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Assessment of Mental Foramen Position by Orthopantomogram Dental Radiograph in an Iraqi Population: A Retrospective Study

Radhwan Abdul-Kareem[1], Athraa A. Abass[2]*

[1]*Oral and Maxillofacial Surgery Department, College of Dentistry, Ahl Al Bayt University, Kerbala, Iraq*
[*2]*Orthodontic Department, College of Dentistry, University of Kerbala, Kerbala, Iraq*
Correspondence: *athraa.a@uokerbala.edu.iq*
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ABSTRACT

OBJECTIVE: To evaluate the horizontal and vertical positions of the mental foramen (MF) in relation to mandibular premolars (first and second premolars) in an Iraqi population and to evaluate potential gender-related differences using orthopantomographic (OPG) radiographs.

METHODOLOGY: A retrospective cross-sectional study was conducted on 200 high-quality digital OPGs (100 males, 100 females) through systematic random sampling from the Department of Dentistry, Ahl Al Bayt University College, Kerbala, Iraq. The mental foramen was evaluated bilaterally. The MF positions were classified horizontally and vertically. Chi-square and Fisher's exact tests were used for data analysis, with $p< 0.05$ considered statistically significant.

RESULTS: The MF was frequently located in line with the second premolar horizontally (48.5%) and at the level of its apex vertically (50%). The second most common position was between the apices of the first and the second premolars. No statistically significant differences were observed between males and females in either horizontal ($p = 0.71$) or vertical ($p = 0.64$) positions of the MF.

CONCLUSION: This study provides anatomical reference data for the MF position in an Iraqi population, confirming its value as a reliable surgical and anesthetic landmark. These findings may help improve the accuracy of mental nerve block administration, implant placement, and surgical interventions in the mandibular premolar region. Future multi-centre studies with larger samples and Cone Beam Computed Tomography (CBCT) imaging are recommended to validate these findings.

KEYWORDS: Mental Foramen; Mandible; Panoramic Radiography; Anatomy; Iraq; Retrospective Studies.

INTRODUCTION

The mental foramen (MF) is a bilateral anatomical opening located on the external surface of the mandible. It transmits the mental nerve, a terminal branch of the inferior alveolar nerve, together with accompanying blood vessels. These structures provide sensory innervation to the lower lip, chin, labial mucosa, and mandibular anterior and premolar teeth[1]. Accurate localization of the MF is essential in dental practice because its position directly influences the success of local anesthesia, implant placement, endodontic treatment, and surgical procedures in the mandibular premolar region[2,3].

Previous studies have shown considerable variation in the position of the MF among different populations. A previous review also emphasized the clinical and anatomical variability of the MF and its importance in dental and maxillofacial procedures[4]. These variations may be influenced by ethnicity, sex, age, and craniofacial morphology[5,6]. Several radiographic and anatomical studies in Indian populations have reported that the MF is most commonly located in line with the mandibular second premolar[7-9]. Similar findings have also been reported in Saudi Arabian populations[10]. In contrast, studies in Tanzanian populations have shown that the MF is more frequently located between the first and second premolars[11]. Studies assessed the mental foramen position horizontally and vertically[12], while CBCT-based studies have further demonstrated variability in MF position across different populations, reflecting ethnic and anatomical differences[13].

Vertical positioning of the MF also shows variability. Some studies have reported alignment with the apex of the mandibular second premolar, while others have described a position slightly below the apex[6,12,13]. These variations highlight the importance of population-specific anatomical reference data to improve the safety and accuracy of clinical dental procedures.

Although many studies have evaluated MF position in different populations, data regarding the Iraqi population remain limited. Previous Iraqi anatomical studies have mainly focused on other mandibular structures rather than the MF itself[14,15]. Therefore, establishing population-specific reference data is important to enhance the accuracy of local anesthesia, reduce surgical complications, and support implant planning.

Therefore, the present study aimed to evaluate the horizontal and vertical positions of the MF in relation to the mandibular premolars using orthopantomographic radiographs in an Iraqi population and to investigate possible sex-related differences. To the best of our knowledge, this study represents one of the few population-based investigations of MF position conducted in Iraq. It provides clinically relevant anatomical reference data for dental practitioners.

METHODOLOGY

This retrospective cross-sectional study used digital panoramic radiographs from the Department of Oral and Maxillofacial Radiology, College of Dentistry, University of Ahl Al Bayt. The Dental Ethics Committee provided ethical approval (Approval No.: M5/57; Date: September 14, 2025). All participants were informed about the study's objectives and procedures, and were given a consent form. The study followed the Declaration of Helsinki and appropriate national legislation.

