

CBCT Assessment of Morphologic Characteristics of Mental Foramen in Indian Subpopulation

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Abstract

Aims: The morphometric characteristics of the mental foramen (MF) vary by race/ethnicity. The MF is an important landmark for dental surgeons for anesthetic & surgical procedures performed in this region. The aim of this study was to provide size, shape, location of MF in an Indian subpopulation by cone beam computed tomographic assessment.

Materials & methods: the study was conducted on 210 CBCT scans. The shape, size, vertical & horizontal location were analyzed & measured. The size of the MF was done in vertical dimension. The vertical location was measured from mental foramen - inferior border of the mandible. (MF-IFB). The horizontal location was measured from mental foramen - mandibular midline. (MF-MM)

Results: the shape of the MF in our study sample was predominantly round. (67.18%). The mean vertical diameter of the MF was 2.74 & 2.58 on right & left side resp. The mean vertical diameter of MF was more in males. The size of MF showed no statistical difference in

different age groups and in dental status. The distance of MF-IBM was statistically significant on right & left side for both males & females. The distance MF-MM was not statistically significant on both the sides for both males & females. The dental status had no influence on the size of MF, MF-IBM & MF-MM distance on both right & left side as there was no statistically significant difference.

Conclusion: The knowledge of the distances from stable anatomical landmarks in the present study provide valuable information to dental surgeons that will facilitate effective localization of the neurovascular bundle passing through mental foramen thus avoiding complications from local an aesthetic, surgical and other invasive procedures.

Keywords: CBCT, cone beam computed tomography, mental foramen, mandibular anatomy, cbct assessment.

Introduction

The MF (mental foramen) is the anterior limit of the inferior alveolar canal. Its image is quite variable, and it may be identified only about half of the time because the opening of the mental canal is directed superiorly and posteriorly. As a result, the usual view of the premolars is

not projected through the long axis of the canal opening. This circumstance is responsible for the variable appearance of the mental foramen. Although the wall of the foramen is of cortical bone, the density of the image of the foramen varies, as does the shape and definition of its border. It may be round, oblong, slit like, or very irregular and partially or completely corticated(1). The clinician must be aware of the position of MF when considering regional anesthesia, incisions, flap elevation, particularly during placement of implants, endodontic surgery, surgical removal of roots or teeth, cyst, tumors, orthognathicsurgery, fixation of bone fractures etc. to avoid damage to the neurovascular bundle emerging from the mental foramen.(2) The location of the MF has been suggested to vary by race/ethnicity.(3)

Some studies have determined the vertical and horizontal positions of mental foramen according to the adjacent premolars and molars on the skull(4,5), conventional radiographs(6,7), and CBCT(2,8–10). But many patients who need treatments in this region have partially or completely lost their teeth; so other stable anatomical landmarks are superior to be used to locate the foramen position.

Materials & Methods

This retrospective cross-sectional study was performed on CBCT images obtained from patients in making diagnosis & treatment planning for various dental pathologies referred to a private radiology clinic. The inclusion criteria were I) presence of permanent dentition i.e. patients older than 18 years whose skeletal growth had completed. (dentate, partial & fully edentulous). ii) CBCT images of full mandible were included. (FOV 8 *8mm).Subjects with missing or incorrect images, presence of mixed dentition, presence of cysts, tumors, fractures, supernumerary teeth etc. were excluded. After

applying the inclusion criteria 210 scans were selected as study sample.

Sample size:The sample size was calculated according to the 80% of power & 95% confidence intervals (CI) which came to 168. Our study sample size was more than that required. The study sample was divided into three age groups 18-30,31-50 & >50 years. The sample was also divided according to the dental status in three groups dentate, partial dentate (missing premolar or molar) & edentulous.

Sample	no of patients	
gender	males	114
	females	94
age groups (years)	18-30	16
	31-50	101
	>50	91
dental status	dentate	150
	partial dentate	30
	edentulous	28

Table 1 : Distribution of sample size .

Measurements

All images were obtained using the same CBCT unit (Sirona orthophosphate -xg3d; Sirona, Benham, Germany). The adjusted scan parameters were 85kvp, 10-42 MA, with 14 s exposure. Voxel size was 0.3 mm³. All CBCT images were analyzed in different planes (tangential, cross-sectional & axial), MF was identified in cross-sectional & axial views. The vertical diameter of the MF & the distance from the inferior border of the mandible to the lower border of the MF was measured in

cross-sectional view as shown in (fig. 1). using the length measuring option in the proprietary software. The horizontal location of the MF was recorded from midline of the mandible to the most anterior part of the mental foramen (MF-MM) this was calculated by the following procedure: 1mm slices were made in cross section from midline of mandible to the mental foramen the distance was calculated by adding the slices. All measurements were done on dell computer, (2Gb graphic card) & LED monitor, by two experienced radiologists, after standardizing the calibration information. To obtain inter examiner reliability the measurements were repeated after 15 days by both the examiners. The inter & intra examiner reliability was calculated.



