INTERNATIONAL JOURNAL OF STUDENTS' RESEARCH
Volume 1, Issue 1, Year 2011 **www.ijsronline.com**

RESEARCH

Morphological and morphometric analysis of mental foramen utilizing various assessment parameters in dry human mandibles

Abu Ubaida Siddiqui[1], Syed Rehan Daimi[1], Parmatama Prasad Mishra[2], Suraj Sudarshan Doshi[3], Jay Yashwant Date[3], Guruditta Khurana[3]

ABSTRACT

Introduction: The mental foramen (MF) is a strategically important landmark during surgical interventions and anaesthetic blockage procedures involving the mental nerve. The purpose of this study was to assess various parameters pertaining to the morphology and morphometry of the mental foramen in 93 dry human mandibles. **Methodology:** Measurements were taken as the distance between alveolar margin and MF, distance between MF and base of the mandible, distance between symphysis menti and MF and distance between MF and posterior border of the ramus of the mandible. The study also included the relation of MF with the lower teeth (the position of the MF was recorded as lying in line with the long axis of a tooth or interdental space in one of the six types, 1 to 6). **Results:** The most common shape of the foramen was oval (70%). The most common position of the MF as related to the lower set of teeth was in line with the second premolar. The mean distance between symphysis menti and anterior margin of MF was 18.8mm (SD= 12.02) and 19.6mm (SD= 12.18), on the right and left sides respectively. Mean distance between posterior margin of MF and posterior border of ramus was 48.8 mm (SD=28.6) on the right side and 47.9 mm (SD=28.1) on the left side. Mean distance between alveolar crest and superior margin of MF was 10.2 mm (SD= 5.4) on right side and 10 mm (SD=5.2) on the left side. Mean distance between inferior margin of MF and lower border of the body of mandible was 9.9 mm (SD= 5.12) on the right side and 10.1 mm (SD= 5.2) on the left side. **Conclusion:** The study carries clinical credibility in ascertaining the accurate location of the MF and thus avoiding any unforeseen injury related to anaesthesia or dental surgeries.

Key Words: Mental foramen, Mental nerve, Mandible, Morphology, Morphometry, Dental Anaesthesia

Introduction

The mental foramen (MF), from which the mental nerve and vessels emerge, lies below either the interval between the premolar teeth, or below the second premolar tooth. The posterior border of the foramen is smooth and accommodates the nerve which emerges posterolaterally [1]. On each side, MF is located on the buccal cortex of mandibular bone and lies near the apices of the premolars. It has been shown to be located at precisely the same level in most humans (13-15 mm superior to the inferior border of mandible) and transmits the mental nerve and vessels [2].

The mental nerve is the terminal branch of the inferior alveolar nerve and gives sensory innervations to lower lip, buccal vestibule and the gingiva mesial to the first mandibular molar [3].The MF is a strategically important landmark during various surgical procedures/anaesthetic interventions, as also for soft tissue procedures and biopsy. It is important to identify the MF in relation to the apex of the root canal. Since instrumentation can produce inflammation of the apical tissue, the distance from the root apex to the MF must be taken into account to reduce post operative symptoms. The trauma to the mental neurovascular bundle (that may result in paresthesia/anaesthesia) can be avoided after an accurate localization of the MF. Furthermore, the accuracy of localization depends a lot on the knowledge of the variability of the position and orientation of the MF.

Considering the importance of the MF, this study was undertaken to investigate the morphology and variations in the position of the MF by the morphometric assessment of the relation of MF to the lower teeth, body of the mandible, mandibular symphysis and to the posterior border of the ramus.

Methodology

In total 124 mandibles were collected, but we incorporated 93 out of these; out of which 53 were procured from the first year students while 40 were from the departmental collection. The mandibles selected were of unknown age and sex as there was no documentation of the bones at the time of acquisition. All the mandibles selected for the study were without any gross deformity or pathology. The samples that were included had a complete dentition (no missing teeth or socket for the same). All the samples had properly aligned teeth (no malpositioning) and did not show any evidence of periodontal lesions. The study was conducted in the Department of Anatomy, RMC, Loni from December 2009 to June 2010.

