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Evaluation of the Position of Mental Foramen and Its Correlation with Age in Selected Indian Population, Using Digital Panoramic Radiograph

Medha Babshet[1,*], Sandeep R[2], Krishna Burde[3], Kirty Nandimath[3]

[1]Department of Oral Medicine and Radiology, Sri Hasanamba Dental College and hospital, Hassan, India
[2]Department of Conservative dentistry and Endodontics, Sri Hasanamba Dental College and hospital, Hassan, India
[3]Department of Oral Medicine and Radiology, SDM College of dental sciences and hospital, Dharwad, India
*Corresponding author: medhababshet@hotmail.com

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Abstract **Objectives:** To assess the most common position of mental foramen in Indian population and to correlate the position with age and gender. **Methods**: In the present study five age groups from 15-76 years were made with 40 dentate patients in each. Digital panoramic radiograph of each patient was assessed for the position of mental foramen bilaterally using a modified technique. The correlation of position with age and sex was evaluated using chi square test and intra - observer variability using kappa statistics. **Results:** 43% of mental foramina were located in between first and second premolars and 39 % in line with second premolar. 66.3% of foramina on right side and 64% on left side were located more towards the second premolar based on modified method. The correlation of position on both right and left sides with age ($p > 0.005$) and sex ($p > 0.005$) was not significant statistically. **Conclusion:** The most common position of the mental foramen was between first and second premolar. The horizontal position of foramen did not vary with gender. Practically the foramen seemed to shift posteriorly with age, however statistically there was no correlation of position with age.

Keywords: *format, age, anatomic location, digital panoramic radiograph, mental foramen*

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1. Introduction

Mental foramen is the exit point of inferior alveolar canal through which the mental neurovascular bundle emerges out from the mandible. As per the English literature the mental foramen changes its position with age, which is also influenced by demographic factors like sex and the ethnicity. The variations in the position of mental foramen can be attributed to the forward growth of the mandible during the craniofacial development and the differential rates of development of the bone and the periosteum. As the mandibular body grows forwards the neurovascular bundle drags along. Moreover since there is differential growth rate of bone and the periosteum, the latter grows slowly than the body which slides forwards beneath the periosteum [1].

The changing direction of the foramen has clinical implications in administration of the local anesthesia to the mental nerve. The knowledge of position of mental foramen is also important in case of surgeries in the mental region and in implant placement. Many textbooks with reference to the position of the mental foramen in the human mandible commend that the most common position of mental foramen is between the two premolars. However, as the position of mental foramen was found to vary with different populations, the present study was performed to assess the most common position of mental foramen in Indian population. An attempt was also made to correlate the position of the foramen with age and gender.

The mental foramen can be located best by 3 – dimensional imaging modalities like Cone Beam Computed Tomography and Denta Scan. However the most commonly used and less expensive alternative to study the position of the foramen is the panoramic radiograph. Hence the study was performed using digital panoramic radiograph.

2. Materials and Methods

In this study patients attending the Department of Oral Medicine and Radiology, SDM College of Dental Sciences, Dharwad, Karnataka, for whom panoramic radiographs were advised, were included. Digital panoramic radiographs were made in Kodak 9000C 3D machine. The exposure factors were customized to every patient with the following exposure factors: 68 – 74 kVp, 13- 15 seconds exposure time and 8 – 10 mA electric current.

The study sample included only dentate patients with erupted first and second premolars and first molars on both sides of mandible. The radiographs with any radioluscent or radiopaque lesion involving the mandible, teeth with periapical pathology obscuring the mental foramen, pathological migrations and patients on orthodontic treatment were excluded from the study. The patients' age ranged from 15 – 76 years and well distributed across diverse age-groups comprising young, middle - aged and elderly individuals (Table 1) with 40 patients in each group.

Table 1. Distribution of age in five age groups

Age groups	Age range in years
A	15 – 25
B	26 – 35
C	36 – 45
D	46 – 55
E	56 & more

The panoramic image was opened in Trophy® Windows software, (Caresrteam 2007) and the lines were drawn on the teeth which were in close relation to the mental foramen, such that the line joined the central cusp and the apex of the tooth (Line I, II and III) (Figure 1). The position of the image of the mental foramen was recorded according to the categories by Jasser and Nwoku [2].

