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Original Research Article

A MORPHOMETRIC ANALYSIS OF THE SHAPE, POSITION, NUMBER AND SIZE OF MENTAL FORAMEN IN DRY HUMAN MANDIBLES

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ABSTRACT

Aim: To provide morphometrical information on the shape, position, number and size of mental foramen in dry human mandibles. The knowledge on the anatomy of mental foramen is very important in clinical dentistry, surgical procedures and nerve blocks, to avoid injuries to the neurovascular bundle in the mental foramen.

Material and Methods: This study was conducted on 45 dry adult human mandibles in the Department of Anatomy, College of Dentistry, Ajman University, Ajman, U.A.E. The shape and number of mental foramen were studied by visual examination. The size and position of the mental foramen were measured using Vernier caliper. The excel software was used for the statistical analysis.

Results: In our study, bilateral mental foramen were present in all the mandibles.The majority of mandibles were oval in shape with 71.12% on left side and 66.67% on the right side. The most common position for mental foramen was found to be along the longitudinal axis passing between the 2nd premolar and 1st molar teeth with 44.45% on the left side and 46.66% on the right side respectively. The mean vertical diameter of mental foramen was found to be 3.23 mm on left side and 3.33 mm on the right , whereas the horizontal diameter was found to be 4.05 mm on the left side and 4.21 mm on the right side. We also found the higher incidence of postero-superiorly directed mental foramen on both sides with 55.33% on left and 44.45% on right side. Their was no incidence of accessory mental foramen in any mandibles studied.

Conclusion: Our study will be a helpful supplement to the data collected previously on the variation in the incidence, position, shape and size of mental foramen. It will provide useful information to dental surgeons, anesthetics and neurosurgeons to carry out nerve block and surgical procedures like apical curettage of mandibular premolars and periodontal surgery. We did not come across any accessory mental foramen in any 45 mandibles studied.

KEY WORDS: Mental foramen, Mandible, Morphometry, Molar teeth, Premolar teeth.

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INTRODUCTION

The mental foramen (MF) is a small foramen situated in the anterolateral aspect of the body of the mandible. It provides the route for the mental nerve and vessels [1,2,3]. Mental nerve is a branch of the inferior alveolar nerve which supplies sensation to the lower lip, labial mucosa, lower canines and premolars. It is present approximately in a vertical line with the supraorbital notch.

Variations in the position of the MF have been reported by many authors in different ethnic groups and various shapes have also been noticed. Any foramen in addition to the MF in the body of the mandible is known as an Accessory mental foramen (AMF).AMF transmits the accessory branch of the mental nerve and is located below the 1st molar teeth.

Standard anatomical and radiological text books contain conflicting statements regarding the location of mental foramen some stating that mental foramen is located between spaces of mandibular premolars, may be between the apex of lower premolars or below the apex of second premolar. According to Tebo and Telford [4],

location of mental foramen is below the apex of second mandibular premolar which was similar to some other studies also [5].

Mental foramen transmits mental nerves and vessels [6]. It marks the termination of mandibular canal in the mandible through which the inferior alveolar nerve and vessels pass. At this point the mandibular canal bifurcates and forms the mental incisive canals. The mental bundle passes through the mental foramen and supplies sensory innervation and blood supply to the soft tissues of the chin, lower lip and gingival region on the ipsilateral side of the mandible [3].

Thus, the precise knowledge on the variations in the position, shape, size and number of the mental foramen and presence of accessory mental foramen would be of much use for dental surgeons while they do surgical procedures on the mandible like curettage of the premolars, filling procedures, dental implants, Root canal treatment, orthognatic surgeries etc. It is also essential to have an effective and a successful anaesthesia during nerve blocks, prior to surgical procedures. Also the Accessory mental foramen which is due to branching of mental nerve before passing through the Mental foramen, its shape, size and verification of its existence would prevent accessory nerve injury during periapical surgery. In addition, if this is not blocked properly, paresthesia will be less in the structures supplied. Hence, this study was conducted to assess the morphometric features of mental foramen and accessory mental foramen.

