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# Radiographic assessment of variability in position of mental foramen in relation to gender and age in local population of Punjab

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## ABSTRACT

**Background and Objective:** Accurate identification of the mental foramen position is crucial for clinicians to prevent nerve injury and improve the safety of dental procedures. The study aims to evaluate the positional variability of the mental foramen (MF) in the mandible, and its comparison with age, side of the jaw and gender.

**Methods:** This cross-sectional study was performed at the 'Oral and Maxillofacial Surgery Department' of Combined Military Hospital (CMH) Lahore, Pakistan, from October 5, 2023, to April 10, 2024. A total of 190 patients over the age of 18 with complete skeletal development were selected using purposive non-probability sampling. 'Cone-Beam Computed Tomography' (CBCT) scans were utilised to measure the closeness of the MF to the alveolar crest and the mandible's lower edge. An independent sample *t*-test was employed to determine differences based on age, gender and jaw side.

**Results:** The study revealed significant gender differences in MF positioning. Males had larger mean distances from the alveolar crest (9.35 ± 5.06 mm) and lower border of the mandible (15.05 ± 5.06 mm) to the MF compared to females, who measured 6.07 ± 3.36 mm and 11.77 ± 3.36 mm, respectively ($p < 0.001$). Age differences were significant only for the distance from the alveolar crest, with younger individuals (18-30 years) showing greater distances than older individuals (31-45 years) ($p = 0.009$). No statistically significant difference was reported between the right and the left sides ($p = 0.13$).

**Conclusion:** There was a significant gender-based variation in the anatomical positioning of the MF with males exhibiting greater distances from both the alveolar crest and the lower border of the mandible. The utility of CBCT imaging in facilitating precise localisation of the MF and contributing to safer surgical planning is invaluable.

**Keywords:** Anatomical variation, cone-beam computed tomography, mental foramen, gender, age.

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## Introduction

The mental foramen (MF) is a crucial anatomical structure in the mandible. It serves as the exit point for the mental nerve, a part of the mandibular nerve, associated with the sensations of the lower lip, facial vestibule, proximal gingiva of the mandibular first molar and the dermal sensation of the chin.[1,2] Meanwhile, the incisive nerve continues within the mandible, innervating the incisors, canines and premolar regions.[3]

Typically, the MF undergoes remodeling throughout life due to various factors, leading to changes in its position with age and these morphological alterations can be easily accessed through 3 dimensional (3D) radiographs.[4] Occasionally, small accessory foramina, known as accessory mental foramina, are present near the MF.[2] The presence of terminal tributaries of the mandibular nerve within the MF highlights its clinical significance in dentistry, particularly in procedures involving 'mental nerve block', 'apical surgery', 'implant therapy' and 'osteotomy treatments'.[5]

Surgical interventions in the lower premolar and molar areas, such as osteotomies and implant placements, pose risks to the mental neurovascular bundle, potentially leading to temporary or permanent sensory abnormalities in the related soft tissues. Accurate identification of the MF is essential to avoid complications during these procedures.[2,6] However, traditional two-dimensional panoramic radiography may not always provide a clear distinction of the MF due to geometric distortions, anatomical variations or the presence of superimposed structures.[7]

Previous studies have documented variations when it comes to the closeness of the MF and the inferior boundary of the jaw among different populations.[2,8,9] For instance, an Egyptian study reported an average distance of 10.0 mm and 10.55 mm for males and females, respectively.[10] Across different time periods, the MF was chiefly found in between the lower second and the lower first premolars. The position remained consistent across various historical groups.[11] In a selected Indian population, 43% of MF were reportedly positioned between the second and the first premolars, and 39% were aligned with the second premolars. There was no significant variation in position with age or gender.[12] The position of MF varies with age, showing a tendency to move posteriorly in older individuals.[13] A study in Switzerland found the superior margin of the MF to be approximately 12 mm above the inferior-border of the mandibular or jaw, and with the lower margin around 3 mm above the mandibular inferior bordary.[8] A study in the Belarusian population found the average distance from the MF to the lower margin of the mandible to be 13.5 mm in men and 12.4 mm in the other gender, i.e., females. Such differences underscore the need for tailored approaches in dental procedures to minimise complications.[10] These findings emphasise the variability in MF positioning across different populations and the importance of region-specific data.

The mental foramen's anatomical variations and its clinical significance necessitate accurate identification and assessment in dental procedures. 'Cone beam computed tomography' (CBCT) has surfaced as a crucial imaging modality, providing detailed 3D images that enhance diagnostic accuracy and treatment planning.[14] The variations in the MF's location among different populations aid in tailoring clinical approaches to minimise complications and improve patient outcomes.[15]

The present study aimed to evaluate the positional variability of the mental foramen using CBCT and to assess its association with gender, age and jaw side to enhance anatomical understanding and clinical decision-making in dental procedures.