Position 1: Situated anterior to the first premolar.
Position 2: In line with the first premolar.
Position 3: Between the first and second premolar.
Position 4: In line with the second premolar.
Position 5: Between the second premolar and first molar.
Position 6: In line with the first molar

A modification in this method was done by marking two extra lines in between two teeth thereby dividing it into three divisions. The position 3 was divided by line Ia and line Ib into 3A, 3B and 3C and position 5 was divided by line IIa and line IIb into 5A, 5B and 5C (Figure 1).

Position 3A: Situated near to first premolar.
Position 3B: In the midline between first and second premolar.
Position 3C: Situated near to second premolar.
Position 5A: Situated near to second premolar.
Position 5B: In the midline between second premolar and first molar.
Position 5C: Situated near to first molar

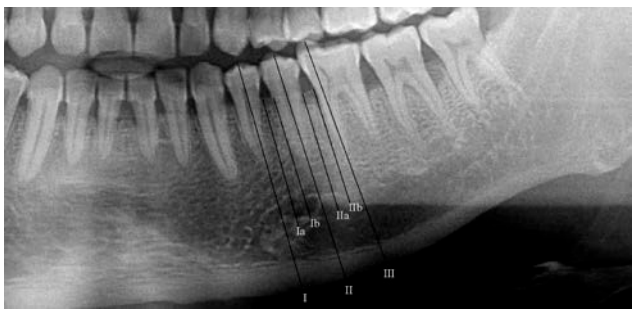

Figure 1. Digitally enhanced cropped image of panoramic radiograph showing the lines drawn for locating the mental foramen in various positions

The digital panoramic images were investigated by one observer and the positions of the foramina were recorded. The observations were repeated by the same observer on 25 images selected randomly. The recordings were entered in Microsoft excel sheet and evaluated for most common position in each age group. The symmetry of the foramen position between right and left side was also assessed. The correlation of the position of mental foramen with age and sex was evaluated using Chi square test. The intra - observer variability was assessed using Kappa statistics.

3. Results

3.1. Sex Distribution

Among 200 patients, 125 (62.5%) were males and 75 (37.5%) were females (M: F = 5:3).

3.2. Position of the Mental Foramen

400 mental foramina were assessed among which 172 (43%) were located in between the first and second premolar (Position 3), 157 (39 %) were located in line with second premolar (Position 4), and the rest 18% included the remaining positions.

3.3. Symmetry of the Mental Foramen

282(70.5%) of the foramina were symmetrical on both sides, 118 (29.5%) were asymmetrical.

Among the symmetrical foramina, 140 of 282 (50 %) were present in the position 3 i.e., between the two premolars. In asymmetrical group 40.67 % were in position 4 i.e., along the long axis of second premolar (on left 44.06% and right 45.76%).

3.4. Distribution of the Foramen Based on Modified Divisions of the Position of the Foramen in All Age Groups

Mental foramen is located more towards the second premolar (Position 3C) in both the sides, on right side 55 (66.3%) and on left side 57 (64%) (Table 2 and Table 3).

Table 2. Distribution of mental foramen on right side according to the modified division of position of mental foramen

POSITION	1	2	3			4	5			6
			3A	3B	3C		5A	5B	5C	
Group A	0	2	0	3	14	13	1	5	2	0
Group B	2	0	0	8	11	12	6	1	0	0
Group C	0	0	0	8	11	15	2	4	0	0
Group D	0	1	1	2	12	18	1	4	1	0
Group E	0	0	0	6	7	20	2	4	0	1
			1	27	55		12	18	3	
TOTAL	**2**	**3**	**83**			**78**	**33**			**1**

Table 3. Distribution of mental foramen on left side according to the modified division of position of mental foramen

POSITION	1	2	3			4	5			6
			3A	3B	3C		5A	5B	5C	
Group A	0	0	0	5	12	17	1	3	2	0
Group B	2	0	0	8	13	16	1	0	0	0
Group C	0	1	0	7	15	12	0	5	0	0
Group D	0	3	0	5	11	13	2	6	0	1
Group E	0	2	0	7	6	21	1	2	0	1
			0	32	57		5	16	2	
TOTAL	**2**	**6**	**89**			**79**	**23**			**1**

3.5. Correlation with Age

Correlation of position of foramen on right and left side with age showed p- values > 0.05 (Table 4).

Table 4. Correlation of position of foramen on right and left side with age

Position	Chi	P value
Right	47.42774	0.0965
Left	43.09677	0.0912

3.6. Correlation with Gender

Correlation of position of foramen on right and left side with sex showed p- values > 0.05 (Table 5).

