

Assessment of mental foramen position on Orthopantomograms (OPGs) in Hamdard Dental hospital Karachi, A retrospective study

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ABSTRACT:

Objective: This study intends to determine the most typical location of the mental foramen and whether the left and right sides differ using panoramic radiography.

Methodology: A retrospective cross-sectional study with Nonprobability convenient sampling was conducted on a digital orthopantomogram (OPG) of the population visiting in OPD of Hamdard University dental hospital Karachi. About 1192 panoramic (OPDG) radiographs between the period of 6 months November 2022 and May 2023 were evaluated with regard to the position of mental foramen in male and female subjects between the age of 15-65 years. The data was entered in SPSS version 16 and analyzed for Frequencies and associations of mental foramen between genders a both sides of mandible.

Results: The mean age of the patient was 34 years with female frequency 57%. The most common location of the foramen was found to be below the apex of the 2nd premolar (n=636) followed by below the apex of the 1st and 2nd premolars (n=286) in relation to both left and right sides. Statistical analysis didn't show a significant relation with the Gender.

Conclusion: Mental Foramen was most commonly observed below the apex of the second premolar, with higher frequencies in females 51%(n=352) compared to males 44%(n=255). Location of Mental Foramen in both genders was found to be at same position and there was no significant association

Key words: Anatomic land mark, Mandible, Mental foramen (MF), Panoramic x-rays (OPG) Orthopantomogram (OPG)

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Introduction:

When planning for any invasive procedure, it is crucial to accurately identify and understand anatomical landmarks on radiographic images. Surgical intervention aims to maintain the structure and functionality of anatomical features. The mandible, known as the strongest bone in the craniofacial region, undergoes most of its morphometric changes in the alveolar process. Among these, key landmarks like the mental foramina hold significant importance. The mental foramina (MF), a vital bilateral structure of the mandible, serve as funnel-shaped openings to the mental canal. The branches of the inferior alveolar artery and nerve, emerge from the mental foramen (MF) provide the blood and nerve supply to the gingiva, alveolar mucosa, and skin of chin and lower lip. On the mandibular lateral surface, the MF typically measures 4.6 mm horizontally and 3.4 mm vertically. MF is found below the first deciduous molar moves into a position above the mylohyoid

line following the second dentition. The mental foramen is typically described in most studies and textbooks as being either exactly beneath the second premolar's apex or between the 1st and 2nd premolars. When mandibular teeth are missing or lost, the surrounding alveolar bone experiences resorption to differing degrees, potentially affecting the mental foramen position. These differences are influenced by factors like age, sex, and dental status. Knowing the precise position of the MF is necessary for many dental operations, including regional anesthesia administration, periapical surgery, implant placement, and endodontic treatments. The location of mandibular foramen in topography has received more interest among dentists because of the developments in implant dentistry, particularly in edentulous and partially tooth-bearing individuals. Its oblique position between the mesiodistal and infero-superior planes makes detection on periapical radiographs highly complex. Due to this positioning, overlapping anatomical structures are usually the end result rendering it hard to get good view. Proper detection for thorough evaluation and diagnosis is best achieved through advanced imaging procedures or multiple radiographic views. Mental foramen (MF) has been accurately identified with a range of methods like computed tomography (CT), cone-beam computed tomography (CBCT), magnetic resonance imaging (MRI), dissection of cadavers, and panoramic and periapical radiography. However some of them have limitations such as high expense, injury to the site of surgery, and risk of radiation.¹ Therefore, panoramic radiography is the best imaging technique to evaluate the MF since it allows for more precise localization in both horizontal and vertical planes.¹⁰ This imaging process is quicker and requires less patient cooperation compared to intraoral radiographs. This also makes it a preferred choice, particularly for patients with gag reflexes or limited mouth opening. Since

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there is no need for intraoral film or sensor placement, patients generally find the procedure more comfortable. This also allows for a comprehensive evaluation of dental and surrounding structures, including the temporomandibular joints, sinuses, and bone. Since the MF lacks definitive anatomical landmarks for precise identification and cannot be clinically visualized or palpated, dental surgeons must have a thorough understanding of its location.