[1]Department of Anatomy, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Maharashtra, India; [2]Department of Anatomy, Padamshree Dr DY Patil Medical College, Pimpri, Pune, Maharashtra, India; [3]First Year MBBS Student, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Maharashtra, India

Corresponding author
Abu Ubaida Siddiqui, Email-its_meesha@yahoo.com

The parameters included were; the situational variability of the MF, the morphology of the MF (especially the shape) and the morphometric measurements which were recorded using Vernier calipers, a non flexible thread and a hand lens. The findings were recorded as 1) the relation of MF with the lower teeth(the position of the MF was recorded as lying in line with the long axis of a tooth or interdental space in one of the six relations [4] (Figure 1) : Anterior to the first premolar-Type 1, below the first premolar-Type 2, between the premolars-Type 3, below the second premolar-Type 4, posterior to the second premolar-Type 5, and below the first molar-Type 6; 2) Distance between symphysis menti(S) and anterior margin of MF ; 3) Distance between posterior margin of MF and posterior border of ramus (PB) 4)Distance between alveolar crest(X) and superior margin of MF, 5) Distance between inferior margin of MF and lower border of the body of mandible (Y) Figure 2.

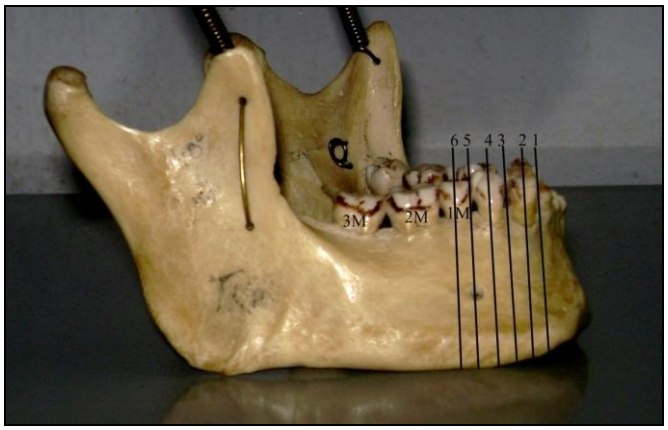

Figure 1: 1M-First molar, 2M –Second molar, 3M-Third Molar. 1/2/3/4/5/6- the lines showing relation of mental foramen to the lower teeth/interdental space (Types 1 to 6 as mentioned in Table No 2).

For measuring the parameters, a standard horizontal plane as defined by Morrant [5,6] was utilized which states that- The mandible when placed on a horizontal surface, the lower border of the mandible comes into greatest contact when vertical pressure is applied to the second molar teeth. The measurements were recorded independently by two observers and the mean of the values recorded. The findings were charted, analyzed and compared with the findings of other workers and studies on different geographical locations and ethnic groups.

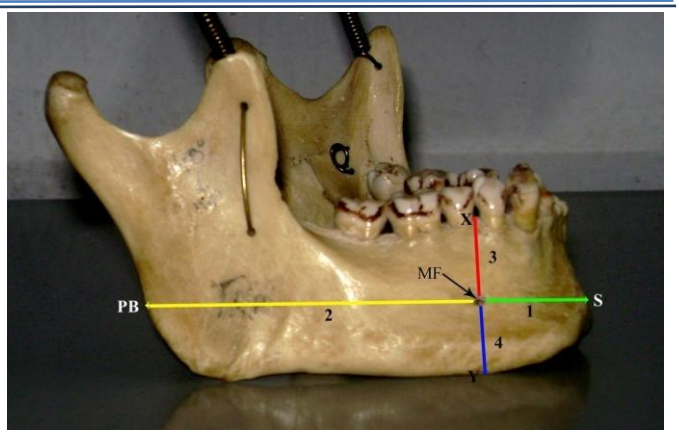

Figure 2: S- Symphysis menti, MF-mental foramen, PB-posterior border of ramus of Mandible, X-alveolar crest, Y-lower border of body of Mandible,1- Distance between S and MF, 2- Distance between MF and PB, 3- Distance between X and MF and 4- Distance between MF and Y. (Refer Table 3)

Results

Our study indicated the situational variability of the Mental Foramen (MF) as well its morphological parameters. The MF was present bilaterally in all the mandibles. It was predominantly present as an oval opening (70%).This opening was observed as horizontal as well as vertical in disposition. Rounded openings were also observed in 30% of the bones examined (Table 1).