MATERIALS AND METHODS

The mandibles used in the present study were procured from the Department of Anatomy, College of Dentistry, Ajman University, Ajman, U.A.E. 45 dry adult human mandibles were selected for the study, irrespective of race, sex , with either all the teeth intact or with preserved alveolar margins. The bones with gross patho logical deformities were excluded from the study.

The number, shape and orientation of the Mental Foramen were determined by visual examination. The position of the mental foramens were measured with respect to the teeth, for which we followed the Tebo and Telford Classification [Table-1]. The position of the mental foramen with respect to the borders of the mandible were also measured [Table-2] with the help of digital Vernier caliper, having a measuring accuracy of 0.01 mm. From the transverse and the vertical diameters obtained, the size of mental foramen was calculated.

Position of Mental Foramen in relation to teeth (Tebo & Telford Classification):

I- Foramen lying on a longitudinal axis passing between the canine and first premolar.

II- Foramen lying on the longitudinal axis of the first premolar.

III- Foramen lying on the longitudinal axis passing between first and second premolar

IV- Foramen lying on the longitudinal axis of the second premolar

V- Foramen lying on the longitudinal axis passing between the second premolar and first molar.

VI- Foramen lying on the longitudinal axis of first molar.

Position of Mental Foramen and its size: It was calculated by transverse and vertical measurements of mandible in relation to borders.

PQ-Distance from symphysis menti to posterior border of mandible.

PR- Distance from symphysis menti to anterior margin of MF.

SQ- Distance from posterior margin of MF to posterior border of mandible.

RS-Transverse Diameter (TD) of MF.

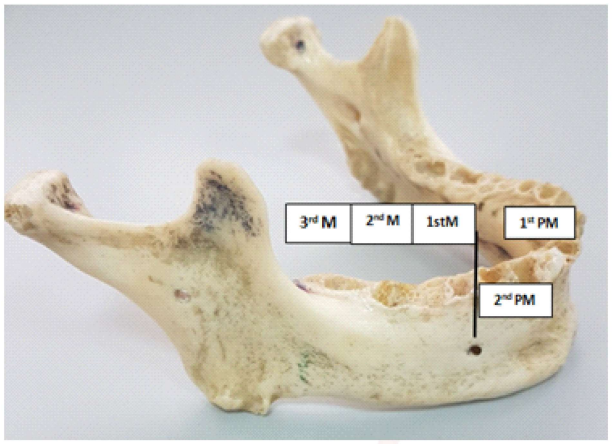
AB- Distance from alveolar margin to base of mandible.

AC- Distance from alveolar margin to superior margin of MF

DB- Distance from inferior margin of MF to base of mandible.

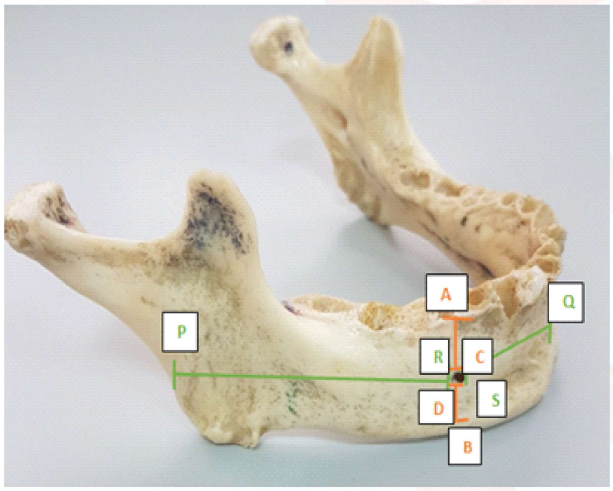
CD-Vertical Diameter (VD) of MF

Fig. 1: Mandible showing the Mental foramen lying in Position V.



(Ist PM- First Premolar, 2nd PM- Second Premolar, 1st M- first Molar, 2nd M- second Molar, 3rd M- third Molar.)