Objective:

To examine the MF's most frequently seen placement and using panoramic radiographs to ascertain whether patients visiting the outpatient department at Hamdard University Dental Hospital have a significant difference in measurements between their right and left sides.

Methodology:

This cross-sectional retrospective study was conducted at Radiology section of Department of Oral & Maxillofacial Surgery at Hamdard University Dental Hospital, Karachi. After getting approval from ERB (vide HCM&D/2458/2022 dated 4th October 2022) data collected between October 22 to April 2023 by using nonprobability convenient sampling. Considering pertinent research, 16 a sample size was determined using Openepi software version 3, at a confidence level of 95%, a margin of error of 5%, and a study power of 80%. The total sample size was determined to be 900, but it was raised to 1192 to improve validity. All OPG were taken by CRANEX D digital x-ray unit # 203371 version 3 with power frequency 50/60 Hz and magnetic field IEC 61000-4-11 as reported by the manufacture. SCANORA 5.2.6 Software was used for imaging. Time of exposure was approximately 11 sec with resolution of 1.34 DPI. The following inclusion criteria was strictly followed.

- Excellent quality radiographs regarding angulation and contrast.
- OPGs of patients in the age range 15-65 years.
- OPGs of both genders.
- Fully erupted permanent teeth.
- OPGs exposed in the Radiology department of Hamdard University Dental Hospital.

Evaluation of OPGs:

After an initial screening, we evaluated 1294 OPG scans out of which 1192 OPGs met the inclusion criteria and were selected for analysis. The lead investigator examined all chosen radiographs, while a random sample of 10 was re-assessed by a collaborating investigator to improve interobserver consistency.

The MF position on each panoramic radiograph was categorized according to Tebo and Telford's classification, , that highlights the anterior-posterior position in relation to the mandibular premolars. (P=Position, Fig 1)

P 1: The MF is located Infront of the 1st premolar.

P 2: The MF is located below the 1st premolar.

P 3: The MF is located among the 1st and 2nd premolars.

P 4: The MF is located below the 2nd premolar.

P 5: The MF is situated behind the 2nd premolar.

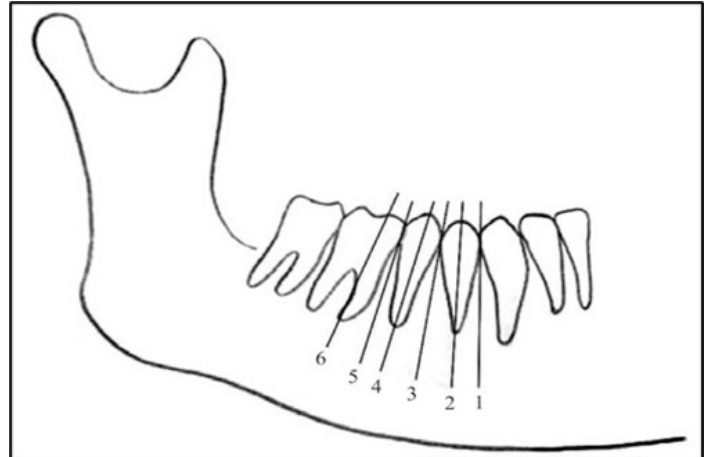
P 6: Below the apex of the 1st molar.

Statistical Analysis:

Data Presentation: Qualitative data, such as the different places of the mental foramen (MF) observed on the OPGs, were presented as frequencies and Percentages to provide an overview of the distribution within the population, while to assess potential differences in MF position between genders and across the both sides of the mandible, Pearson's chi-square test (significance level of 5%, $p < 0.05$) was applied. This test was suitable for examining associations between categorical variables, such as gender and

MF location.

Fig No 1:Position of the mental foramen in the anterior-posterior plane concerning the lower teeth



Results:

During period of study, 1294 digital panoramic radiographs (OPG) were assessed, with 1192 radiographs meeting the inclusion criteria. The age of the participants ranged from 15 to 65 years. The gender distribution indicated a higher number of females, with males totaling $n=512$ (43%) and females totaling $n=680$ (57%). The average age of the patients was 34 years $SD \pm 13.648$. The 34% population frequency observed in the age group of 15-25 years indicates a young demographic, as illustrated in table 1.

