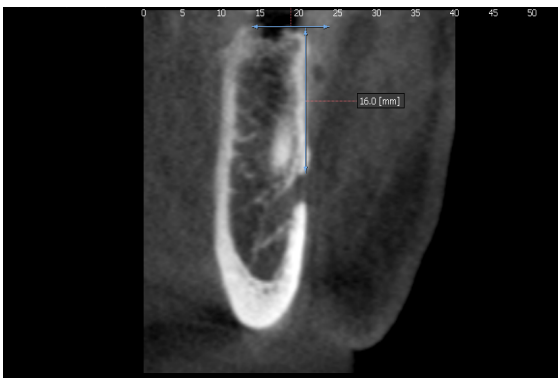
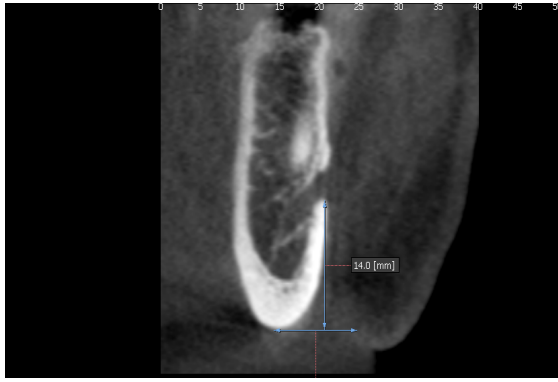


Figure 1: Location of mental foramen on the transaxial plane

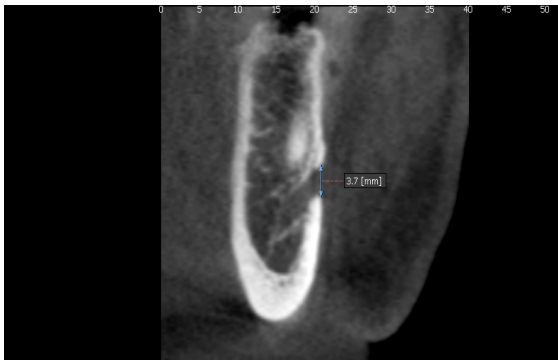


Figure 2: Size of mental foramen

3D reconstruction was used to determine the location, shape and presence of accessory holes. To determine the location, the longitudinal axes of teeth were taken as reference as per Al Jasser & Nwoku's classification (21). Position 1: Mesial to first premolar; position 2: In line with first premolar; position 3: Between first and second premolars; position 4: In line with second premolar; position 5: Be-

tween second premolar and first molar, position 6: In line with first molar (Figure 3).

Oval and round shapes were taken as evaluation criteria, as well as the presence of accessory holes (Figure 4).

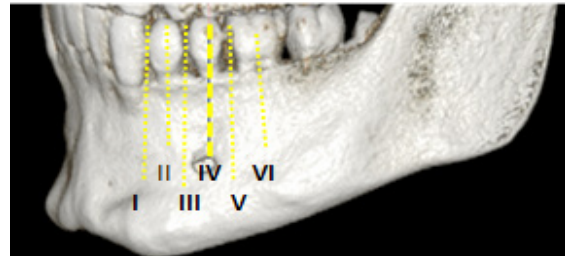


Figure 3: Location of mental foramen as per Al Jasser & Nwoku's classification

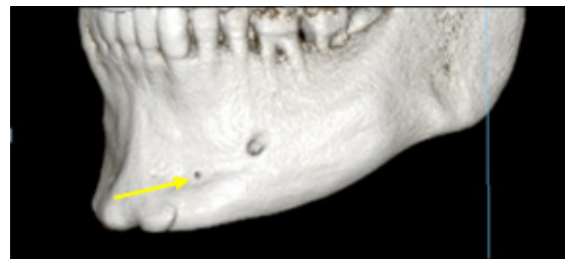


Figure 4: Presence of accessory mental foramina

Data processing and analysis was conducted using SPSS statistical software, version 15. Quantitative variables were presented in minimum values, maximum values, mean values and standard deviation. The Mann-Whitney U test was used to compare the differences between the right and left sides.

Qualitative values were presented via frequency distribution tables, and Pearson's chi square test and Fisher's exact test were used to compare the difference between the right and left sides. All tests had a significance level of 5%.

Results

The tomographies were evaluated by three calibrated examiners (Kappa 1.00).

The distance from the upper and lower cortical areas of the mental foramen to the al-

veolar crest and the mandibular basal bone respectively was measured. No statistically significant differences were found between the right and left sides in either measurement ($p^*0.178$), ($p^*0.215$) (Table I).

Table I. Mean of the distances from the upper cortical areas to the top of the alveolar crest, and distances from the lower cortical areas to the mandibular basal bone.

Parameters	Distance from upper cortical area to alveolar crest		Distance from lower cortical area to mandibular basal bone	
	Right	Left	Right	Left
Mean	15.1 mm	14.9 mm	13.6 mm	13.9 mm
Standard deviation	2.4mm	2.1 mm	2.0 mm	1.8 mm
p [†] value	0.178		0.215	

The most frequent location of the mental foramen was the longitudinal axis of the second premolar on both sides (position IV), followed by positions V, III, VI and II. No

mental foramen was found in position I, neither significant differences compared to the contralateral side ($p^*0.764$) (Table II).

