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RESEARCH ARTICLE

EVALUATION OF POSITION OF THE MENTAL FORAMEN USING PANORAMIC RADIOGRAPH IN NORTH INDIAN POPULATION

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ABSTRACT

Introduction: Mental foramen is an important anatomical landmark situated on the antero-lateral aspect of the body of the mandible and transmits mental nerves and vessels. Knowledge regarding the position of the mental foramen is important when administering regional anaesthesia, performing periapical surgery, dental implant surgery and open reduction of the mandible fractures as the mental nerve bundle can be traumatized during surgical procedures resulting in the paresthesia/ anesthesia in the area innervated by the mental nerve. **Objective:** The aim of the study was to evaluate the position of the mental foramen using panoramic radiograph. **Material and method:** This study was undertaken using panoramic radiograph of 200 patients who reported to the department of oral and maxillofacial surgery. The location of the mental foramen was recorded with respect to the longitudinal axis of the mandibular premolar and evaluated on the basis of gender and symmetry. **Results:** The most common location of the mental foramen was observed between the first and second premolar followed by that in line with the second premolar. **Conclusion:** It was concluded that since the position of mental foramen is variable hence it should always be assessed radiographically before the surgical procedure so as to reduce unwanted surgical sequel.

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INTRODUCTION

Anatomical landmarks are the primary anthropometric parameters on skeletal tissues. Restoration of form and function without violating important anatomic structures is a fundamental goal in the surgical management of any maxillofacial patient. One of the important anatomic landmarks in the mandible is mental foramen. The development of surgical techniques in the mandible and the progress of radiological imaging procedures have brought much interest in the clinical anatomy of the mental foramen. Knowledge of the anatomic characteristics of the mental foramen is important in the myriad of surgical procedures in the maxillofacial area as the mental nerve bundle passes through the mental foramen and supplies the sensory innervation to the soft tissues of the chin. Peripheral local anesthetic block of the mental neurovascular bundle provides adequate analgesia for surgery on the soft tissues of lower lip and chin area. However, the surgical procedures of lower chin involve considerable risk of damage to the mental nerve. Hence, this nerve should be protected during surgical procedures such as for fractures of the symphysis or parasymphysis region, genioplasty and surgery for odontogenic cysts and tumors. The knowledge about the position and morphological variations of mental foramen thus helps to localize the neurovascular bundle passing through the mental foramen and prevents the occurrence of damage to the mental nerve.

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MATERIALS AND METHODS

The study was undertaken in 200 patients aged between 16-48 years, who reported to the department of Oral and Maxillofacial surgery. Patients were selected irrespective of gender, cast, creed and socio-economic status. The position of the mental foramen was determined using panoramic radiographs. These radiographs were taken using Kodak 8000C Digital Panoramic System (tube potential: 60-90 kV, tube current: 2-15 mA, total filtration: 2.5mm Al, magnification factor of 1.27) and had high quality processing. The selection criteria consisted of patients who had fully erupted permanent dentition with no crowding or spacing in the lower arch, patients who had all mandibular teeth present from the right first molar to the left first molar. On the other hand, patients who had deep caries or had any dental treatment (root canal treatment, orthodontic treatment, various restorations) or periodontal lesion in the lower teeth between

36 and 46 and also in whom mental foramen could not be identified on panoramic radiograph, were excluded from the study.

Methods

All the panoramic radiographs were interpreted using the viewbox in a dim lighted room:

- Position of the mental foramen was recorded in line with the longitudinal axis of the mandibular premolars using the edge of a metal ruler.
- If mental foramen was too large or present between two teeth, the position of foramen was recorded by drawing an imaginary line parallel to the long axis of the teeth.
- When there appeared to be multiple foramina, the uppermost one, nearest to the mandibular canal was considered to be the true radiographic mental foramen.
- The location of the mental foramen was evaluated on the basis of gender, symmetry and asymmetry.
- The position of the image of the mental foramen was recorded according to the categories as described by Al Jasser and Nwoku[1] (Fig.1):

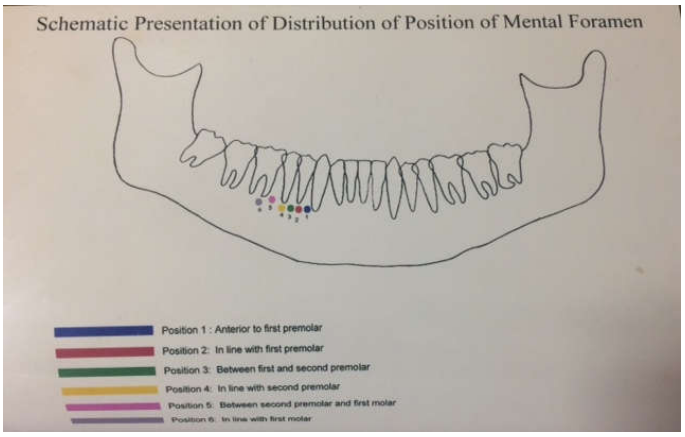


Figure 1. Schematic presentation of distribution of position of mental foramen

Position1: Situated anterior to the first premolar
Position 2: In line with the first premolar
Position 3: Between the first premolar 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

Statistical analysis of the data was done using Statistical Package for Social Sciences (SPSS Software, version 19.0). $P<0.05$ was considered to be statistically significant. Cross-tabulations and chi-square tests were carried out on factors investigated.