Fig. 2: Relation of the mental foramen to the body of the mandible:



A: point at the alveolar crest lying on a longitudinal axis with the mental foramen. B: point at the lower border of the mandible lying on a longitudinal axis with the mental foramen. C: point at the upper margin of the mental foramen. D: point at the lower margin of the mental foramen. P: point at the posterior border of ramus lying on a transverse axis with the mental foramen. Q: point at the symphisis menti lying on a transverse axis with the mental foramen. R: point at the lateral margin of the mental foramen. S: point at the medial margin of the mental foramen.

The transverse and vertical diameters were measured by using various parameters viz., the distance from the symphysis menti, the posterior border of the mandible, the base of the mandible and from the alveolar margins.

Direction: The direction of the mental foramen was measured by inserting a fine pin into the foramen from its lateral aspect. The direction in which the pin pointed was visually recorded. The results of different directions or route of the foramina was then grouped into 5 as follows:

A1- Anteriorly A2- Anterosuperiorly

A3- Posteriorly A4- Posterosuperiorly

A5- Superiorly.

All the measurements were recorded by one investigator to reduce bias.

Statistical Calculations: The Excel software was used for the statistical analysis to calculate the mean and the standard deviation. The Formula used for Standard Deviation (S) :

$$S = \sqrt{1/(N-1)\sum^{N}(X_i - X)^2}$$

[X_i= One sample value, X= Sample mean , N= Sample size

RESULTS

Number: In our study all the bones showed only a single mental foramen on both sides of the mandible. Accessory mental foramen was not present in any of the mandibles studied.

Shape: The shape was found to vary between round and oval. The Incidence was:

Table 1: Showing the Shape of Mental Foramen:

Shape	Frequency		Percent		Cumulative Percent	
	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side
Oval	30	32	66.67	71.12	66.67	71.12
Round	15	13	33.33	28.88	100	100
Total	45	45	100	100		

The most common shape was Oval on both left and right side.

Position:

The position of the mental foramen with respect to teeth of the lower jaw was classified according to the method of Tebo and Telford, 1950.

I-Foramen lying on a longitudinal axis passing between the canine and first premolar.

II-Foramen lying on the longitudinal axis of the first premolar.

III-Foramen lying on the longitudinal axis passing between first and second premolar

IV-Foramen lying on the longitudinal axis of the second premolar

V-Foramen lying on the longitudinal axis passing between the second premolar and first molar.

VI-Foramen lying on the longitudinal axis of first molar.

Table 2: Position of Mental foramen in relation to Teeth:

Position	Frequency		Percent		Cumulative Percent	
	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side
I	0	0	0	0	0	0
II	3	2	6.67	4.44	6.67	4.44
III	8	7	17.78	15.55	24.45	19.99
IV	13	16	28.89	35.56	53.34	55.55
V	21	20	46.66	44.45	100	100
VI	0	0	0	0		

According to this classification, the data showed that the most common position of the Mental foramen on both right and left sides lay on the longitudinal axis which passed between the second premolar and the first molar (Position V), followed by position IV i.e lying on the longitudinal axis of the second premolar. Position I and VI were not observed in any of the mandibles.

Table 3: Morphometric measurement of mental foramen from different parts of the mandible:

Parameter	Number		Minimum(mm)		Maximum(mm)		Mean(mm)		SD	
	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side
AB	45	45	22.04	22.36	34.06	34.36	27.44	28.98	±4.14	±3.655
AC	45	45	10.26	10.2	15.23	16.21	12.89	13.51	±1.618	±2.01
DB	45	45	8.25	9.15	14.67	14.2	11.06	11.76	±1.960	±1.652
CD	45	45	3.53	3.01	4.16	3.95	3.33	3.23	±0.185	±0.292
PQ	45	45	89.39	86.26	98.35	100.36	93.52	93.08	±2.818	±4.658
PR	45	45	44.24	44.01	48.25	50.06	46.89	47.05	±1.269	±1.823
SQ	45	45	42.32	40.11	45.23	46.05	43.59	42.92	±1.072	±1.735
RS	45	45	2.83	2.14	4.87	4.25	4.21	4.05	±0.583	±0.724

The vertical diameter of mental foramen was found to be 3.23 mm on the left side and 3.33 mm on the right side. The horizontal diameter was found to be 4.05 mm on the left side and 4.21 mm on the right side.

