

Localization of Mental Foramen in Panoramic Radiographs of 18-30 Year Olds: A Hospital Based Study

Luitel A,¹ Rimal J,² Maharjan IK,² Shrestha A,² Tamang R³

¹Department of Dentistry
Mechi Zonal Hospital,
Bhadrapur, Jhapa, Nepal.

²College of Dental Surgery,
BP Koirala Institute of Health Sciences,
Dharan, Nepal.

³Department of General Surgery
Koshi Zonal Hospital,
Biratnagar, Morang, Nepal.

Corresponding Author

Abhinaya Luitel,

Department of Dentistry,

Mechi Zonal Hospital,

Bhadrapur, Jhapa, Nepal.

E-mail: abhinayaluitel@gmail.com

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ABSTRACT

Background

The position of the mental foramen demonstrates anatomical variations, although typically it is reported to be either between the apices of the first and second premolars or below the apex of the second premolar.

Objective

To determine the radiographic position of mental foramen in relation to Premolar crown and apex, in panoramic radiographs.

Method

Following ethical approval a retrospective study was conducted in 510 panoramic radiographs of 18-30 year olds from archives of Department of Oral Medicine and Radiology. The position of mental foramen was scored using crown and apex scores according to scoring criteria given by Jasser and Nwoku, 1998. Descriptive statistics was calculated and Chi-square test was applied to assess variation in position of mental foramen between genders and right and left side of mandible. Kappa statistics was applied to assess intra-observer reliability.

Result

The most common scoring for position of mental foramen on right side crown and apex was 3 (49.4%) followed by 4 (45.9%). Similarly, on left side the most common score for crown and apex was 3 (50.8%) followed by 4 (44.3%). There was no statistically significant difference in position between the genders. Comparing the right and left sides, the position was symmetrical in 83.3% for crown and apex scores. The Kappa values indicated good agreement for intraobserver reliability.

Conclusion

The most common position for the mental foramen is between the first and second premolar teeth; though, anatomical variations are seen.

KEY WORDS

Mental foramen, Panoramic radiograph, Premolar

INTRODUCTION

The inferior alveolar nerve, branch of the trigeminal nerve, divides into its terminal mental and incisive branches at the mental foramen (MF).¹ It is defined as "A funnel like opening on the lateral surface of the mandible at the terminus of the mandibular canal".²

The position of the MF demonstrates anatomical variations, although typically it is reported to be either between the apices of the first and second premolars (PM) or below the apex of the second premolar. However, it can be found as far anterior as the canine and as far posterior as the first molar.¹

The nerve bundles emerging from the MF can be injured while administration of local anesthesia for mental nerve block during intraoral biopsy and intralesional injection procedures. It results in paresthesia or anesthesia of the chin, lower lip and gingiva from the MF to the midline of the ipsilateral side.³ Traumatic neuromas in oral cavity may occur in any location where a nerve is damaged; the mental foramen area being the most common location.⁴ The accuracy of the MF identification and correlating it with clinically visible structure is hence essential for performing effective nerve block and avoiding injuries to the neurovascular bundles passing through the MF.³

Thus, the aim of the present study was to determine the radiographic position of MF in relation to PM crown and apex, from panoramic radiograph archives in Department of Oral Medicine and Radiology, College of Dental Surgery (CODS), B.P. Koirala Institute of Health Sciences (BPKIHS), Dharan.

METHODS

A retrospective hospital based study, on panoramic radiographs of 18-30 year olds from departmental archives. It was conducted in the Department of Oral Medicine And Radiology, CODS, BPKIHS. It took 8 months (6th April 2017 – 5th December 2017) for completion.

Sample size/sampling method: 510/ Purposive sampling. The Panoramic Radiographs fulfilling all inclusion criteria were selected and included. This study was conducted after the approval from Institutional Review Committee of BPKIHS (IRC/0814/016).

Panoramic radiograph falling in the age range of 18-30 years old, presence of all mandibular teeth between right first molar and left first molar, Type I and Type II (Yosue and Brook 1989) criteria for MF were included (Table 1).⁵

Table 1. Yosue and Brook, 1989 criteria for MF

Types	Yosue and Brook, 1989
I, continuous	The MF is continuous with mandibular canal.
II, separated	The MF is separated from mandibular canal.
III, diffuse	The MF has indistinct border.
IV, unidentified	The MF cannot be visualized.