Table II. Location of mental foramen as per Al Jasser & Nwoku's classification

Location	N	%
Mesial to 1st premolar (position I)	0	0
In line with 1st premolar (position II)	4	1.1
Between 1st and 2nd premolars (position III)	62	17.2
In line with 2nd premolar (position IV)	165	45.8
Between 2nd premolar and 1st molar(position V)	95	26.4
In line with 1st molar (position VI)	34	9.4

Oval was the most frequent shape, and no significant differences were observed compared with the contralateral side ($p^*0.057$) (Table III)

Table III. Shape of mental foramen

Shape	N	%
Oval	194	53.9
Round	166	46.1

The size of the mental foramen was classified into five measuring ranges. Most (n=153; 42.5%) were included in the 2 mm to 2.99 mm range on both sides. No significant differences were observed compared with the contralateral side ($p < 0.023$) (Table IV)

Table IV. Size of mental foramen classified into ranges

Size	N	%
1.0 - 1.99 mm	31	8.6
2.0 - 2.99 mm	153	42.5
3.0 - 3.99 mm	134	37.2
4.0 - 4.99 mm	35	9.7
5.0 or more mm	7	1.9

Accessory holes were found in 100 cases (55.5%) out of the 180 tomographies taken (Table V).

Table V. Frequency of accessory holes per side

Presence of accessory holes		n	%
Right side			
No hole		108	60.0
One hole		55	30.6
Two holes		12	6.7
Three holes		4	2.2
Four holes		1	0.6
Left side			
No hole		110	61.1
One hole		52	28.9
Two holes		14	7.8
Three holes		4	2.2
Four holes		0	0.0

Discussion

This research found a distance from the upper cortical area of the mental foramen to the alveolar crest which is similar to the distance found in other studies (4, 11). Furthermore, other studies (6, 12) where measurements were taken on dry mandibles reported shorter distances, results which differ from the findings of this study.

The distance from the lower cortical area of the mental foramen to the mandibular basal bone was (13.6 mm \pm 2.0 mm) and (13.9 mm \pm 1.8 mm) on the right and left sides respectively, which, on average, is consistent with the results of other studies (4, 13, 14).

There is considerable debate in the literature regarding the location of the mental foramen in different ethnic groups. This study showed that this structure was found in all the samples between the root of the first premolar and the root of the first molar.

These results are similar to those of other stud-

ies (4, 6, 11, 13–17, 24), where the mental foramen was found on the longitudinal axis of the second premolar (Position IV). Other studies (7, 12, 18, 19) showed that the most frequent location of the mental foramen was position III, which differs from this study, as positions V and III ranked second and third respectively regarding frequency. Several authors have studied the location of the mental foramen using the longitudinal

axes of teeth as reference. However, there were variations in the results, which could be attributed to ethnic differences (Table VI)

Table VI. Location of mental foramen in different populations

Authors	Population	Location of mental foramen %					
		I	II	III	IV	V	VI
Virendra B.	North of India	0	3.4	20.5	60.1	14.5	1.4
Amorin et al.	Brazil	0	0	21.4	69.6	8.8	0
Kekere-Ekun	Nigeria	0.17	1.66	26.99	55.63	12.25	3.3
Liyiam M.	Perú	0	1.2	25.4	70.6	2	0
Igbigbi et al.	Malawi	0	2.8	10	62.9	24.3	0
Wanger et al.	China	0	21	59	19	1	0
Kim	Korea	0	8.9	26.8	64.3	0	0
Santini et al.	England	0	9.1	59.1	31.8	0	0
This study	Perú	0	1.1	17.2	45.8	26.4	9.4

Regarding the shape of the mental foramen, there are several studies whose results do not agree on the classification of shapes itself. However, other studies take the oval and round shapes as evaluation criteria. These studies (4, 6, 11, 12, 15, 22) show an oval shape in most cases, which is consistent with the present study. However, other authors (14, 16, 20, 24) disagree with our results as they report that the round shape is the most frequent one.

The size of the mental foramen was classified into 5 ranges. In most cases, they were located in the 2 mm to 2.99 mm range on both sides, with a frequency of 75 cases (41.7%) on the right side and 78 cases (43.3%) on the left side.

Several authors have evaluated the size of the mental foramen on dry mandibles. Their results are similar to the results of this study: within the 2 mm to 2.99 mm range (Table VII).

Table VII. Size of mental foramen in different populations

Author	Right side	Left side
Virendra ⁽⁶⁾	2.61 mm ± 0,17 mm	2.53 mm ± 0.14 mm
Deppa R ⁽¹¹⁾	2.15mm	2.13 mm
Ilayperuma ⁽¹⁵⁾	2.50 mm ± 0.61	2.50 mm ± 0.61
Oliveira J. ⁽¹²⁾	2.38 mm ± 0.63 m	2.39 mm ± 0.58 mm
Igbigbi S. ⁽⁴⁾	2.43 mm ± 0.15 mm	2.71 mm ± 0.18 mm
Rajani S. ⁽²⁰⁾	2.79 mm	2.57 mm
Sumit G (14)	2.62 mm	2.62 mm

Accessory mental foramina were present in 55.5% of all cases, which differs from the results of most studies conducted on dry mandibles and evaluated using cone-beam CT (6, 14, 15, 20, 23). Singh R. & Srivastav observed the presence of accessory holes in 13% of the total population evaluated, while other studies (6, 14, 15, 23) showed a prevalence of 6.67%, 6.6%, 3.92% and 6.5% respectively.

All the variables studied are consistent with the results of Igbigbi & Lesbona, who evaluated the morphology and morphometry of the mental foramen in an African population.

Conclusion

It is concluded that the mental foramen in a dentate adult population is located, on average, 13.75 mm above the mandibular basal bone. The most frequent location was below the longitudinal axis of the second premolar, in most cases it was oval shaped and its size was within the 2 mm to 2.99 mm range. Accessory mental foramina were observed in over half the cases studied (55.5 %).

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Juan Cabanillas Padilla: juancabanillaspadilla@gmail.com