The Oral and Maxillofacial Radiology archive contains approximately 200 digital panoramic radiographs obtained between January 1, 2022, and June 30, 2023.

Following the application of inclusion and exclusion criteria, 200 digital panoramic radiographs in total were chosen by systematic random sampling, which involved choosing every kth radiograph until the desired sample size was attained. Assuming $p = 0.5$, the sample size was determined to be approximately 196 to estimate the prevalence of MF positions with a 7% margin of error at a 95% confidence level. To account for possible exclusions and guarantee sufficient precision, the sample size was expanded to 200 (100 males and 100 females).

The study's inclusion criteria were patients over the age of eighteen, with fully erupted mandibular premolars and molars, and high-quality digital panoramic radiographs free of distortion or artefacts.

The exclusion criteria in this study included patients with pathological lesions, developmental anomalies, mandibular bone fractures, a history of orthodontic or orthognathic treatment in the mandibular region, and suboptimal image quality of digital radiographs with indistinct anatomical landmarks.

All radiographs were obtained utilizing a standardized digital panoramic system (Planmeca ProMax®, Helsinki, Finland), with exposure settings of 66–70 kVp, 8–10 mA, and an exposure duration of 13–16 seconds.

The MF was measured on both sides; each panoramic radiograph contributed two observations (right and left mental foramina). Therefore, a total of 400 mental foramina (200 from males and 200 from females) were included in the positional analysis, and their location was classified as horizontal and vertical according to standard rules.

Two experienced oral radiologists independently evaluated all images. In case of disagreement, we reached consensus through discussion. Intra- and inter-examiner reliability was assessed by re-evaluating 20 randomly selected radiographs after a two-week interval. Agreement was quantified using Cohen's kappa (weighted kappa for ordinal variables) with 95% confidence intervals.

Data were analyzed using SPSS software (version 25.0, IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies and percentages) were calculated based on the total number of mental foramina ($n = 400$). Male and female percentages were calculated using 200 mental foramina for each sex. Chi-square tests were used to evaluate gender-related differences, and the level of statistical significance was set at $p < 0.05$.

RESULTS

A total of 200 panoramic radiographs (100 males and 100 females) met the inclusion criteria. They were included in the analysis because the mental foramen was evaluated bilaterally; a total of 400 mental foramina were included in the positional analysis.
. Horizontally, the MF was most frequently located in line with the second premolar (46.8%), followed by between the first and second premolars (30.5). Less common positions included between the second premolar and first molar (13.0%), in line with the first premolar (4.8%), in line with the first molar (2.8%), and anterior to the first premolar (2.3%). No statistically significant difference was observed between males and females regarding horizontal MF position (p = 0.71), as seen in **Table I** and **Figure 1.**

Table I: Distribution of mental foramen horizontal position among males and females with corresponding p-values (Chi-square test)

Position	Males n (%)	Females n (%)	Total n (%)	p-value
Anterior to the first premolar	4 (2.0)	5 (2.5)	9 (2.3)	
In line with the first premolar	11 (5.5)	8 (4.0)	19 (4.8)	
Between the first and second premolars	62 (31.0)	60 (30.0)	122 (30.5)	
In line with the second premolars	97 (48.5)	90 (45.0)	187 (46.8)	
Between the second premolar and first molar	22 (11.0)	30 (15.0)	52 (13.0)	
In line with the first molar	4 (2.0)	7 (3.5)	11 (2.8)	**0.71**

A chi-square test was applied; no statistically significant difference was found between males and females (p > 0.05).