Radiographs not falling under above mentioned age range. Radiographs with even single tooth missing between mandibular right and left first molar, Type III and Type IV (Yosue and Brook 1989) criteria for MF, Presence of radiolucent or radio-opaque lesion in the lower jaw that may interfere in position of MF, Presence of gross asymmetry, fracture in the lower arch, Cases with severe periodontitis.⁵

Radiographs were taken by Panoramic Machine (Gendex Orthoralix 9200 DDE) which has a constant magnification of 1.25. Images were produced by digital imaging technique.

All images with constant exposure parameters (Kvp: 70, mA: 4, sec: 12) that fell under above mentioned inclusion criteria were selected, coded and documented by Oral Medicine and Radiology staff member and was handed over to the investigator so that investigator is blind to demographic details of radiograph. The concealed data remained with the chief guide and was revealed at the time of data analysis.

The investigator scored the radiographs in a same room, same computer screen, under ambient light with all curtains closed at a viewing distance (horizontal) of 50 cm from the screen.⁶ Vertical height was maintained according to examiner's comfort. A line was drawn along the longitudinal axis of the PM and the position of the mental foramen was recorded relative to the axis (Fig. 1).

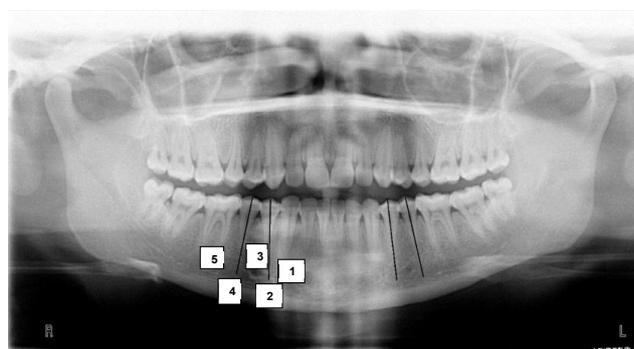


Figure 1. Mental Foramen score

Under supervision of chief guide 25 radiographs was scored by the investigator to check for the intraobserver variability until a score of > 0.8 (almost perfect agreement) was obtained.

In agreement with Yosue and Brooks when there appeared to be multiple foramina, the true radio-graphic mental foramen was considered to be the uppermost one, nearest the mandibular canal.⁵

Intraobserver Variability was checked in 10% of sample size after random selection of samples. The position of the image of the mental foramen was scored according to the criteria by Al-Jasser and Nwoku (1998) (Table 2).⁷

The data collected was entered in Microsoft Excel Sheet. It was then transferred to SPSS (Statistical Package for Social Sciences, version 11.5). Coding was assigned to enter the data. Data was monitored every week.

Table 2. MF scoring criteria, Al-Jasser and Nwoku, 1998

Crown score	Position
1	Anterior to first PM cusp tip
2	Directly inferior to first PM cusp tip
3	Posterior to first PM cusp tip and anterior to second PM cusp tip
4	Directly inferior to second PM cusp tip
5	Posterior to second PM cusp tip
Apex score	
1	Mesial to first PM apex
2	Directly below the first PM apex
3	Distal to first PM apex, mesial to second PM apex
4	Directly below second PM apex
5	Distal to the second PM apex

Variations in MF position between sides of the mandible and between genders was analyzed using Chi square test.

The intraexaminer agreement in determination of MF position was assessed by kappa coefficient. Kappa values classified by Landis and Koch was used.⁸

By using the formula, $n=4 pq/L^2$, where, n is sample size, p is the prevalence (44%)¹, q(100-p) is 56 and considering least permissible error to be 10%, L² is 19.36, we get sample size of 509.09, approx. 510.

RESULTS

Five hundred and ten radiographs taken for diagnostic purposes, and meeting the inclusion criteria were obtained from the archives of Department of Oral Medicine and Radiology, corresponding to 216 males and 294 females (Table 3), with a mean age 27.2 year (Age range: 18-30 years).

