Correlation of Radiographic Mental Foramen Position and Occlusion in Three Different Indian Populations

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ABSTRACT

Background: *The knowledge of the position of the mental foramen (MF) is important for administering local anaesthesia for diagnostic, surgical or operative procedures.*
Aims: *To determine the shape, position, symmetry of MF and its continuity with the inferior dental canal (IDC) on a digital panoramic view and to find its correlation with Angle's molar relations in three Indian subpopulations. The study also determines the correlation of inter-foramen distance in both genders of three Indian subpopulations.*
Subjects and Methods: *One hundred and twenty digital panoramic radiographs were evaluated from three Indian subpopulations (Punjab, Rajasthan and Northeast [NE]). The assessment of occlusion was based on Angle's molar relationships. The data obtained were statistically analysed.*
Results: *The commonest position of MF in Rajasthan and NE populations was position 4 bilaterally, while in the Punjab population, it was position 3 on the right and position 4 on the left side. The majority of the MF was round in shape, followed by oval. The mean distance between two MF was highest among the Punjab male population and least among the NE female population. The most frequent pattern of MF continuity with IDC was diffuse in Rajasthan population, separated in NE and continuous in Punjab. Correlation between Angle's molar relation with the MF position was significant for Classes I and II but not for Class III. Correlation of inter-foramen distance between genders was highly significant in the NE and Punjab populations.*
Conclusion: *The commonest MF position was aligned with the 1st premolar and between the 1st and 2nd-premolar.*

Keywords: India, malocclusion, mental foramen, panoramic

Correlación de la Posición Radiográfica del Foramen Mentoniano y la Oclusión en Tres Diferentes Poblaciones de la India

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RESUMEN

Antecedentes: *El conocimiento de la posición del foramen mentoniano (FM) es importante a la hora de aplicar anestesia local en procedimientos diagnósticos, quirúrgicos u operativos.*
Objetivos: *Determinar la forma, posición, simetría del FM y su continuidad con el conducto dentario inferior (CDI) en una vista panorámica digital, y hallar su correlación con las relaciones molares de Angle en tres subpoblaciones de la India. El estudio también determina la correlación de la distancia del foramen mentoniano en ambos sexos en tres subpoblaciones de la India.*
Sujetos y métodos: *Se evaluaron ciento veinte radiografías panorámicas digitales de tres subpoblaciones de la India (Punjab, Rajastán y Noreste [NE]). La evaluación de la oclusión se basó en las relaciones molares de Angle. Los datos obtenidos se analizaron estadísticamente.*
Resultados: *La posición más común del FM en la población de Rajastán y NE fue la posición 4 bilateral, mientras que en la población de Punjab, fue la posición 3 a la derecha y la posición 4 en el lado iz-*

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quierdo. La mayoría de los FM era de forma redonda, seguida de la oval. La distancia media entre dos FM fue más alta entre la población masculina de Punjab y menos entre la población femenina de NE. El patrón más frecuente de la continuidad FM con CDI fue difuso en la población de Rajastán, separado en NE, y continuo en Punjab. La correlación entre las relaciones molares de Angle con la posición de los FM fue significativa para la clase I, II, pero no para la clase III. La correlación de la distancia de los inter-forámenes entre géneros fue altamente significativa en las poblaciones de NE y Punjab.
Conclusión: *La posición más frecuente de la FM se hallaba alineada con el 1er premolar, y entre el 1er y 2do premolares.*

Palabras claves: India, maloclusión, foramen mentoniano, panorámica

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INTRODUCTION

The mental foramen (MF) is a funnel-like opening in the lateral surface of the body of the mandible at the terminus of the mental canal, which is the anterior limit of the inferior alveolar canal (1). The opening is directed outward, upward and posteriorly. The mental bundle passes through the MF and supplies sensory innervations and blood supply to the soft tissues of the chin, lower lip and gingiva on the ipsilateral side of the mandible. Philips *et al* reported that its average size was 4.6 mm horizontally and 3.4 mm vertically. The wall of the MF is made up of cortical bone (2). The density of the foramen's image on radiographs varies, as does the shape and definition of its border.

The knowledge of the position of the MF is important in clinical dentistry when administering local or regional anaesthesia, orthodontic tooth movement/surgery, performing periapical surgery and implant placement in the mental region of the mandible. The MF is occasionally misdiagnosed as a radiolucent lesion in the periapical area of the mandibular premolar teeth (3). The MF also aids in interpreting anatomical landmarks in oral and forensic pathology (4).