Fig. 1 : The red line shows the vertical diameter of the mental foramen , the blue line is the distance from the lower border of the mental foramen to inferior border of the mandible. (MF- IBM)

Statistical analysis

Descriptive statistics for each variable was calculated. Two sample t-test was performed to compare all measurements between males & females by independent population & ANOVA test followed by Post Hoc Tukey test for comparison between age intervals & dental status. Statistical analysis was performed using SPSS software. Differences were considered significant with $p < 0.05$

Results

The study sample consisted of 114 males (%) & 94 females (%). The mean age of males was 52 years & females 44 years. The distribution of patients in the three age groups 18-30,31-50 & >50 years was 61,101,91 respectively & in relation to dental status was 28,30, & 150 in edentulous, partial dentulous & dentate respectively. (Table 1)The Kappa values for inter examiner assessment was 0.877. Mental foramen was present on both the sides of all the images. The mean (SD) of MF on right was 2.74 (0.52) & 2.78(0.53) on left side. The paired t test showed no statistically significant difference on right & left side. ($p=0.430$).Table 2 : shows the mean values, SD, P-value in gender wise comparison. There was a statistically significant difference on size of MF on right side, as well as on left side. The distance of MF-IBM was statistically significant on right & left side for both males & females. The distance MF-MM was not statistically significant on both sides for both males & females.

variable		right side		left side	
		mean (SD)	p-value	mean (SD)	p-value
size of MF	males	2.94 (0.59)	0.000	2.85 (0.52)	0.007
	females	2.63 (0.49)		2.64 (0.54)	
MF-MIB	males	13.09 (1.33)	0.000	13.14 (1.51)	0.000
	females	12.02 (1.14)		11.87 (1.40)	
MF-MM	males	27.83(1.84)	0.51	28.02 (1.95)	0.91
	females	28.04(2.64)		27.99 (2.68)	

Table 2 : Gender wise comparison of the study sample.

variable		18-30 years	31-50 years	>50 years	p-value
		mean (SD)	mean (SD)	mean (SD)	
size of MF	right side	3.08 (0.89)	2.76(0.54)	2.80 (0.51)	0.10
	left side	2.99 (0.87)	2.72 (0.57)	2.74(0.56)	0.20
MF-MIB	right side	12.24 (1.29)	12.57 (1.31)	12.71 (1.42)	0.41
	left side	12.59 (0.99)	12.30(1.71)	12.86(1.49)	0.43
MF-MM	right side	26.77(1.85)	27.73(2.31)	28.34(2.13)	0.16
	left side	27.50(2.94)	27.83 (2.43)	28.23 (2.02)	0.38

Table 3 : Comparison of the study sample according to the age groups

Table 3 shows the mean values, SD, p-value of all variables according to the three age groups. The different age groups had no influence on the size of MF, MF-IBM & MF-MM distance, on both right & left side as there was no statistical significant difference. Table 4 shows the mean values, SD, p-value of all variables according to the dental status. The dental status had no influence on the size of MF, MF-IBM & MF-MM distance on both right & left side as there was no statistical significant difference.

variable		edentulous	partial edentulous	dentate	p-value
		mean (SD)	mean (SD)	mean (SD)	
size of MF	right side	2.74 (0.49)	3.01(0.70)	2.77 (0.54)	0.18
	left side	2.70 (0.49)	2.91(0.68)	2.73 (0.54)	0.25
MF-MIB	right side	12.72 (1.42)	12.79(1.43)	12.55(1.33)	0.61
	left side	12.66 (1.41)	12.44 (1.88)	12.57(1.57)	0.86
MF-MM	right side	27.46 (2.29)	28.08 (2.33)	27.98(2.21)	0.49
	left side	27.70 (2.20)	28.32 (2.31)	28.00 (2.33)	0.59

Table 4 : Comparison of the sample according to the dental status

Discussion

Mental foramen is an important landmark in the mandible. CBCT is an invaluable radiographic technique for pre-operative diagnosis. CBCT offers accurate evaluation in all three planes as well as its variations. The present study assessed the size, shape & position of the mental foramen with the help of cone beam computed tomography.

Shape of MF: There are variations in the shape of MF in different studies with no consistent pattern. In present study we took oval & round shape as evaluation criteria with round (67.18%) being the predominant variety. According to Al Khatib T et.al(7), Rastogi et.al.(11) the majority of the foramina were round in shape.