Table 3. Frequency distribution, Male and Female.

Gender	Frequency (n)	Percent (%)
Male	216	42.4
Female	294	57.6
Total	510	100

As a part of training and calibration, initially 25 radiographs were examined for position of MF and intra-observer reliability was assessed using kappa. Comparing the two occasions, the Kappa values indicate almost perfect agreement (Table 4).

Table 4. Kappa values for training and calibration.

	Right Crown	Right Apex	Left Crown	Left Apex
Kappa Value	1	1	0.83	0.83

The most common scoring for position of MF on right side crown and apex was 3 (49.4%) followed by 4 (45.9%) (Table 5a). Similarly, on left side the most common score for crown and apex was 3 (50.8) followed by 4 (44.3%) (Table 5b).

Table 5a. Frequency of Right Crown and Apex score for MF.

Score	Frequency (n)	Percent (%)
2	4	0.8
3	252	49.4
4	234	45.9
5	20	3.9
Total	510	100

Table 5b. Frequency of Left Crown and Apex score for MF.

Score	Frequency (n)	Percent (%)
2	3	0.6
3	259	50.8
4	226	44.3
5	22	4.3
Total	510	100

While comparing genders, the most frequent position was between the first and second premolar teeth for both males (Table 6a, 6b) and females (Table 7a, 7b). However, comparing score 3 and 4 for MF between male and female did not show statistically significant difference (Pearson's Chi-square, p value was 0.5).

Table 6a. Frequency of Right Crown and Apex score for MF in male.

Score	Frequency (n)	Percent (%)
2	1	0.5
3	105	48.6
4	104	48.1
5	6	2.8
Total	216	100

Table 6b. Frequency of Left Crown and Apex score for MF in male.

Score	Frequency (n)	Percent (%)
3	113	52.3
4	93	43.1
5	10	4.6
Total	216	100

Table 7a. Frequency of Right Crown and Apex score for MF in Female.

Score	Frequency (n)	Percent (%)
2	3	1
3	147	50
4	130	44.2
5	14	4.8
Total	294	100

Table 7b. Frequency of Left Crown and Apex score for MF in Female.

Score	Frequency (n)	Percent (%)
2	3	1
3	147	50
4	130	44.2
5	14	4.8
Total	294	100

Comparing the right and left sides, the MF position was symmetrical in 83.3% for crown and apex scores. However, Pearson’s Chi-square test showed significant difference in score 3 and 4 for MF between right and left side of mandible (Table 8).

Table 8. Symmetry of MF in Right and Left side of Mandible.

Mental Foramen Score	Left Crown and Apex Score				Total	P Value
	2	3	4	5		
Right Crown and Apex Score	2	1	3	0	0	4
	3	2	218	31	1	252
	4	0	37	191	6	234
	5	0	1	4	15	20
Total	3	259	226	22	510	

*Pearson’s Chi Square p value for score 3 and 4.

To check for intraobserver variation 10% of the sample size was reassessed for position of MF and Kappa score was calculated. The values indicate good agreement between the two observations (Table 9).

Table 9. Kappa values for intraobserver reliability.

	Right Crown	Right Apex	Left Crown	Left Apex
Kappa Value	0.79	0.79	0.78	0.78

DISCUSSION

Radiography is the most common non-invasive process for diagnosis and treatment planning. Among different maxillofacial radiographic technique, panoramic radiograph is routinely used to diagnose, screen and plan the clinical procedures.⁹ The precise identification of MF position is important for both diagnostic and clinical procedures in mandible.¹⁰ The primary objective of this study was to determine the possibility of relating the position of the MF to a clinically apparent landmark, the premolar crowns, using panoramic radiographs. However, for comparison of the results with existing documents, the MF position was also related to the premolar apices. The location of the mental foramen could change with development of the jaws.¹¹ We thus evaluated radiographs with completely developed permanent teeth.