Table 5. Correlation of position of foramen on right and left side with sex

Position	Chi	P value
Right	10.49906	0.31166
Left	11.79939	0.16043

3.7. Intra-observer Reliability

Kappa statistics showed significant ($p < 0.05$) intra-observer reliability (Table 6).

Table 6. Kappa statistics to assess intra-observer reliability

Kappa	0.6667
% of agreement	84%
P – value	0.004

4. Discussion

The mental nerve is prone to injury while performing surgical procedures in the foraminal area. [3] The knowledge of location of the mental foramen especially for a dental surgeon is essential to prevent the injury to the nerve during administration of local anesthetic agent. However it is also important to preserve the nerve during invasive procedures like cosmetic surgeries like mentoplasty, osteotomies and implant placement. The nerve injury otherwise may lead to temporary or permanent paresthesia or sensory dysfunction of the chin, lower lip and gingiva in the anterior region.

The position of the mental foramen alters its vertical relation within the body of the mandible from the infancy to old age. When the teeth are present the mental foramen is located midway between the upper and lower border of the mandible. In edentulous mandible, lacking alveolar ridge, the mental foramen appears near to the upper margin of the thinned out mandible. [1] The mental foramen may show variations in its location in the anterio – posterior direction.

The best noninvasive method of assessing the position of mental foramen is by radiography. Few studies were performed on intraoral periapical radiographs and conventional panoramic images. [4,5] In intraoral periapical radiograph the foramen is not visualized as it is usually below the inferior edge of the film.[5] In the present study digital panoramic image was utilized to study the position of the mandible. Digital images offer the advantage of good diagnostic quality and reduced patient radiation dose compared to conventional panoramic radiography.

In our study 200 digital panoramic radiographs were considered and 400 mental foramina were assessed, among which highest percent of mental foramen was located in position 3 i.e. between the first and second premolars, and then followed by position 4. In a study performed in Turkish population by Gungor et al., on conventional panoramic radiographs, showed similar results where 71.5 % of the total mental foramina were located in Position 3 followed by Position 4 (22.4%). [4] On contrary, the commonest position in Pakistanis [6], Singaporean Malays and Indians [7] and Saudi population [2], was found to be in line with the second premolar. Studies done in other ethnic and racial groups showed the common position ranged between three positions that is between two premolars, along the long axis of second premolar and between second premolar and first molar. [4] These variations of position of mental foramen may be because of ethnic and racial discrimination of the selected population. In our case a fixed Indian population was selected. However, since India is known for its diverse racial and ethnical background, variations in the position of the mental foramen might result.

In our study an attempt was made to categorize the ages and compare the positions in each age group. As in Figure 2, the commonest position in the first three age groups (A, B and C) was the Position 3. In the age group D (46-55 yrs), Position 3 and 4 shared an equal distribution, while in the age group E the most common position was Position 4. This can be explained by the fact that there is anterior drifting of the teeth with age leading to relative posterior positioning of the mental foramen.

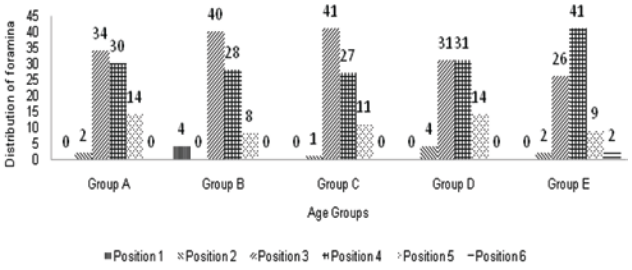

Figure 2. Position of mental foramen in each age group. X- axis shows the age groups arranged in ascending order and Y- axis shows the number of foramen in different positions

In the study 70.5% of the foramina were symmetrical which is comparable in most of the studies like 86 % in Turkish population [4], 80 % in Saudis [2] and 68% in Malaya. [8] The most common (50%) location among the symmetrical foramina was position 3 i.e., between first and second premolars. In asymmetrical group the commonest position was 4 i.e., along the long axis of 2nd premolar in both left and right sides. Wei Cheong et al., studied that the most common position in symmetric cases was position 4 (80.7%), followed by position 3 (n = 15, 13.9%) while in asymmetric cases, the highest frequency was at position 4 (51.1%), followed by position 3 (27.7%). [8] Gungor et al., in his study in Turkish population observed that 50% of mental foramina were located between the second premolar and first molar on the right side on the mandibular, while on the left side 50% was located in line with the second premolar.[4] Jasser et al., found the position between the first and second premolars (46.2%) was more common than below the second premolar (35.4%) in the asymmetrical case [2].