RESULTS

The mean age of patients was 25.8 years (range 16-48 years). There were 105 female (52.5%) and 95 male patients (47.5%) making female to male ratio 7:6. Out of 200 patients, maximum number of patients (n=111; 55.5%) were within the age group of 15-25 years (Table1). Table 2 shows agewise distribution of position of mental foramen. Out of 400 foramina studied, the most common location of the mental foramen in different age groups was position 3 (n=227; 56.75%) on both right (n=119; 59.5%) as well as left side (n=108; 54.0%). The only exception to this trend was age group of 35-45 years in which the most common location was position 4 (n=23; 54.7%). Further, position 3 was most common (n=139; 62.6%) in age group 15-25 years. The most common location of the mental foramen relative to the teeth was between first and second premolar (position 3; 56.75%) (Table 2; Graph1 and 2). The association between position of mental foramen and gender showed that the position 3 (56.75%) was the most common location in both male (n=97, 51.0%) and female (n=130, 62.0%) patients whereas the least common location was position 1 (2.5%). Chi-square test showed no statistical significant ($p>0.005$) association between gender and position of the mental foramen on both right and left side (Table 3; Graph 3). Table 4 shows the distribution of 400 mental foramina according to symmetry. The location of mental foramen was symmetrical in 119 radiographs (n=238, 59.5%) whereas 81 radiographs revealed 162 asymmetrically placed mental foramina (40.5%). Further, statistical analysis applied to analyse the association between symmetry and gender of patient showed non-significant relationship ($p=0.660$, $x^2 = 0.194$) (Table 4). The most common position of both symmetrical and asymmetrical mental foramen was position 3 (between the first and second premolar) and it was found to be 69% and 38.9% respectively (Table 5 and 6; Graph 4 and 5). The statistical analysis showed highly significant association between the symmetry and position of the mental foramen on both the right ($p=0.004$, $x^2= 15.447$) and left side ($p=0.000$, $x^2= 44.538$) (Table 7). Out of 200 panoramic radiographs studied, accessory mental foramina were observed in nine radiographs.

Table 1. Agewise distribution of mental foramen

Age (years)	Number of patients	Number of foramen
15-25	111 (55.5%)	222 (55.5%)
25-35	64 (32%)	128 (32%)
35-45	21 (10.5%)	42 (10.5%)
45-55	4 (2.0%)	8 (2.0%)
Total	200	400

Table 2. Distribution of position of mental foramen according to age

AGE (years)	NUMBER OF MENTAL FORAMEN						
	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6	Total number of mental foramen
15-25	7 (3.1%)	8 (3.6%)	139 (62.6%)	50 (22.5%)	18 (8.1%)	0 (0%)	222
25-35	1 (0.78%)	5 (3.9%)	69 (53.9%)	44 (34.4%)	9 (7.0%)	0 (0%)	128
35-45	2 (4.8%)	0 (0%)	15 (35.7%)	23 (54.7%)	2 (4.8%)	0 (0%)	42
45-55	0 (0%)	1 (12.5%)	4 (50%)	2 (25%)	1 (12.5%)	0 (0%)	8
TOTAL	10 (2.5%)	14 (3.5%)	227 (56.7%)	119 (29.7%)	30 (7.5%)	0 (0%)	400

Position 1: Anterior to first premolar; Position 2: In line with first premolar; Position 3: Between first and second premolar; Position 4: In line with second premolar; Position 5: Between second premolar and first molar; Position 6: Between second premolar and first molar

Table 3. Statistical analysis of relationship between gender and position of mental foramina

	Gender	Position						Total	Value of Chi-square	P value
		1 (n)	2 (n)	3 (n)	4 (n)	5 (n)	6 (n)			
Right	Female	1	3	68	28	5	0	105	5.412	0.248
Side	Male	0	1	51	35	8	0	95		
	Total	1	4	119	63	13	0	200		
Left	Female	6	4	62	26	7	0	105	4.096	0.393
Side	Male	3	6	46	30	10	0	95		
	Total	9	10	108	56	17	0	200		