Size of MF: Since our study sample was predominantly rounded, we did the measurement of the size of MF in vertical diameter only. the size of MF was 2.74 & 2.78 on right & left side respectively. Several authors have evaluated the size of MF on cbct. (table 2).Oliveira et al(12), von Arx et al(2), Zhang et al(13), Zmyslowska-Polakowska E et al (14), Gungor et al(3), in their studies reported sexual dimorphism with higher values in males and no difference in the size of MF in different age groups which was consistent with our study. Cagayan et.al(15) reported larger dimensions of MF in Turkish population. Muinelo et al(10) found no correlation between size of MF in vertical diameter with dental status confirming our findings.

Position of MF: We evaluated the location of MF to inferior border of the mandible (MF-MIB) & distance of mandibular midline to most anterior part of MF (MF-MM) as vertical & horizontal location resp. as we had a mixed sample of dentate, partial dentate & edentulous. Regarding the vertical location the findings of our study were consistent with the studies of Sheikhi et al(8), Kabak et al(16), Oliveira et al(12), Gungor et al (3)(table 4) with statistically significant difference in gender with males

showing higher values . Our findings of significant differences in sexes were consistent with Oliveira et al(12) Carruth et al(17), they also reported no difference in relation with age groups, however Zhang et al(13) reported that the horizontal diameter of MF was affected by age groups & males had higher values of than females. Muinelo et al (10) reported no significant difference in (MF-MIB) distance for dental status. For horizontal location the values in our study confirmed with those of Sheikhi et al,(8) Kabak et al.(16). The differences in the findings between this current study and other studies can be potentially attributed to the differences in methodology, ethnic & racial variations.

The vertical position of MF is different from infancy to old age. In dentate patients the MF is located midway between alveolar crest & inferior border of the mandible, as age advances the distance between MF & alveolar crest decreases as a result of alveolar resorption due to periodontitis & then loss of teeth. As the span of edentulism increases the MF comes on the crest itself. opposing this the MF-MIB distance remains stable throughout life. The use of CBCT imaging has now become standard of care in dentistry. Based on the results of the present study and their comparative similarities to prior studies, a clinician can get a reasonable expectation of the size and location of the MF based on the average measurements. after assessing the existing literature and the present study, CBCT is a reliable way to determine the size and location of the MF. This could greatly aid a clinician preoperatively to minimize iatrogenic errors to the nearby neurovascular bundle.

Finally, the study is purely radiographic & the sample was local population the ethnic & racial variations were not highlighted. Therefore, the results need to be validated with subsequent studies & larger sample sizes.

Author	Sample size	Size of MF		MF-IFB		MF-MM	
		right	left	right	left	right	left
zmyslowska-polohowska et al (2019)	201	v- 4.24 h-3.55 in males & v- 3.89 h-3.02 in females	v- 3.41 h- 4.06 in males & v- 3.03 h- 3.92 in females	-	-	-	-
Oliveira et al (2018)	104	v-3.11 h- 3.20		12.31		-	-
Muinelo -lorenzo J et al (2017)	344	v-4.44 h-2.92		13.55		-	-
Chalko et al (2018)	108	2.64	2.85	13.77	13.75	-	-
Kabak et al (2017)	117	v-2.38 h-3.61	v-2.31 h-3.54	-	-	51.6 (MF-MF)	
Gungor et al (2017)	210	v-3.12 h-3.56	v-3.13 h-3.31	12.75	12.65	-	-
Paul Carruth et al (2016)	106	m-3.94 f-3.39		-	-	-	-
Caglayan et al (2014)	192	v-3.29 h-3.83	v-3.36 h-3.80	12.86	13.13	-	-
Von arx et al (2013)	142	v-3.0 h-3.2		13.2		-	-
Zhang et al (2015)	172	v-3.98 h- 5.14in males & v-3.65 h- 4.89 in females		14.37 in males & 12.65 in females		-	-
Sheikhi et al (2016)	180	-	-	13.26	13.37	25.86	25.53
Present study	208	2.94 in males ; 2.63 in females	2.85 in males & 2.64 in females	13.09 in males & 1.02 in females.	13.14in males & 11.87 in females	27.83 in males & 28.04 in females	28.02in males & 27.99 in females

Conclusion

On a CBCT assessment in an Indian subpopulation, the average MF size and the average distance between the MF and the base of the mandible were higher in men, but there

was no sex predilection in the distance from the anterior border of mental foramen to midline. there was no significant difference between the age groups & dental status. the mean size of the mental foramen can vary in a wide range due to different measurement methods.

hence, we can conclude that the size & vertical and horizontal positions of mental foramen can be determined from stable anatomical landmarks such as mandibular inferior border and skeletal midline in both dentulous and edentulous patients. the diameter of the foramen & its location should be determined on individual cases in cbct imaging routinely.

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