The most commonly present position of the MF as related to the lower set of teeth was in line with the second premolar, i.e Type 4. This position was present in 44.08 % cases on the right and 46.23% cases on the left side. Next common position was Type 3, i.e between the premolars (41.93% on right and 35.48% on the left sides)-Table 2. Referring to table 3, the mean distance between symphysis mentii and anterior margin of MF was 18.8mm (SD= 12.02) and 19.6mm (SD= 12.18), on the right and left sides respectively. Mean distance between posterior margin of MF and posterior border of ramus was 48.8 mm (SD=28.6) on the right side and 47.9 mm (SD=28.1) on the left side. Mean distance between alveolar crest and superior margin of MF was 10.2 mm (SD= 5.4) on right side and 10 mm (SD=5.2) on the left side. Mean distance between inferior margin of MF and lower border of the body of mandible was 9.9 mm (SD= 5.12) on the right side and was 10.1 mm (SD= 5.2) on the left side. Similar findings have been reported in Turkish mandibles[4]. The variability in the readings may be attributed to the chewing habits, age, mesiodistal tooth size and the attrition of the proximal surface.

Table 1 Shape of the Mental Foramen (MF)

	Present study (n=93)	Ilayperuma [7] (n=51)	Fabian [8] (n=100)	Prabodha [9] (n=24)
Shape	**2010**	2009	2007	2006
	Western India	Sri Lanka	Tanzania	Sri Lanka
Oval	**65(70%)**	30(59%)	54(54%)	16(66.67%)
Rounded	**28(30%)**	21(41%)	46(46%)	8(33.33%)

The data from other studies have been presented in a tabular form for a better comparative analysis amongst different geographical locations.

Table 2 Position of the MF in relation to lower teeth/interdental space (Comparison with other studies)

	Location	Year		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Present study (n=93)	Western India	2010	R	1(1.07%)	6(6.45%)	39(41.93%)	**41(44.08%)**	6(6.45%)	0
			L	1(1.07%)	8(8.60%)	33(35.48%)	**43(46.23%)**	8(8.60%)	0
Ilayperuma et al [6] (n=51)	Sri Lanka	2009				26.47%	52.94%		
Yesilurt [9] (n=70)	Turkey	2008	R			34.3%	55.7%		
			L			25.7%	61.4%		
Fabian [7] (n=100)	Tanzania	2007					45%	35%	
Kim et al [10] (n=72)	Korea	2006				26.8%	64.3%		
Ngeow [11] (n=169)	Malaysia	2003				19.6%	69.2%		
Gingor [12] (n=361)	Turkey	2006				71.5%	22.4%		

Table 3 Situation of MF with respect to mandibular parameters (Comparison with other studies)

Variable studied	**Present study (n=93)**	Yesilurt [4] (n=70)	Kim et. al [10] (n=72)	Prabodha [9] (n=24)	Apinhasmit et al [13] (n=69)	Singh et al [14] (n=96)
	Western India	Turkey	Korea	Sri Lanka	Thailand	North India
	2010	2008	2006	2006	2006	1992
	Mean values	Mean values				
Distance between S and MF	**R=18.8**	R= 19.18		26.52	28.83	23.6
	L=19.6	L= 19.37				
Distance between MF and PB	**R=48.8**	R= 48.58		65.38	68.85	76.2
	L=47.9	L= 48.27				
Distance between X and MF	**R=10.2**	R= 10.5				15.3
	L=10	L=10.64				
Distance between MF and Y	**R=9.9**	R=9.44	14.33	12.25	14.88	14.0
	L=10.1	L=9.46				

All values in mm. S- Symphysis menti, MF-Mental Foramen, PB- posterior border of ramus, X- Alveolar crest, Y- Lower border of the body of mandible

Discussion

Profound anaesthesia of the mental nerve is imperative for endodontic treatment and thus the credibility of this study lies in the fact that the accurate knowledge of the various morphologic and morphometric parameters of the MF can be of immense help in proper localization of the important maxilla-facial neurological structures in and around the MF. Also, it is of clinical assistance during surgical interventions.