n – Number of mental foramina

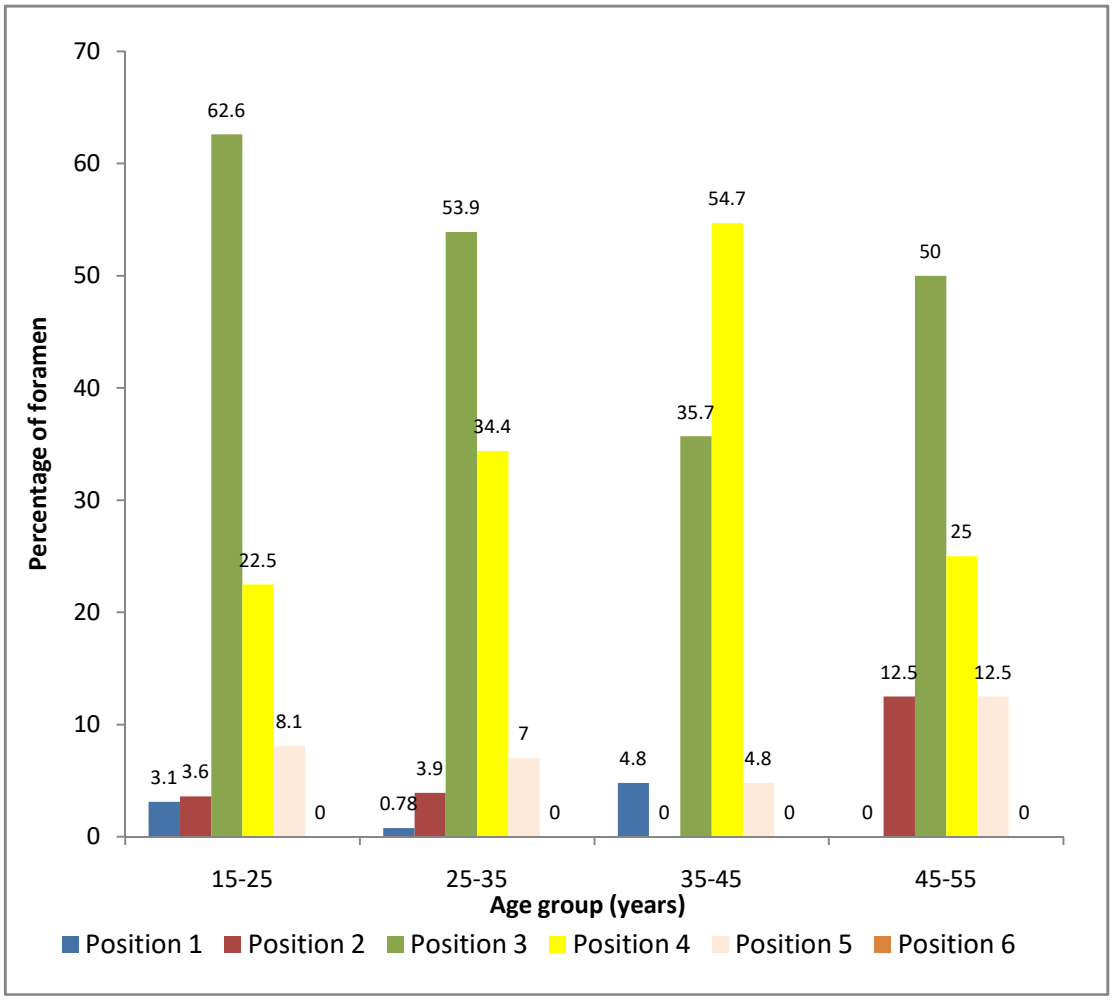
Table 4. Distribution of position of mental foramen according to symmetry

Symmetry	Number of patients (N)			Number of mental foramen (n)	Percentage	Value of Chi-square	P value
	Male	Female	Total				
Symmetrical foramen	55	64	119	238	59.5	0.194	0.660
Asymmetrical foramen	40	41	81	162	40.5		
TOTAL	95	105	200	400	100.0		