Table 4: Direction of the mental foramen:

Direction	Frequency		Percent		Cumulative Percent	
	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side
A1	10	9	22.22	20	22.22	20
A2	-	-	-	-	22.22	20
A3	15	12	33.33	26.67	55.55	46.67
A4	20	24	44.45	53.33	100	100
A5	-	-	-	-	100	100

Most of the mental foramens on the left side (55.33%) and 44.45% on the right side were oriented postero-superiorly and this was followed by anterior and posterior directions on each side.

DISCUSSION

The location of the Mental foramen is an important factor in both diagnostic and clinical procedures [7]. The accurate knowledge of morphometric and morphological dimensions of mental foramen are of much help in proper localisation of important maxillo-facial neurovascular structures in and around the mental foramen [8].

Our study demonstrated the presence of mental foramen in all 45 mandibles and was present bilaterally. Some other studies also found bilateral presence of mental foramen in all mandibles studied [9,10,11].

In our study the most common shape was found to be oval on both left (71.12%) and right (66.67%) with round being on left (28.88%) and right (33.33%) [Table-1]. Two other studies also found oval (69%) and round shape (31%) and the other who reported oval mental foramen 71% on left and 73.8% on right side [12,11]. Also another study observed oval shaped mental foramen in 83.3% mandibles and round in 16.7% [13] The domination of oval shape compared to round shape was noted by other authors as well [14,15,16]. In contrast to this observation some

studies found round shaped mental foramen in 51.7% and oval in 48.3% [17]. Two more studies found round mental foramen more with one study having values of right (75%) and left (60%) and the other observed round mental foramen in 94% of cases in right and 87% cases in left [9,10].

According to Hauser and De Stefano [18], the different variants in shape of mental foramen would be due to epigenetic traits since they may be seen as the products of genetically determined growth process of other tissues affecting bone formations. Consequently, they may undergo modification during ontogeny in the presence of modifying genes or relevant environmental conditions and such genes generally show variable degree of expression. Thus, variations in the position, shape, number and size of the mental foramen depends on the modification of genes. A comparison between results of the present study and previous ones is given in Table 5.

Table 5: Shape of Mental foramen in percentage in different Studies compared to the Present Study:

Authors	Oval	Round
Gerhenson et al (1986)	65.5	34.5
Mbajiorgu et al (1998)	56.3	43.8
Prabodha and Nanayakkara (2006)	66.7	33.3
Singh and Srivastava (2010)	6	94
Agarwal and Gupta (2011)	92	8
Rastogi R et al (2012)	48.3	51.7
Present study	68.89	31.11

There are significant differences reported in the location of mental foramen among different authors and also in different ethnic groups. The most common position of mental foramen in our study is position V [Fig-1] on both sides with 44.45% on the left side and 46.66% on the right side, followed by position IV, III and II on both sides [Table-2]. No mental foramen was observed in positions I and VI. Some studies had similar results with position V (65%) on right and position III (40%) on the left side [9]. A radiological study of mental foramen reported the most common position to be position III (42.7%) [22]. Some other studies showed the most common position to be Position IV in 64.7% cases on right side and 66.7% cases on the left sides [12] , which was similar to the findings in some other studies [10,23,24] . Another study also showed position IV as most common position on right and position III on left side [13]. Similar study done on Indian population found the most common position to be IV followed by V on both sides [7,17]. In relation to ethnic groups, position IV is prevalent in 52.94% of Srilankans, 44.08% (right) and 46.23% (left) of cases in western India, 55.7% (right) and 61.4% (left) of cases in Turkish,, 45% cases in Malay populations [12].These results differed significantly from that of some other studies who reported the higher incidence of positions I, II and VI between Indian and Sinai populations [19]. Also in the studies on Nigerians and Kenyans , the most common position was found to be III followed by II [25]. Table-6 shows the Comparison of position of Mental foramen in different studies and the present study.