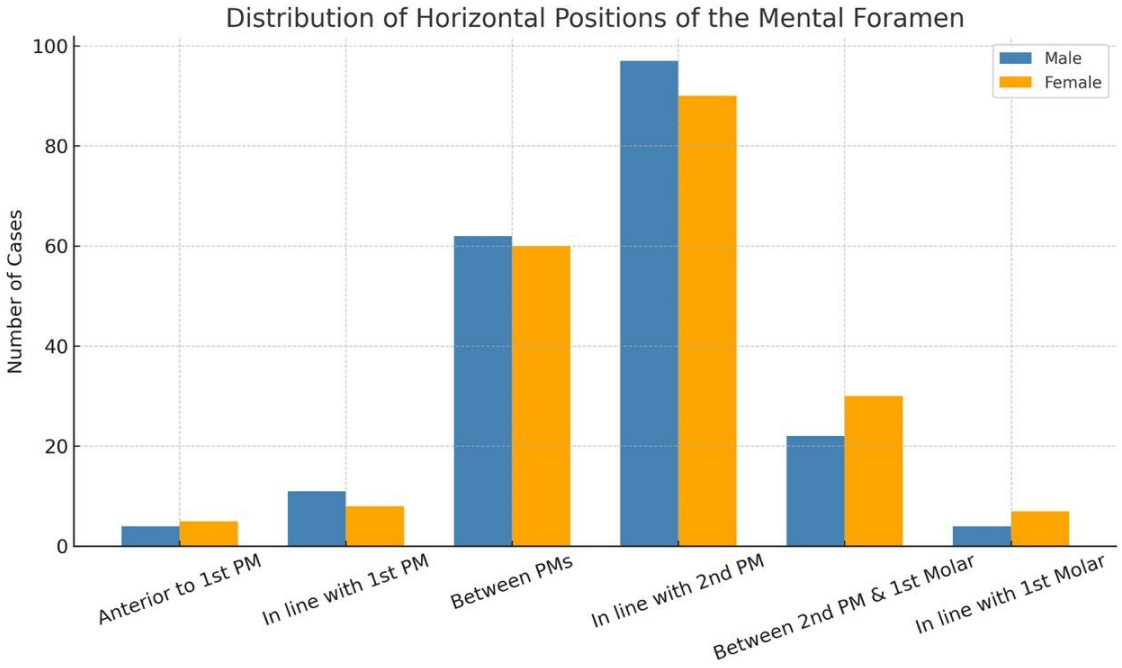


Figure 1: Distribution of mental foramen horizontal positions among males and females.

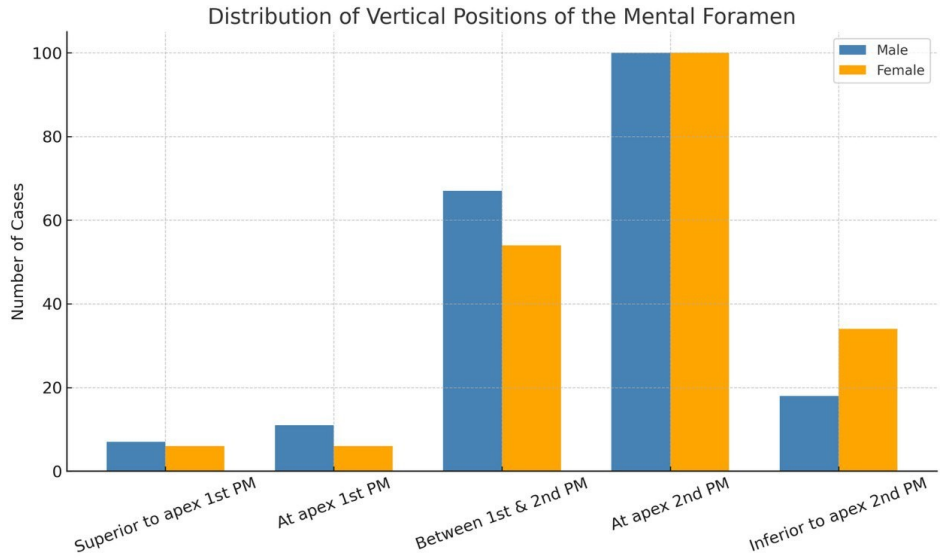
Vertically, the MF was most frequently observed at the level of the second premolar apex (50%;), followed by between the apices of the first and second premolars (28.0%), inferior to the apex of the second premolar (13%), at the apex of the first premolar (4.3%), and superior to the apex of the first premolar (3.3%). No statistically significant sex-based differences were detected in vertical MF position (p = 0.64), as seen in **Table II** and **Figure 2**.

Table II: Distribution of mental foramen vertical position among males and females with corresponding p-values (Chi-square test)

Position	Males n(%)	Females n(%)	Total n(%)	P-value
Superior to the apex of the first premolar	7 (3.5)	6 (3.0)	13 (3.3)	
At/in line with the apex of the first premolar	11 (5.5)	6 (3.0)	17 (4.3)	
Between the apices of the first and second premolars	67 (33.5)	45 (22.5).	112 (28.0)	
At/ in line with the apex of the second premolar	100 (50.0)	100 (50.0)	200 (50.0)	
Inferior to the apex of the second premolar	18 (9.0)	34 (17.0)	52 (13.0)	**0.64**

A chi-square test was applied; no statistically significant difference was found between males and females (p > 0.05).

Note: Each panoramic radiograph contributed two observations (right and left mental foramina). Therefore, percentages in the Total column were calculated based on 400 mental foramina, whereas male and female percentages were calculated based on 200 mental foramina for each sex.