The MF has been reported to vary in its position in different genders and ethnic groups having different craniofacial skeletal and dental occlusion (5). The studies on various populations demonstrated that the most common location of MF was its alignment with the second premolar, followed by its position between the first and second premolar (6).

Panoramic radiography is the most utilized diagnostic modality. The advantage of this technique is that it aids viewing the entire body of the mandible and allows a more accurate location of the MF in both horizontal and vertical dimensions. As the bone density increases, the mental foramen becomes more difficult to identify on panoramic radiographs.

The purpose of this study is to report any correlation between Angle's molar relationship and the position of mental foramen bilaterally in three different Indian subpopulations; and to determine the correlation of the inter-foramen distance by gender in three Indian subpopulations.

SUBJECTS AND METHOD

The study was conducted on outpatients who sought orthodontic treatment, of which 120 patients, including 45 males and 75 females aged between 18 and 25 years, were randomly selected from three populations (40 each from Northeast, Punjab and Rajasthan). All the subjects were briefed about the purpose of the study and a written informed consent was obtained after their ethnic confirmation. Institutional ethical approval was obtained to carry out the study.

Each patient had a clinical examination and Angle's molar relationship was recorded on both sides. The selected patients were subjected to radiography using 'Kodak 8000C Digital Panoramic and Cephalometric system' with exposure parameters of 74 kVp, 10 mA and 13 seconds.

The exclusion criteria were non-visualization of the mental foramen on radiography, presence of missing teeth between the two first molars, incomplete eruptions of permanent teeth, presence of tooth anomalies, a history of orthodontic treatment and trauma to the jaws and the presence of radiolucent or radiopaque lesions between the first mandibular molars on both sides. The position of MF was recorded relative to the adjacent mandibular teeth (Figure) as follows:

Position 1: anterior to apex of the first premolar.
Position 2: at the apex of the first premolar.
Position 3: between the apices of the first and second premolars.
Position 4: the apex of the second premolar.
Position 5: between the apices of the second premolar and the first molar.
Position 6: at the mesial half of the first molar.

The position of MF was reported on the basis of gender and symmetry or asymmetry.

Symmetrical: mental foramina on both sides have the same anterio-posterior position relative to the teeth.

Asymmetrical: mental foramina on both sides have different anterio-posterior position relative to the teeth.

Continuity of the foramen was studied on both sides as per Yosue and Brooks (7) classification as:

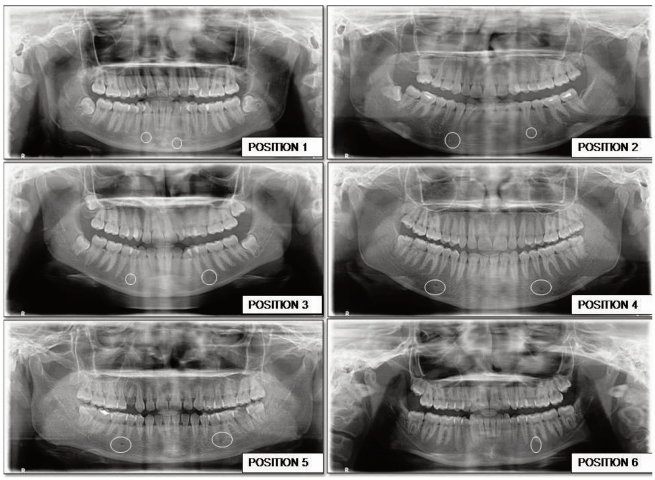

Figure: Various positions of mental foramen (circles) in panoramic radiographs.

Type I: mental canal is continuous with the mandibular canal.
Type II: foramen is distinctly separated from the mandibular canal.
Type III: diffuse with distinct border of foramen.
Type IV: unidentified group.
The shape of MF was recorded as: oval, round and irregular.

The distance between two foramina was measured from their centres. This inter-foramen distance was measured in millimetre using 6.12.24.0 Kodak Dental Imaging software. All the measurements were performed by two oral and maxillofacial radiologists independently to reduce the inter-observer bias.

The molar relationship was assessed by following Angle's molar relationship classification (8):
Class I: Those malocclusions exhibiting normal mesiodistal relation of jaws and dental arches indicated as normal locking of first permanent molar.
Class II: A distal relation of the lower arch when related to the upper arch, the lower first permanent molar locking more than one-half of a cusp distal to normal relation with the upper permanent molar.
Class III: A mesial relation of the lower arch when related to the upper arch, the lower first molar locking more than one-half of a cusp mesial to normal relation with the upper first molar.