Table 6: Comparison of position of Mental foramen in different Studies in Percentage (%).

S.No	Authors	I	II	III	IV	V
1	Tebo and Telford (1950)	0	3.5	23	49.4	24.1
2	Green. R.M (1987)	0	21	51	24	4
3	Mbajioru.E.F et al (1988)	0	0	12.4	56.3	31.3
4	Santini. A et al (1990)	0	9.1	59.1	31.8	0
5	Mawaniki.D.L et al (1992)	0	31.9	56.1	12.1	0
6	Shankland.W (Asian Indians) (1994)	0	5.8	75.36	18.84	0
7	Shankland.W (East Africans) (1994)	0.3	7.57	57.88	31.52	0
8	Shankland. W (Chinese) (1994)	0	21	59	19	1
9	Oguz et al (2002)	0	0	44.1	55.9	0
10	Igbigbi.P.S et al (2005)	0	2.8	10	62.9	24.3
11	Singh.R, Srivastava (2010)	0	2.08	17.71	68.75	11.46
12	Udhaya.K et al (2013)	0	4.4	16.67	52.22	27.78
13	Present Study (2017)	0	5.55	16.67	32.23	45.55

In our study the most common direction of mental foramen is posterosuperiorly (A4) on both left (53.33%) and right (44.45%) [Table-4]. The same direction was also the most prevalent in some other similar studies [7,26] . But some studies showed anterior (A1) as most common position on both left (57.5%) and right (62.5%) sides [9].

In the study we also measured the size of mental foremen [Fig-2]. The mean vertical diameter of mental foremen in our study is 3.23mm on the left side and 3.33mm on the right side respectively.The mean transverse diameter is 4.05 mm on the left side and 4.21 mm on the right side respectively [Table-3]. Our results are much similar to some other studies who showed mean transverse diameter to be 4.57mm on right side and 4.61mm on the left side and mean

vertical diameter to be 3.58mm and 3.55mm on right and left sides respectively [17]. In another study, mean vertical diameter is 2.43mm on right side and 2.71mm on left , whereas the horizontal diameter was 5.05mm on right and 5.00 mm on left [1]. In another study, the vertical diameter was 1.71mm on the right side and 1.69mm on the left side respectively and the mean transverse diameter was 2.56mm on right side and 2.41mm on the left side [13]. In another study the transverse diameter was 3.14mm on the left side and 2.93mm on the right side whereas the vertical diameter was 2.31mm and 2.64mm for vertical diameter for right and left sides respectively [27]. These differences in vertical and horizontal diameters in the above studies was due to high number of oval shaped mental foramen. In another study only transverse diameter was taken and the results showed the mean transverse diameter to be 2.79mm on the right side and 2.57mm on the left side [10].

Similarly in another study , the mean transverse diameter of mental foramen was 2.63mm and 2.61mm on right and left sides respectively, whereas mean vertical diameter was 2.33mm and 2.29mm on the right and left sides respectively [9]. The similarity in the values in vertical and transverse diameters is due to the fact that most of the mental foramen were round in shape. These studies show the values of transverse diameter much less than the present study. The most probable reason for the difference was the higher number of round shaped mental foramen than oval in these studies, whereas in our study oval shape is more common.

CONCLUSION

Injury to the mental nerve is one of the major complications of the surgery of mandibular canal and mental foramen. Therefore it becomes very necessary for dental surgeons to identify mental foramen in it's various positions and analyze its morphometry while doing nerve block and surgical procedures such as apical curettage of mandibular premolars and periodontal surgery to avoid injury to the neurovascular bundle.

In majority of mandibles we found in the present study, mental foramen was oval shaped, lying in position V and oriented postero-superiorly. However, variations exist in the position, shape and size of the mental foramen in different population groups. Hence, it is essential to be aware of the possibility of the anatomical variations while planning surgery in this region, to avoid nerve damage and to do effective mental nerve block anesthesia.

Conflicts of Interests: None

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