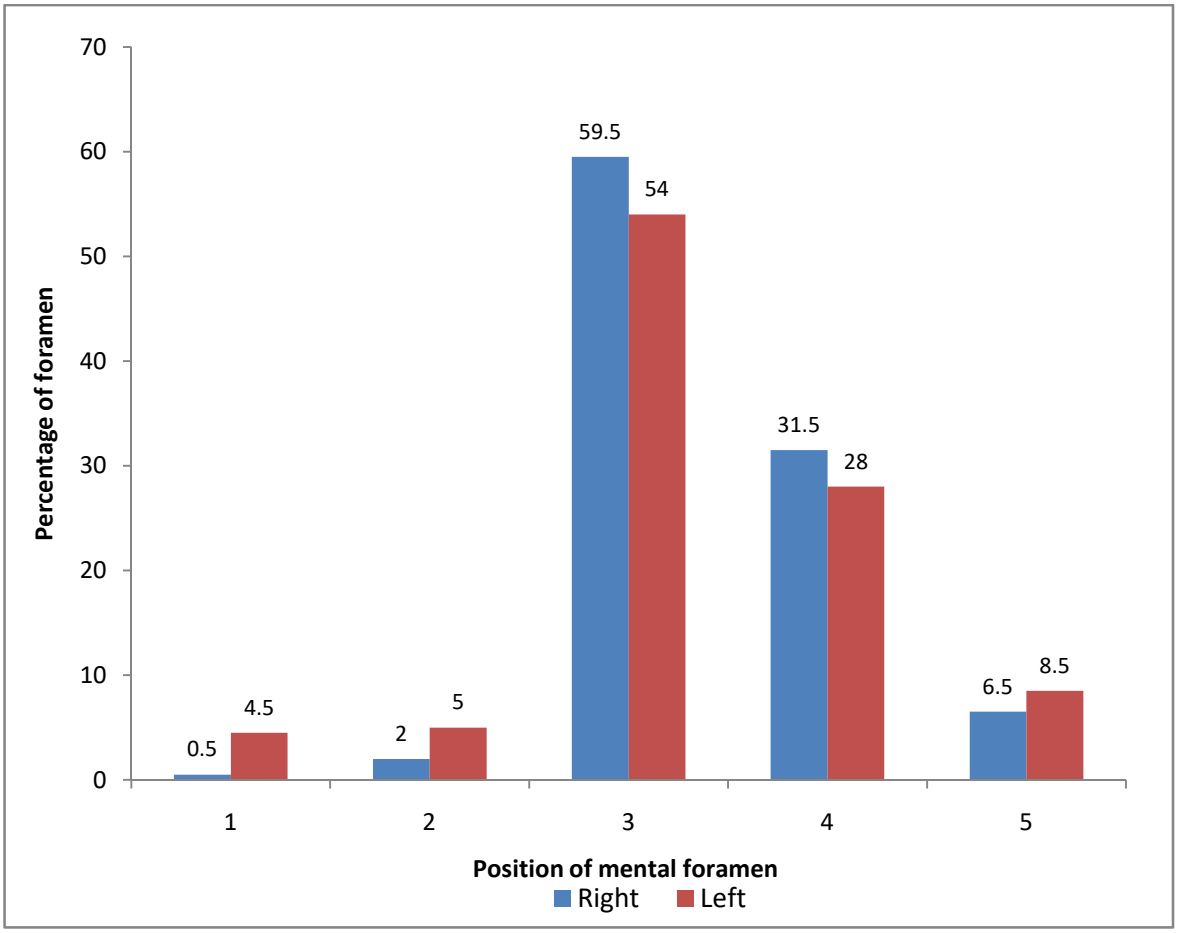
Table 5. Distribution of symmetrical mental foramen in 119 patients

Position	Location of mental foramen	Right Side (n)	Left side (n)	Total number of mental foramen
		Frequency (%)	Frequency (%)	Frequency (%)
1	Anterior to the first premolar	0 (0%)	0 (0%)	0 (0%)
2	In line with first premolar	0 (0%)	0 (0%)	0 (0%)
3	Between first and second premolar	82 (69%)	82 (69%)	164 (69%)
4	In line with second premolar	31 (26%)	31 (26%)	62 (26%)
5	Between second premolar and first molar	6 (5%)	6 (5%)	12 (5%)
6	In line with first molar	0 (0%)	0 (0%)	0 (0%)
Total		119 (100%)	119 (100%)	238 (100%)