MF- Mental foramen, 1st PM- First premolar of the mandible, 2nd PM- Second premolar of the mandible

Figure 2: Distribution of mental foramen vertical positions among males and females

DISCUSSION

The mental foramen (MF) is a key anatomical landmark in dental and maxillofacial practice and is essential for procedures such as local anesthesia, implant placement, periapical surgery, and trauma management. Precise localization of the MF is necessary to avoid neurovascular injury and improve procedural safety and patient outcomes. To the best of our knowledge, this study is the first to provide population-specific reference data regarding the position of the MF in an Iraqi population using orthopantomographic radiographs, thereby filling an important gap in regional anatomical data, despite the availability of several studies addressing other mandibular anatomical features in Iraqi populations[14,15].

In the current study, the MF was most frequently located horizontally in line with the mandibular second premolar and vertically at the level of its apex. These findings are consistent with previous radiographic and anatomical studies conducted in different populations. Similar findings have been reported in Indian and Saudi Arabian populations, where the mandibular second premolar was identified as the most common reference point for MF localization[7,10,12]. The similarity among these populations may reflect shared craniofacial characteristics and anatomical patterns. Conversely, studies in Tanzanian populations showed a higher prevalence of the MF being located between the first and second mandibular premolars[11]. Other investigations have also shown slight positional variations depending on ethnicity and population characteristics[14,16]. This variability highlights the influence of ethnic, genetic, and functional factors, including dietary habits, masticatory muscle activity, and craniofacial morphology, on MF positioning.

Regarding vertical positioning, the present findings demonstrated that the MF was most commonly aligned with the apex of the mandibular second premolar, in agreement with previous studies conducted in Iranian and Indian subjects[6,12]. However, some CBCT-based investigations have reported the MF to be located slightly below the apex[1,16-18]. Differences between CBCT and orthopantomographic imaging modalities may partly explain this discrepancy due to variations in image magnification and geometric distortion [1,18]. CBCT provides three-dimensional imaging with minimal distortion, whereas orthopantomographic radiographs are two-dimensional and more susceptible to magnification errors. Nevertheless, orthopantomographic radiography remains widely used in routine dental practice because of its accessibility, lower radiation dose, and cost-effectiveness, making the present findings clinically relevant for dental practitioners in Iraq.

Despite these limitations, the present study provides clinically relevant baseline reference data for Iraqi dentists and oral healthcare professionals.

No statistically significant gender-related differences were observed in either the horizontal or vertical position of the MF. These findings support the relative consistency of MF positioning across genders. Similar observations have been reported in several previous studies demonstrating minimal or no sexual dimorphism in MF localization[2,5,10,19]. Minor variations reported in other populations may reflect differences in mandibular size rather than true anatomical divergence. The findings of the present study are also consistent with those reported by Sheth K 2022[16] in an Indian sub-

population, in which the MF was most frequently located in line with the mandibular second premolar.

The findings of this study provide valuable reference data for the safe administration of mental and inferior alveolar nerve blocks, implant planning, and periapical surgical procedures in the mandibular premolar region. Accurate knowledge of MF localization reduces the risk of nerve injury, paresthesia, and anesthetic failure. Since orthopantomographic radiography is the most accessible imaging modality in Iraqi dental practice, these findings have important clinical implications for daily clinical practice.

This study has several limitations. Age-related differences and right–left symmetry were not evaluated, and the sample was obtained from a single center, which may limit the generalizability of the findings. In addition, digital panoramic radiographs provide only a two-dimensional assessment and may not fully capture the anatomical variability of the MF. Future multicenter studies using CBCT with larger, more diverse samples are recommended to validate and refine these findings and establish a more comprehensive anatomical reference for the Iraqi population.

CONCLUSION

This study provides the first anatomical reference data for the Iraqi population regarding the position of the mental foramen. The mental foramen was most frequently found horizontally aligned with the mandibular second premolar and vertically positioned at the apex of the tooth, with no notable differences between sexes. These findings validate the mental foramen as a reference anatomical marker and endorse its application to develop the localization of local anesthesia, implant placement, and surgical interventions in the mandibular premolar region. Further studies using CBCT and larger sample sizes from more than one centre are needed to reinforce these population-specific observations.

Ethical permission: College of Dentistry, University of Kerbala, Iraq, Dental Ethics Committee ERC approval letter No. M5/57. Written informed consent was obtained from all participants.
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Data Sharing Statement: The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions prevented us from sharing the data publicly.

AUTHOR CONTRIBUTION

Abdul-Kareem R: Contributed to data acquisition and analysis, collecting data from the College of Dentistry at Ahl al-Bayt University.
Abass AA: Prepared the manuscript, checked the accuracy of information, including data, collected the panoramic radiographs, and wrote the references.

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