The data were tabulated and transferred to SPSS 20 software (SPSS Inc., Chicago, IL, USA) for statistical analysis.

RESULTS

Among the sample, 37.5% were males and 62.5% were females. The results from the two observers were analysed for MF parameters by Wilcoxon signed ranks and test showed insignificant inter-observer bias. The most common position for the mental foramen related to the teeth in the Rajasthan population was position 4 (in line with the apex of the second premolar) on both the left (n = 17; 21.3%) and right side (n = 16; 20%). In the Northeast population, position 4 (n = 20; 25%) of the MF was the most commonly noted position on both

Table 1: Distribution of mental foramen (MF) positions, shapes and its continuity with inferior dental canal in three Indian subpopulations

MF Position	**Rajasthan**			**Northeast**			**Punjab**		
	Right	**Left**	**Total**	**Right**	**Left**	**Total**	**Right**	**Left**	**Total**
Position 1	1 (1.25%)	2 (2.5%)	3 (3.75%)	4 (5%)	1 (1.25%)	5 (6.25%)	2 (2.5%)	2 (2.5%)	4 (5%)
Position 2	2 (2.5%)	3 (3.75%)	5 (6.25%)	4 (5%)	2 (2.5%)	6 (7.5%)	4 (5%)	6 (7.5%)	10 (12.5%)
Position 3	16 (20%)	12 (15%)	28 (35%)	8 (10%)	14 (17.5%)	22 (27.5%)	20 (25%)	15 (18.75%)	35 (43.75%)
Position 4	16 (20%)	17 (21.25%)	33 (41.25%)	20 (25%)	21 (26.25%)	41 (51.25%)	14 (17.5%)	16 (20%)	30 (37.5%)
Position 5	5 (6.25%)	6 (7.5%)	11 (13.75%)	4 (5%)	2 (2.5%)	6 (7.5%)	0	0	0
Position 6	0	0	0	0	0	0	0	1 (1.25%)	1 (1.25%)
Total	**40**	**40**	**80 (100%)**	**40**	**40**	**80 (100%)**	**40**	**40**	**80 (100%)**
r[i]	1			0.945			0.908		
p-value	–			0.004*			0.012*		
MF Shape	**Right**	**Left**	**Total**	**Right**	**Left**	**Total**	**Right**	**Left**	**Total**
Round	26 (32.5%)	19 (23.75%)	45 (56.25%)	21 (26.25%)	16 (20%)	37 (46.25%)	26 (32.5%)	26 (32.5%)	52 (65%)
Oval	8 (10%)	11 (13.75%)	19 (23.75%)	14 (17.5%)	16 (20%)	30 (37.5%)	7 (8.75%)	8 (10%)	15 (18.75%)
Irregular	6 (7.5%)	10 (12.5%)	16 (20%)	5 (6.25%)	8 (10%)	13 (16.25%)	7 (8.75%)	6 (7.5%)	13 (16.25%)
Total	**40**	**40**	**80 (100%)**	**40**	**40**	**80 (100%)**	**40**	**40**	**80 (100%)**
r[i]	1			0.981			0.999		
p-value	–			0.123			0.031*		
Continuity	**Right**	**Left**	**Total**	**Right**	**Left**	**Total**	**Right**	**Left**	**Total**
Continuous	9 (11.25%)	11 (13.75%)	20 (25%)	14 (17.5%)	14 (17.5%)	28 (35%)	20 (25%)	23 (28.75%)	43 (53.75%)
Separate	17 (21.25%)	12 (15%)	29 (36.25%)	20 (25%)	20 (25%)	40 (5%)	11 (13.75%)	9 (11.25%)	20 (25%)
Diffuse	14 (17.5%)	17 (21.25%)	31 (38.75%)	6 (7.5%)	6 (7.5%)	12 (15%)	9 (11.25%)	8 (10%)	17 (21.25%)
Total	**40**	**40**	**80 (100%)**	**40**	**40**	**80 (100%)**	**40**	**40**	**80 (100%)**
r[i]	1			-0.251			-0.998		
p-value	–			0.838			0.042*		

[i]Pearson correlation coefficient; *correlation is significant ≤ 0.05 level (2-tailed)

sides, while no foramen was noted at position 6. In the Punjab population, position 3 of MF (n = 20; 25%) on the right side and position 4 (n = 16; 20%) on the left side were noted most commonly (Table 1).

Position 4, followed by position 3, was recorded as most commonly associated with Angle's Class I and Class II molar relation in all the three subpopulations, while a single case of Class III molar relation with position 1 was recorded in the Punjab population (Table 2). Correlation between Angle's molar relation with MF position was significant for Classes I and II, but not for Class III.