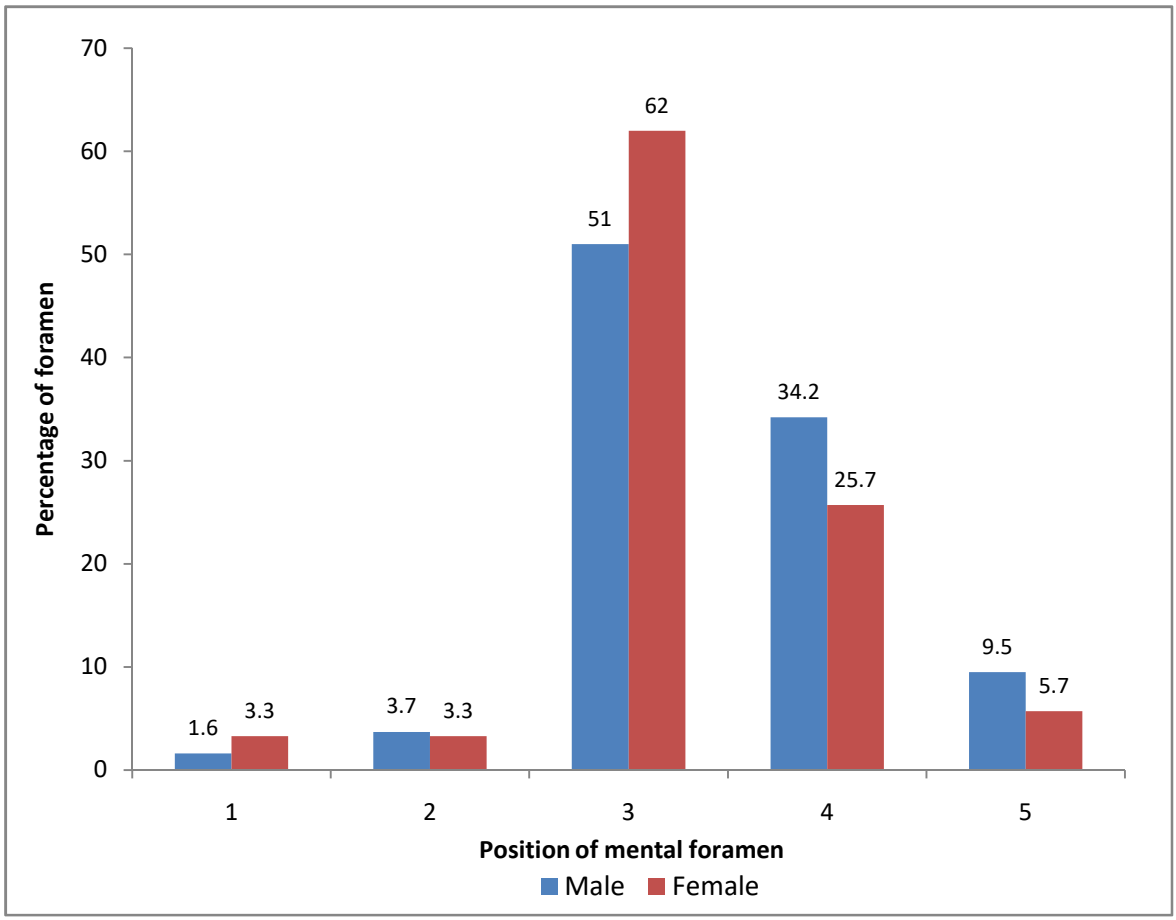
n = number of mental foramen



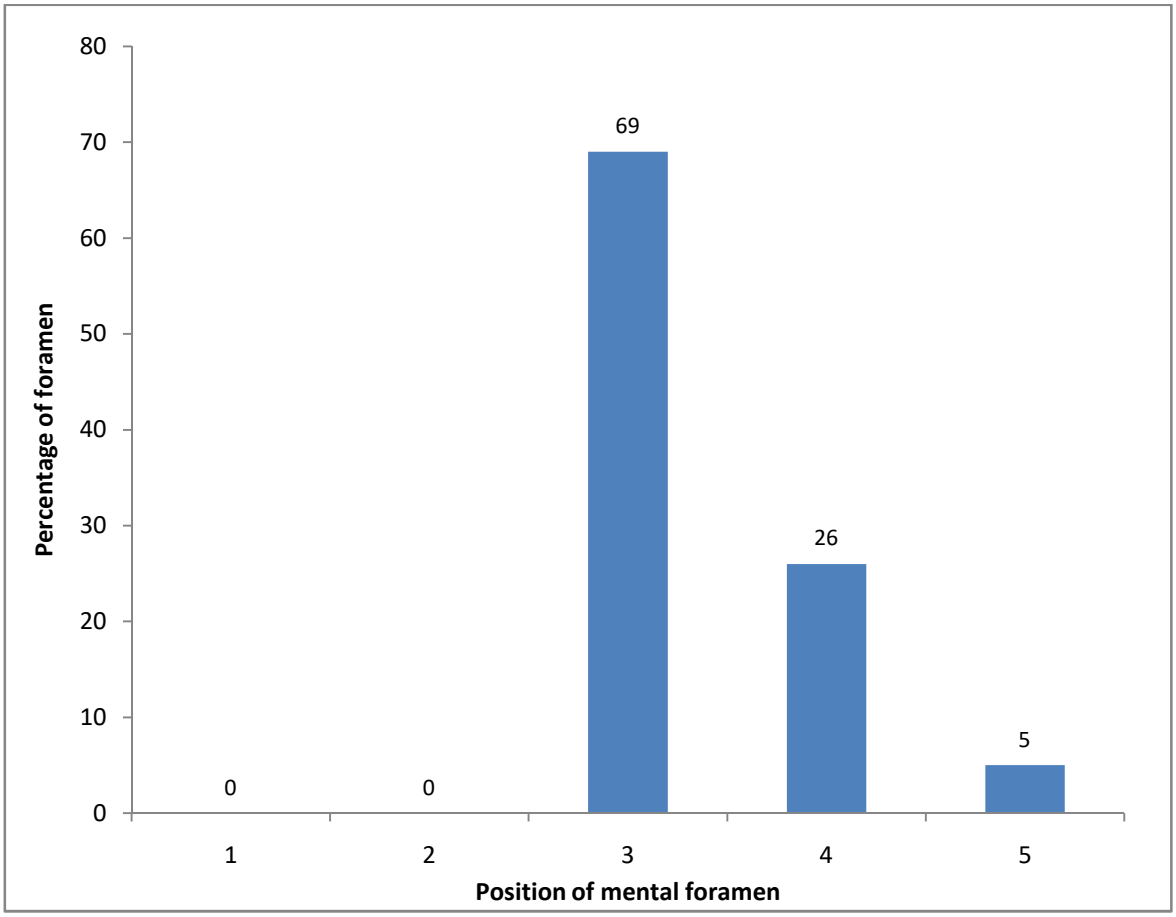
Graph 1. Distribution of mental foramen according to age on panoramic radiograph