Most common location of MF

In our study the most common score for position of MF was 3 (posterior to first PM and anterior to second PM cusp tip and distal to first PM and mesial to second PM apex), i.e., 49.4% on right side and 50.8% on left side. Our study is similar to the study done by different authors in various populations.^{1,12-20} Our study revealed score 4 (directly inferior to second PM cusp tip and directly below the second PM apex), to be the second most common score for position of MF i.e., 45.9% on right side and 44.3% on left side. However, in contrast to our findings, studies done by various authors in different population, reported MF to be most commonly present below the apex of second PM (score 4).^{3,10,21-33} Reported that the most common MF position was in line with the longitudinal axis of the lower second PM.

Symmetry in localization of MF between right and left side of mandible

In our study we reported 83.3% symmetry comparing crown and apex scores for position of MF in right and left side of mandible. There is wide variation in symmetry of position of MF in right and left sides of the mandible.^{14,18-19,21,25} Reported 70-90% symmetry in location of MF.^{1,10,13,15-16,22-24} Reported 50-70% symmetry in position of MF between right and left sides of mandible. However, according to Popovic et al. there was no statistically significant difference in symmetry of location of MF.²⁸

As there is no single study showing 100% of symmetry in position of MF on both sides, it clearly indicates that MF is not always symmetrical even in same individuals.¹⁰

Comparison of position of MF between genders

Our study revealed no statistically significant difference comparing score 3 and 4 for MF between males and females. The scores 1, 2 and 5 were not comparable as 2 cells had expected cell count less than 5. Our study findings are similar to the findings of the study done by various authors in different population reported similar findings.^{14-16,21,26,28}

In contrast to finding of our study, statistically significant difference ($p < 0.05$) in symmetry of location of MF was found between the genders by Al-Shayyab et al. and Suragimath et al.^{10,18}

Intra-observer reliability in localization of MF

Our study reported good intra-examiner agreement (Kappa: 0.79 for right side and 0.78 for left side) in localization of MF position reported good agreement while calculating intra-observer reliability.^{14,34} However, Currie et al. reported moderate to perfect intra-examiner agreement in localization of MF.¹

Ethnic and racial discrimination of the selected population, the geographical variation, pre and post natal growth and

development and difference in sample size can be one among the reasons for variation in position of MF.¹⁴ The studies conducted on different races have reported that MF is located more posteriorly in Blacks than in Whites. Hence, we can infer that population and geography based differences plays a role in the most common location, bilateral symmetry and difference in position of MF between males and females.³⁵

Owing to its variability of location, frequent failures are well-documented during mental nerve blocks. Radiological misinterpretation of MF as a radiolucent lesion in the apical region of the mandibular premolars can end up in iatrogenic injuries to the mental nerve. This will result in paresthesia from 8.5% to 24% for periods of up to 3-16 months.² Thus, accurate localization of the MF is vital for diagnosis of pathologies and mandatory for clinical procedures.

Based on literature search, panoramic radiograph is one of the most feasible and widely used digital imaging techniques to localize the antero-posterior position of MF. Staying within our financial and infrastructural constraints, we were able to deliver results quiet comparable to previous studies. However to generalize the study findings, further studies with larger sample sizes are needed. Further, to explore upon the bucco-lingual position of MF, its dimension and shape, presence of accessory MF and to trace the route of mandibular canal from mandibular foramen to the MF, study involving advanced imaging modalities like CBCT appears to be more convincing.

The unavailability of patient's information to assess previous dental treatment, like orthodontic treatment, may have affected the position of the MF in relation to the landmarks used.

Radiographs were recruited by purposive sampling, and are thus not representative of the general population and prone to selection bias.

The panoramic radiograph is a two-dimensional image. Thus, the exact position of the mental foramen in a bucco-lingual direction could not be identified.

Location and symmetry of MF was based on simple observation rather than measurement.

CONCLUSION

The findings of this study suggests that the most common position of the MF is between the first and second PM teeth in a selected young population of Eastern Nepal ; however, it may be found directly below the second premolar in a high proportion of cases. The position of MF was symmetrical in 83.3% of the subjects for both crown and apex scores. There was no statistically significant difference in position of MF among the genders. A radiograph may aid in locating the foramen in relation to the tooth apices, however, when relating position to the premolar crowns the technique is less reliable. The best site for local anesthetic injection is between the mandibular PMs or under the mandibular second PM. One must be careful when carrying out procedures close to these areas to avoid mental nerve injury.

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