The majority of MF was round in shape (n = 134), followed by oval shape (n = 64) and the remaining were considered irregular (n = 42) in shape (Table 1).

In the Rajasthan population, the most common location with symmetrically as well as asymmetrically placed MF was position 4. In the Northeast population, the most common location with symmetrically placed MF was position 4, whereas the most common location with asymmetrically placed MF was position 3. In the Punjab population, the most common location with symmetrically placed MF was position 3 and the most common location with asymmetrically placed MF was position 4 (Table 3).

The overall most frequent pattern of MF continuity with inferior dental canal (IDC) noted was continuous (n = 91), followed by separated (n = 89) and diffuse (n = 60). The diffuse pattern was most commonly seen in the Rajasthan population, separated in the Northeast and continuous in the Punjabi population (Table 1). The highest mean distance between two MF was recorded highest among the Punjabi male population (62.43 ± 6.11 mm) while least was among the Northeast female population [55.29 ± 9.74 mm] (Table 4). A positive and a statistically significant correlation was found between males and females in the Northeast and Punjab populations.

In the study, Angle's Class I molar relationship was noted as the most predominant in all the three populations (n = 102), followed by Angle's Class II (n = 16) and Angle's Class III molar relation (n = 2). No Angle's Class III molar relation case was reported in the Rajasthan population (Table 4).

Table 2: Correlation of mental foramen (MF) positions with Angle's molar relationship in three Indian subpopulations

MF Position	Angles' Class I	Angles' Class II	Angles' Class III
Position 1	11 (5.44%)	0	1 (100%)
Position 2	21 (10.39%)	0	0
Position 3	70 (34.65%)	15 (42.86%)	0
Position 4	90 (44.55%)	16 (45.71%)	0
Position 5	9 (4.46%)	4 (11.42%)	0
Position 6	1 (0.49)	0	0
Total	**202 (100%)**	**35 (100%)**	**1 (100%)**
Mean	33.67 ± 36.99	5.83 ± 7.65	0.17 ± 0.41
Pearson correlation coefficient (r)	1	0.952	-0.300
Significance (*p*-value)	–	0.003*	0.563

*Correlation is significant ≤ 0.05 level (2-tailed)

Table 3: Distribution of mental foramen position according to their symmetry in three subpopulations

Position	Symmetrical				Asymmetrical				r‡	*p*-value
	Rajasthan	Northeast	Punjab	Total	Rajasthan	Northeast	Punjab	Total		
Position 1	2 (5%)	2 (4.54%)	4 (6.25%)	8 (5.4%)	1 (2.5%)	3 (8.33%)	0	4 (4.35%)	1.000	–
Position 2	2 (5%)	2 (4.54%)	6 (9.37%)	10 (6.75%)	3 (7.5%)	4 (11.11%)	4 (25%)	11 (11.96%)	-1.000	0.000*
Position 3	14 (35%)	8 (18.18%)	30 (46.87%)	52 (35.13%)	14 (35%)	14 (38.88%)	5 (31.25%)	33 (35.86%)	1.000	0.000*
Position 4	18 (45%)	30 (68.18%)	24 (37.55%)	72 (48.65%)	15 (37.5%)	11 (30.56%)	6 (37.5%)	32 (34.78%)	1.000	0.000*
Position 5	4 (10%)	2 (4.55%)	0	6 (4.05%)	7 (17.5%)	4 (11.11%)	0	11 (11.96%)	-1.000	0.000*
Position 6	0	0	0	0	0	0	1 (6.25%)	1 (1.09%)	1.000	0.000*
Total	**40 (100%)**	**44 (100%)**	**64 (100%)**	**148 (100%)**	**40 (100%)**	**36 (100%)**	**16 (100%)**	**92 (100%)**	**1.000**	**0.000***

‡Pearson correlation coefficient; *correlation is highly significant < 0.001

Table 4: Inter-foramen distance and distribution of Angle's molar relationship in three subpopulations