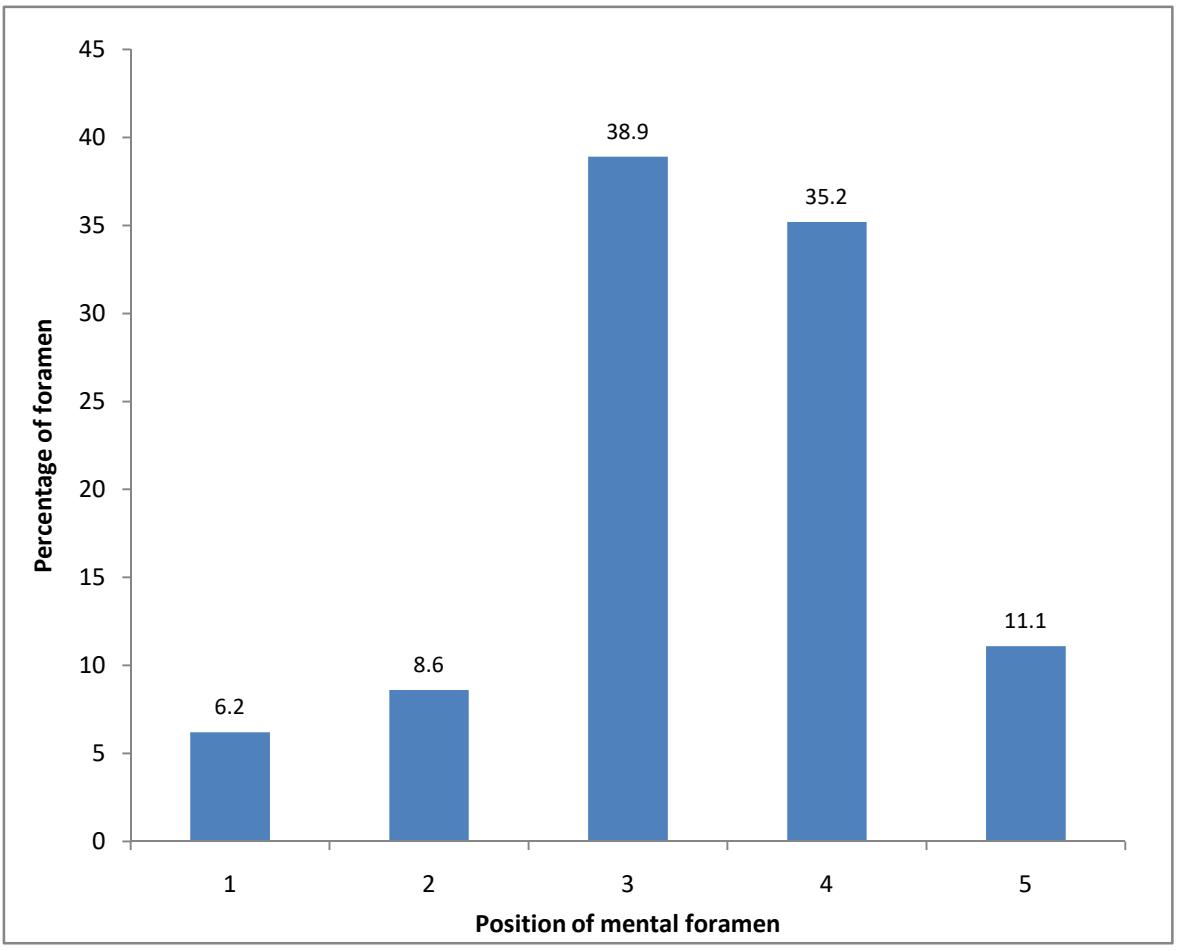
Graph 2. Distribution of mental foramen on right and left side on panoramic radiograph



Graph 3. distribution of mental foramen in male and female patients on panoramic radiograph



Graph 4. Distribution of symmetrical mental foramen in 119 patients



Graph 5. Distribution of asymmetrical mental foramen in 81 patients

Table 6. Distribution of asymmetrical mental foramina in 81 patients

Position	Location of mental foramen	Right Side (n)	Left Side (n)	Total number of mental foramen
		Frequency (%)	Frequency (%)	Frequency (%)
1	Anterior to the first premolar	1 (1.2%)	9 (11.1%)	10 (6.2%)
2	In line with first premolar	4 (5%)	10 (12.3%)	14 (8.6%)
3	Between first and second premolar	37 (45.7%)	26 (32.1%)	63 (38.9%)
4	In line with second premolar	32 (39.5%)	25 (30.9%)	57 (35.2%)
5	Between second premolar and first molar	7 (8.6%)	11 (13.6%)	18 (11.1%)
6	In line with first molar	0 (0%)	0 (0%)	0 (0%)
TOTAL		81 (100%)	81 (100%)	162 (100%)

n = number of mental foramen

Table 7. Statistical analysis of relationship between symmetry and position of mental foramen

Side	Symmetry	Position					Total number of mental foramen	Value of Chi-square	P value
		1	2	3	4	5			
Right	Symmetrical	0	0	82	31	6	119	15.447	0.004
	Asymmetrical	1	4	37	32	7	81		
	Total	1	4	119	63	13	200		
Left	Symmetrical	0	0	82	31	6	119	44.538	0.000
	Asymmetrical	9	10	26	25	11	81		
	Total	9	10	108	56	17	200		