As mentioned earlier, subdivisions were made in positions between two teeth, in positions 3 and 5, to observe any relation existing between the position and age. It was observed that in all the age groups the mental foramen was located more towards the second premolar (Position 3C) in both right (66.27%) and left side (64.04%). Correlation between the position and age was evaluated using chi square test with level of significance set to be 5%. The p - values were more than 0.05 in both left and right side suggesting there was no correlation of the horizontal position of foramen with age.

An attempt to correlate the position of the foramen with gender was also made; however, the values were not significant suggesting any correlation existing between gender and the position of the foramen on both right and left side. This is consistent with the results obtained by Amorim et al., in their study on dry mandibles both dentate and edentulous arches in which no differences were observed in relation to the gender and side. [9] The intra-observer reliability was assessed using kappa statistics which showed 84 % agreement. K value of 0.6667 is considered as substantial agreement [10].

The present study evaluated the position of mental foramen in horizontal relation. To assess the superior-inferior location of the foramen, the assessment in vertical relation should be performed. The vertical position of mental foramen is assessed using hard and soft tissue landmarks. There are various methods to assess the position of mental foramen clinically and radiographically. The mental foramen is evaluated radiographically by measuring its position from various structures like cusp tip or CEJ of the related tooth, inferior cortex of the mandible and superior border of alveolar ridge. The location of mental foramen is also assessed using cone beam computed tomography, magnetic resonance imaging and multi-slice computed tomography. [11,12,13] Traxler et al in their study, on use of ultrasound in the assessment of residual ridge width in implant placement has commented that even ultrasound may be beneficial to locate mental foramen.[14] Clinically, the position is assessed by calculating the distance of the foramen from chelion (corner of the mouth, where the upper lip meets with the lower lip) and inferior border of the mandible.

The vertical position was assessed by comparing the position of mental foramen in relation to the tooth apex. Fishel et al. in their study using periapical radiographs, showed that the mental foramen in relation to first premolar was situated coronal to the apex in 38.6% of cases, at the apex in 15.4% of cases, and apical to the apex in 46.0% of cases. The mental foramen in relation to the second premolar, was coronal to the apex in 24.5% of cases, at the apex in 13.9% of cases, and apical to the apex in 61.6% of cases. [15] Neiva et al studied the position of mental foramen in relation to CEJ of premolars and lower border of the mandible. They found the distance from MF to cervico-enamel junction of the premolars was 15.52 ± 2.37 mm, MF to the most apical portion of the lower cortex of the mandible was 12.0 ± 1.67 mm. [16] Kim et al studied the position of mental foramen in Korean population. The average distance between the cusp tip and the superior border of the mental foramen by direct measurement on dry skull was 23.42 mm and on panoramic radiograph was 25.69 mm and the mean distance between the superior border of the mental foramen and the bottom of the mandible was14.33 mm by direct measurement and 16.52 mm by radiographic measurements. [17] Chrcanovic et al. stated that with tooth loss the alveolar ridge resorbs and gets closer to the mental foramen. [18] Soikkonen et al studied that the mental foramen was situated on average of 3.8 mm lower in edentulous jaws than in dentulous jaws with respect to a superior reference point (the alveolar crest). [19] Song et al in their study using digitized photographs, reported that mental foramen was located 20.4 ± 3.9 mm inferior and 3.3 ± 2.9 mm medial to the chelions [20].

5. Conclusion

The most common position of the mental foramen in selected Indian population was between first and second premolar. Most of them were symmetrical. Among the asymmetrical foramina most common position was along the long axis of second premolar. It was observed that the position of the mental foramen shifted posteriorly from position 3 to position 4 as the age advances. However statistically there was no significant correlation between the position and age. Also no statistically significant correlation of position with gender was observed. Considering that the position of the mental foramen varies between position 3 and position 4, this area should be well thought-out while performing invasive procedures in this region. Moreover assessment of vertical position of the foramen will aid in deciding the depth of bone above the foramen. Hence future studies should concentrate on localizing the mental foramen in both horizontal and vertical relations.

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