Mean inter-foramen distance (mm)	**Rajasthan**	**Northeast**	**Punjab**	**Total**
Male	58.85 ± 8.83	61.83 ± 5.97	62.43 ± 6.11	61.04 ± 6.97
Female	58.80 ± 5.44	55.29 ± 9.74	55.47 ± 10.71	56.52 ± 8.63
Pearson correlation coefficient (r)	1	1.000	1.000	1.000
Significance (p-value)	–	0.000**	0.000**	0.000**
Angle's molar relationship	**Rajasthan**	**Northeast**	**Punjab**	**Total**
Class I	34 (28.33%)	36 (30%)	32 (26.67%)	102 (85%)
Class II	6 (5%)	3 (2.5%)	7(5.83%)	16 (13.33%)
Class III	0	1 (0.83%)	1 (0.83%)	2 (1.67%)
Total	**40**	**40**	**40**	**120 (100%)**
Pearson correlation coefficient (r)	1	0.993	1.000	0.999
Significance (*p*-value)	–	0.073	0.011*	0.023*

*Correlation is significant ≤ 0.05 level (2-tailed); **correlation is highly significant < 0.001

DISCUSSION

The three subpopulations were selected based on ethnic differences: the Punjabi population belongs to the Indo-Aryans, Rajasthani population belongs to the Gujjar and the Northeast population belongs to Mongoloid. The patients' ages were between 18 and 25 years because the position of MF changes with age and loss of alveolar bone. All the patients had permanent set of dentition, because in mixed dentition, permanent tooth buds might obscure the mental foramen. Panoramic radiographs were used in this study because the MF was seen more consistently on the wide field of view in these radiographs than on the periapical, which do not reveal the position of MF if it falls below the edge of the film (9). Phillips *et al* demonstrated that the size of the foramen on panoramic radiographs was slightly larger than that reported on periapical radiographs, but they stated that the horizontal position of the MF on panoramic radiographs generally agreed with the position reported on periapical radiographs (10).

In our series of 120 panoramic radiographs, the most common position for the MF was in line with the second premolar in two (Rajasthan and Northeast) out of three Indian subpopulations. The position was determined along the long axis of the tooth, considering the whole width of the tooth. The results were in accordance with previous studies performed in other populations such as the Malays, Asian Indians, Kenyan Africans, Saudis and Moroccan (11). In the Punjabi Indian subpopulation, MF was located mostly between the roots of the first and second premolars. Similar results were seen by Moiseiwitsch (12) in a North American Caucasian population and also by Fishel *et al* (13) and Olasoji *et al* (14) in northern Nigerian adults. The variations in the position of MF can occur due to dental loss and ageing. Green also reported that gender influences the position of MF, which is more anterior in the Caucasoid groups (15). Moreover, genetics is an important factor in the morphological characteristics of dental structures (16). According to Yesilyurt *et al*, the position of MF may vary in different ethnic groups and gender as seen in the present study (17). The accurate identification and anatomical location of the mental foramen is very important for diagnostic purposes and clinical dentistry.

The mental foramina had similar bilateral positions in 61.6% of the patients, while previous studies by Yosue and Brooks (7), al Jasser and Nwoku (18) and al-Khateeb *et al* (19) reported similarities in 67%, 80% and 84.4% of the cases, respectively. The differences in the bilateral positions of the MF may occur if the MF is funnel shaped in the buccal cortex of the mandible. The mental canal passes from the posterior to the superior border of the mandible. In the present study, round shaped MF was most commonly reported in the three Indian subpopulations. Very few were unidentified, which were excluded from the study. The literature also supports this finding (20).

The radiographic appearance of continuity of MF with IDC showed an ethnic difference. The finding was consistent with studies by Al Faleh *et al* (3) and Panjabi *et al* (21). This might be due to genetics controlling the craniofacial development in different ethnic groups. This is important as the mental bundle can be injured during surgical procedures resulting in paraesthesia. In our study, the mean distance between the MF was recorded. It was standardized by taking the central point as the reference point. It was higher in males than females in all three subpopulations; the results were in accordance with studies by Afkhami *et al* (22) and Shah *et al* (6). The gender difference was noted as the female jaw size was smaller. When MF cannot be localized in patients, where there is absence of mandibular posterior teeth or malposition of teeth, it can be accurately localized from the symphysis menti. In the present study, the relationship of the MF position with Angle's molar was studied as there are reported cases of mental nerve paraesthesia in orthodontically treated cases. The po-

sition 4 of the MF was most commonly recorded in Angle's Classes I and II molar relationship. No case of Angle's Class III was noted with position 4 of MF. The results were consistent with studies by Gangotri *et al* (23).

The weakness of the study was the use of panoramic radiographs for localization of the MF, as distortion and magnification factors inherent in the orthopantomogram techniques were not taken into consideration.

CONCLUSION

Correlation between Angle's molar relation with MF position was significant for Classes I and II, but not for Class III. The most common MF positions were below the 1st premolar and between the 1st and 2nd premolar.

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