One radiograph showed bilateral accessory mental foramina. Hence, a total of ten accessory mental foramina (2.5%) were found on 200 radiographs. Out of ten accessory mental foramina, five were situated on right side (1.25%) and five on left side (1.25%). Out of these ten accessory foramina in 200 panoramic radiographs, the most common location of accessory foramen was position 3 in four radiographs followed by position 1 in three radiographs and position 2, 5 and 4 in one radiograph each respectively. Out of these ten foramina, three foramina were situated posterior to the mental foramen, four were situated anterior and three were situated superior to the mental foramen respectively.

DISCUSSION

The advances in development of surgical techniques in the mandible and progress of the radiological imaging procedures have brought much interest in the clinical anatomy of the mental foramen. Mental foramen is a funnel shaped opening of the mental canal onto the lateral surface of the mandible. It is located entirely in the buccal cortical bone. The largest diameter of the foramen is found at the lateral surface of the mandible. The accurate identification of the location of mental foramen is important for both diagnostic and clinical procedures. Clinically, the mental nerve bundle can be traumatized during surgical procedures resulting in paresthesia or anesthesia. As accurate localization of the mental foramen position makes possible better treatment planning, safer surgical procedures and successful administration of local anesthesia. It is important for the operator to know exactly the position of the mental foramen when performing periapical surgery, cyst enucleation, endosseous implant placement and orthognathic procedures such as mandibular body osteotomy in order not to damage the mental nerve. The location of mental foramen differs not only in the mesiodistal plane but also in the superoinferior plane and in its relation to the apices of the adjacent premolar teeth. One possible explanation for this variation of the mental foramen location is the known variation in the growth and development of the mandible which is affected by adaptation to physiological and functional needs. Thus, variation in the location of the mental foramen in different samples might be explained by variation in food habits, eruption and size of the teeth, geographical, environment and racial origin. Since there are no anatomical landmarks to accurately locate the mental foramen, therefore radiographs must be used to aid in its identification. The area of the mental foramen seen on the radiograph is usually smaller than the actual anatomical area of the foramen either on the external or internal surface of the cortical plate. It appears that the radiographic foramen corresponds to the smallest diameter of the foramen on the internal surface of the buccal plate. This would be the area where the mental canal joins the cortical bone. The X-rays must pass directly through the long axis of the mental canal for the radiographic area of the foramen to approach the same dimensions of actual anatomical foramen (Phillips *et al.,* 1992). The mental foramen appears more consistently on panoramic radiograph than on periapical radiograph, because of vertical angulation in the panoramic radiograph and the wide field of view.The magnification of the mandible on radiographs may account for the improved visualisation of the foramina. Phillips *et al.* (1992) reported the radiographic size of the foramen on panoramic radiograph slightly larger than that on the periapical radiograph. Also, the ability to view entire body of mandible on a panoramic radiograph is a great help in locating mental foramen. The radiographic appearance of the mental foramen may result in a misdiagnosis of a radiolucent lesion in the apical area of mandibular premolar teeth. It is therefore crucial to find the exact location of the mental foramen by radiographic picture and to be familiar with the variations in its location. In literature, there are numerous reports stating the anatomical variations in the position of mental foramina in different races. These studies were done either on dry skull or on panoramic radiographs.

In the present study which was performed on 200 digital panoramic radiographs, it was found that the position of the mental foramen varied between the long axis of the canine and the mesial root of the first molar which concurs with the findings of studies done by Al Jasser and Nwoku (1998); Moiseiwitsch (1998); Gungor *et al.* (2006). The most common position of the mental foramen in the current study was between the first and second premolar (56.75%), followed by that in line with the second premolar (29.75%), between second premolar and first molar (7.5%), in line with first premolar (3.5%) and anterior to first premolar (2.5%) respectively. Similar pattern of distribution of position of