Table No 1: Frequency of mental foramen according to age.

Age Group	Frequency	%
15-25	412	34
26-35	394	33
36-45	147	12
46-55	120	10
56-65	119	10
Total	1192	99
Mean		34.23805532
SD±		13.67486771

The position most frequently observed concerning the apices of the teeth in the study from the panoramic radiograph was at P4 (50%), followed by P3 (26%) on the left side. On the right side, the most frequently observed position in relation to the apices of the teeth was at P4 (53%), followed by P3 (23%). The connection between both parties was determined to be significant with $p=.0001$ as shown in table 2.

When the mental foramen location was compared in genders, the common position was found to be at P4 ($n=607$) on right side and ($n=636$) on left side followed by P3 but no significant association ($p=0.291$) was seen among genders (table 3).

When the mental foramen position was analyzed with age groups the common the highest numbers ($n=636$) was found on position 4 with maximum number of populations on both side of mandible and between the age of 15-35 years of age (table 4)

Table No 2: Frequency of mental foramen according to position and assessment of symmetry

Position	Left mental foramen		Right Mental foramen		P value
	Frequency	%	Frequency	%	
P1	31	2.59	26	2.17	.0001
P2	73	6.11	74	6.19	
P3	314	26.29	286	23.95	
P4	607	50.83	636	53.26	
P5	85	7.11	84	7.035	
P6	82	6.86	86	7.20	
Total	1192	99.83	1192	99.83	

Table No 3. Frequencies of location of mental Foramina in relation to gender

		Right Side		Total	Left Side		Total	P-Value
		Gender			Gender			
		Male	Female		Male	Female		
Mental fora- men	P1	18	13	31	13	13	26	0.291
	P2	27	46	73	29	45	74	
	P3	143	171	314	129	157	286	
	P4	255	352	607	265	371	636	
	P5	32	53	85	35	49	84	
	P6	37	45	82	41	45	86	
Total		512	680	1192	512	680	1192	

Table No 4. Location of mental foramen according to age groups

Mental foramen Right Side							
Age groups	P1	P2	P3	P4	P5	P6	Total
15-25	11	21	98	218	40	23	411
26-35	9	29	90	214	18	34	394
36-45	1	10	40	82	7	6	146
46-55	3	8	34	58	7	11	121
56-65	2	6	24	64	12	11	119
Total	26	74	286	636	84	85	1191
Mental foramen Left Side							
15-25	11	24	108	205	40	23	411
26-35	14	27	102	204	20	27	394
36-45	1	10	44	77	8	6	146
46-55	3	5	30	67	6	10	121
56-65	2	7	30	53	11	16	119
Total	31	73	314	606	85	82	1191

Discussion:

Over the past three decades, panoramic radiographs have gained a lot of popularity due to their numerous advantages over intraoral radiography. These advantages include the continuity of the visible region, the wide coverage of both soft and hard tissues, and the speed at which the radiographic image is produced. This imaging method has been very helpful in the clinical assessment and study of the mental foramen (MF), a significant mandibular anatomical feature. 16 The MF assumes a relatively constant position for surgeons doing various mandibular surgeries

because of its stiffness in relation to the surrounding tissues. 17 OPG is a low-cost, non-invasive imaging method for assessing the location of the MF and the surrounding structure. 18 By using panoramic radiographs, it is possible to avoid harming the neurovascular bundles that emerge from the MF. Neurotmesis (complete nerve discontinuity), neuropraxia (transient nerve conduction block), and sensory abnormalities like the "numb chin sign" might result from injury to this bundle. These complications highlight the importance of precise surgical planning and preoperative imaging. 19