In the present study, the most commonly encountered shape of the MF was oval (70%) followed by a rounded shape in 30% cases. Referring to table no 1, this predominance of the oval shape has also been reported by other workers, though the values vary in different populations [7,8,9].

The most commonly seen position of the MF in relation to the lower teeth/interdental space was seen below the 2nd premolar (Type 4) in 44.08% cases on the right and 46.23% on the left. Referring to Table No 2, this commonest position has been described in 52.94% cases in Sri Lankan cases [7]' 55.7%(R) and 61.4%(L) cases in Turkish mandibles [4], 45% in Tanzanian studies [8], 64.3% in Koreans [10] and 69.2% in Malay populations [11].

Yesilyurt et al (2008) [4] in their study have quoted that the most common positions for the MF were a) below the second premolar tooth (Type 4) in Chinese, Kenyan Africans, Nigerians and Mongoloid populations, b) posterior to the second premolar (Type5) in Caucasians and Zimbabweans, between the premolars (Type 3) in Negroid, British, Central Anatolian and North American white populations. A very similar scenario for Types 3 and 4 was present in Saudi population.

Haghanifar and Rokouei(2009) [2] in their radiological study of the MF ,reported that the most common position of the MF was between the two premolars (as in Type 3 in our case),it being 47.2%.Another study from Turkey has shown that the most common position of the MF was between the two premolars, Type 3, (71.5% cases) [12]. As regards the situation of the MF with respect to mandibular parameters (Table No 3), differences are seen amongst Turkish [4], Korean [10], Sri Lankan [9], Thai [13] and North Indian samples [14].

The review of the available literature shows that the MF shows racial and ethnic variations. Moreover the variations in the values indicate towards the variational mandibular dynamics of the population under consideration. Many of the differences can also be attributed to the variability in the chewing habits of different populations, leading to differential development of the mandible. The relative position of the MF may be influenced by factors which include age, race, ethnicity, mesiodistal tooth size and attrition of the proximal surface.

The restoration and form and function without violating important anatomic structures are the fundamental goal in the surgical management of any patient. One of these is the Mental Foramen. Its identification and preservation in periapical surgery, implant surgery, maxillofacial surgery and orthognathic procedures is of utmost importance [15]. Moreover, it also aids in interpreting landmarks in oral pathology and forensics [16]. To avoid nerve injury during surgery in the foraminal area, guidelines should be developed based on the literature with respect to verification of the position of the MF [17].

Conclusion

The present study suggests that variations in the Mental Foramen occur across various populations and races. Knowledge of various morphological and morphometric parameters shall facilitate accurate anaesthetic maneouvres and avoid repeated failures pertaining to mental nerve block. The major limitation of this study was the non-availability of records pertaining to the sex of the bone being examined. Nonetheless, the study suggests various geometric variability related to the MF which carries along with it great importance in diagnosing radiographic periapical areas and whenever performing periodontal and endodontic surgery in the area from the canine to the mesial root of the first molar. It is suggested that pre-operative radiographs and additional radiographs from different angles if necessary should be taken to locate the MF prior to surgery. This would help immensely in ascertaining the accurate location of the MF because of its great variability and thus avoid any unforeseen injury.

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Acknowledgements

The authors would like to thank all the first year medical, dental and physiotherapy students of the 2009 batch at Rural Medical College, Pravara Institute of Medical Sciences, Loni for their support by the means of lending the mandibles for study.

Competing Interest

The authors declare that they have no competing interests.

Funding

Sources of funding- None

Please cite this paper as: Siddiqui AU, Daimi SR, Mishra PP, Doshi SS, Date JY, Khurana G. Morphological and morphometric analysis of mental foramen utilizing various assessment parameters in dry human mandibles. *Int J Stud Res* 2011;1(1):19-22.
doi: 10.5549/IJSR.1.1.19-22