mental foramen was observed in Indian population by Rupesh *et al.* (2011) using digital panoramic radiographs who reported the most common position of mental foramen as between the first and second premolar (47.6%) followed by that in line with the second premolar (33.5%). Similarly, Gungor *et al.* (2006) in a radiographic study on panoramic radiograph of the Turkish population also found the most common position of the mental foramen to be between first and second premolar (71.5%), followed by that in line with the second premolar (22.4%). Similarly, Al-Khateeb *et al.* (2007) in their study on panoramic radiograph of Jordanian population, found that the most common location of the mental foramen was between first and second premolar (47%) followed closely by that in line with second premolar (40%). However on the contrary, Thakare *et al.* (2016) in their study on Indian population found the most common position of mental foramen to be in line with second premolar (46%) followed by the position between the first and second premolar (37%). Other studies which were contrary to the present study were those conducted by Srinivas *et al.* (2017) and Parnami *et al.* (2015) who found the most common location of mental foramen to be position for 4 (i.e below long axis of 2nd premolar) (58% and 61% respectively). Also contrary to our resultswere the studies conducted by Ngeow and Yuzawati (2003); Liverdos *et al.* (2007); Talabani *et al.* (2008) who reported that the most common position of mental foramen was in line with second premolar on the panoramic radiographs in Malay (69.2%), Greek (52.9%) and Kurdish populations, respectively. Various studies have been carried out on the Indian population for evaluating the position of mental foramen relative to the mandibular teeth. These studies revealed the most common position of mental foramen in line with second premolar as reported by Roopa *et al.* (2003) on South Indian mandibles (53.43%), Singh R and Srivastav AK. (2010) on Indian adult human skulls (68.8%), Agarwal and Gupta (2011) on adult human mandibles from South Gujarat population (81.5%). Contrarily, in this study on panoramic radiographs this position (mental foramen in line with second premolar) was found only in 29.75% cases. Mental foramen location varies with the increasing age. At birth it is found nearest the canine germ and with increasing age this relocates posteriorly. Literature supports this direct correlation betweenageing and position of mental foramen. In the present study, the mental foramen was positioned more distally in patients above 35 years of age (mental foramen in line with second premolar in 50% cases) than patients below 35years of age (mental foramen between first and second premolar in 59.4% cases).

In the present study, no significant correlation could be established between gender and position of mental foramen. Similarly, no gender difference was observed in the distribution of mental foramen by Ngeow and Yuzawati (2003); Apinhasmit *et al.* (2006); Liverdos et al. (2007) and Amorim *et al.* (2008), Thakare *et al.* (2016) in Malay, Thai, Greek, Brazilian and Indian population respectively. It would therefore appear that the location of the mental foramen is not gender-dependent. However, Mohamed et al (2016) and Suragimath *et al.* (2016 in their study on Indian population found a significant difference in the position of mental foramen between males and females. In the present study, mental foramen was symmetrical in 59.5% of the radiographs with the most common symmetrical position of mental foramen being between the first and second premolar (69%) followed by that in line with second premolar (26%) and between second premolar and first molar (5%), respectively. This is in concurrence with the study by Rupesh *et al.* (2011) on panoramic radiographs of Asian Indian population who found the mental foramen to be symmetrical in 57% radiographs out of which mental foramen was located symmetrically between the first and second premolar in 52.5% radiographs, in line with second premolar in 33.3% radiographs, between second premolar and first molar in 10.5% radiographs, anterior to first premolar and in line with first molar in 1.75% radiographs respectively. Similar pattern of distribution of symmetrical location of mental foramen with the most common symmetrical site between first and second premolar followed by that in line with second premolar was reported by Haghanifar and Rokouei (2009) and Gungor *et al.* (2006) in Iranian (85.7%) and Turkish population (85.8%) respectively. Contrarily, the most common symmetrical position of mental foramen in line with second premolar (80.7%) followed by that between first and second premolar (13.9%) was observed by Ngeow and Yuzawati Y. (2003) in Malay population. Bilateral symmetry in the position of mental foramen was reported by Liverdos *et al.* (2007); Talabani *et al.* (2008); Apnihasmit *et al.* (2006) and Al Jasser and Nwoku (1998) in Greek (69.2%), Kurdish (81.2%), Thai, (73.91%) and Saudi population (80%) respectively. Further, the present study revealed no statistical significance regarding gender, in assessing both symmetrical and asymmetrical location of mental foramen. This is in concurrence with Haghanifer and Rokouei M. (2009). Whereas on the contrary, Talabani *et al.* (2008) found that asymmetry of mental foramen was more frequently seen in the female gender than in male gender. Any additional foramen present in the vicinity of the mental foramen is known as accessory mental foramen. Accessory mental foramen is found due to branching of mental nerve prior to its passing through the mental foramen. Thus, verification of existence of accessory mental foramen is important for surgeons because ignorance of presence of accessory mental foramen may lead to nerve block failure or insufficient anesthesia and accessory nerve injury during surgery.

The incidence of accessory mental foramina varies between ethnic groups. In the present study, a total of ten (2.5%) accessory mental foramina were found on 200 radiographs out of which five were situated on right side (1.25%) and five on left side (1.25%). This incidence of accessory mental foramen is less than that reported in Indian population by Roopa *et al.* (2003) in South Indian mandibles i.e. 3.52% on left side and 4.22% on right side. Similarly, high incidence of accessory mental foramen was reported by Singh and Srivastav (2010) in Indian adult human skulls i.e. 8 % on left side and 5% on right side. The present study reveals a valuable insight on the information concerning the location of mental foramen in Indian population. The results of this study, coupled with other studies indicate that the location of the mental foramen is variable. This knowledge of the variation in position of mental foramen and presence of accessory mental foramen may assist surgeons to avoid injury to the neurovascular bundle and facilitate local anesthetic and surgical procedures. Since the foramen does not have any static and dependable landmarks, it is the surgeon's responsibility to gain an understanding of the mental foramen's location with adequate imaging prior to initiating surgical intervention, thereby reducing the risk of unwanted surgical squeal.

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