The mental foramen (MF) has different physical locations in different groups, which are usually determined by genetic and anatomical factors. The MF is normally situated between the apexes of the first and second premolars, according to conventional anatomical references. Nevertheless, research has indicated that this stance is not universal and may vary among genders and ethnic groups.²⁰ The MF was most commonly observed below the apex of the second premolar in the current study, with higher frequencies in females (51%; n = 352) than in males (44%; n = 255). The following spot was noted between the first and second premolar apices. Fascinatingly, studies by Fatima S.14 and the Nepalese population²¹ showed that the MF was most commonly seen in first and second premolars. This implies that there are population-specific variations, most likely brought about by variations in dental occlusion and craniofacial structure.⁸ Similar results have been documented by comparative research across populations. The MF was most commonly found between or in line with the first and second premolars in the Malay²² and UK²¹ populations. The position below the apex of the second premolar was common among Saudi²³, Indian^{5,6,24}, UK-based²⁵, Singaporean²⁶, and Serbian²⁷ populations. This is consistent with the results of the current study, which showed that the most common location was on the right at 58.67% and on the left at 64%.

The MF's position in the current study was symmetrical on both sides of the jaw, with both genders most frequently occupying the position at P4. Saudi populations likewise exhibited this symmetry and stability.²⁸ Additionally, the study found no evidence of a significant correlation between age and the MF's position. Although this trend was not seen in Polish populations²⁹ or the current study, reports indicate that the MF's status may deteriorate in some populations as people age. These results highlight how important it is to take population-specific anatomical variances into account when performing dental and maxillofacial operations. This knowledge ensures that surgical techniques are optimized to minimize the danger of nerve damage and improve procedural results. The new study further emphasizes how crucial it is to supplement panoramic radiography³⁰ with high-tech imaging techniques like cone-beam computed tomography (CBCT).

These findings are corroborated by recent research. One study in the *Journal of Oral Rehabilitation*³¹, as well as several others, emphasized the significance of CBCT in determining the MF's three-dimensional position, particularly in individuals with anatomical abnormalities or unique presentation, such as uneven bite spacing. Another study published in the *international journal of oral and maxillofacial surgery*³² found that CBCT scans significantly reduced the number of nerve-related problems after implant insertion. These changes make it necessary for clinicians to include high-resolution imaging technologies into their treatment and diagnostic practices.³³

Population studies have enriched our understanding of the MF's variability. For example, a study of Chinese and Caucasian populations³⁴ discovered differences in the MF's position and organization that were linked to craniofacial morphology and dental systems. Similarly, studies on the South African and Nigerian populations have emphasized different morphology and dental occlusal systems. Similarly, studies on South African and Nigerian populations identified unique trends in MF location, emphasizing the importance of ethnicity and heredity. These findings empha-

size the importance of individualized treatment planning based on a thorough understanding of patient anatomy.

Conclusion:

Practitioners doing procedures must be able to accurately identify the location of the mental foramen. This is critical to preventing nerve damage and facilitating adequate anesthesia, regardless of the patient's racial or ethnic background. The inconsistent position of the mental foramen emphasizes the importance of pre-surgical imaging (e.g., panoramic radiography or CBCT) or palpation to determine its placement. In our study, the most common site of the mental foramen in men and women aged 15 to 35 was P4. Our findings also revealed that the site of the mental foramen is symmetrical on both sides of the mandible. When considering implant implantation operations in the mandibular bicuspid region, take care to note the position of the mental foramen. Furthermore, it is advised that the current study, if performed on updated diagnostic instruments (CBCT), can produce improved and precise results on this issue, with more attention on the size of the foramen and vertical dimension of the foramen, which can be compared across all genders and age groups.

Limitation of the Study:

The current study admits some limitations. While panoramic radiography gives useful information, it may not capture the entire intricacy of the MF's anatomy. The use of CBCT could have provided more exact data, notably about the MF's vertical dimension and size. Furthermore, the study's sample size and demographic diversity were confined, which may limit the application of the findings. To build on these findings, future study should include larger and more diverse populations, as well as better imaging techniques. By overcoming these constraints, researchers can improve our understanding of the mental foramen and its clinical implications.

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Author's contribution

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Haifa Saqib Baqai,	Data collection/ grammatical revision
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