## Methods

This study, having an observational cross-sectional design, aims to determine the mean closeness of the MF from the alveolar crestal bone of the jaw as well as the inferior border of the mandibular bone, using a CBCT analysis. The research was performed at the 'Oral and Maxillofacial Surgery Department' of CMH Lahore Medical College from October 5, 2023, to April 10, 2024.

The sample size consisted of 190 cases, determined using a 95% confidence level and an absolute precision ($\alpha$ = 0.05), based on previous data showing a mean distance from the superior margin as 12.6 ± 3.8 mm.[8] Participants were recruited using a purposive sampling technique. The inclusion criteria encompassed individuals over the age of 18 with completed skeletal development, as well as patients who were partially or completely edentulous and had been advised to undergo CBCT for implant assessment as part of their treatment plan. Exclusion criteria included a history of orthodontic treatment, the presence of a pathology or disease in the region of MF, jawbone (including maxilla and mandible) fractures and low-resolution quality, faulty or damaged CBCT images.

Data collection and analysis were done by collecting CBCT scans of 190 patients meeting the inclusion and exclusion criteria. The CBCT image scans were obtained using the Villa Sistemi Medical Cone Beam Dental Panoramic unit maintaining uniform imaging parameters across all participants. Standardised patient positioning was followed, with the Frankfort horizontal plane aligned parallel to the floor to minimise variations in head tilt and angulation. The field of view, voxel size, exposure settings and scanning protocol were kept constant to enhance reproducibility and eliminate technical inconsistencies. Moreover, to minimise the operator-dependent variations, all CBCT scans were performed by a single experienced radiology technician. Observations focused on the number of MF on the right and the left sides. In cases where more than one foramen was located on either side, no further data were collected from those cases.

Measurements were recorded and included the distance calculated in millimeters from the upper border of the MF to the alveolar bone's crest, and from the inferior edge of the MF to the lower boundary of the mandible, including both the right and the left sides. Specific anatomical landmarks were used as reference points, and all measurements were taken by a single examiner to prevent inter-observer variability.

The research was conducted after the approval of the Institutional Review Board of the Institute of Dentistry CMH Lahore Medical College and informed consent was obtained from all the participants.

## Statistical analysis

The data were analysed using statistical software SPSS (version 23). Initially, the normality of the data was assessed using the 'Shapiro-Wilk' test. Frequencies and percentages were calculated for gender, while mean and standard deviation were computed for age, as well as the distance in millimeters from the alveolar crest, and the lower border of the mandible on both sides. The data were compared using an independent sample *t*-test, with a $p \leq 0.05$ considered statistically significant.

## Results

The data from the current study were normally distributed, as indicated by a Shapiro-Wilk test with a *p*-value of 0.243. The study sample comprised 190 individuals, including 77 females (40.53%) and 113 males (59.47%). The age distribution showed that the majority of participants (58.42%) fell within the 31-45 age group, while the remaining 41.58% were within the 18-30 age group. The mean age was 31.24 ± 8.58 years.

Moreover, the anatomical measurements revealed that the mean closeness (mm) from the MF to the alveolar bone's crest was 8.03 ± 4.72 mm. Moreover, the closeness of MF from the lower border of the mandible was reportedly 13.73 ± 4.72 mm.

A significant gender difference was reportedly found when it came to the closeness of MF from the alveolar-crest and the lower border of the mandible. Specifically, males exhibited a mean distance of 9.35 ± 5.06 mm from the alveolar crest to the MF, significantly greater than the 6.07 ± 3.36 mm observed in females ($p < 0.001$).

Correspondingly, the distance from the inferior boundary of the mandibular bone to the MF was 15.05 ± 5.06 mm in males, compared to 11.77 ± 3.36 mm in females, with this difference also being statistically significant ($p < 0.001$).

Age-related analysis reported that the mean closeness from the crest of the alveolar bone to the MF was significantly greater in the 18-30 years age group (8.99 ± 4.60 mm) compared to the 31-45 years age group (7.21 ± 4.69 mm), with a *p*-value of 0.009. However, there was no statistically significant difference in the mean distance or closeness from the lower edge of the mandible to the MF between the two age groups, indicating that this distance remains relatively stable with age.

The study found no statistically significant association in the positioning of the MF, when comparing the sides of the jaw. (Table-1)

**Discussion**

The importance of accurately locating the MF in dental procedures cannot be overstated, as it is crucial for avoiding complications during surgeries such as implant placement and root canal treatments.[8]

The present study indicated significant gender differences in the mean closeness of the MF from the alveolar crest of the bone and from the lower boundary of the mandible. Males exhibit larger mean distances compared to females.[15] Similarly, the distance from the mandible's lower border to the MF was around 15 mm in males and 11.7 mm in females in the present study. The findings of the current study align with the previous studies by Goyushov et al. [15] and Muinelo-Lorenzo et al. [16] and which have reported gender-based differences in MF positioning. Shankland [17] conducted a study indicating that the MF in males is generally positioned at a greater distance from the alveolar crest compared to females. Salsabilla et al. [18] in a previous study reported that the vertical position of MF, when measured from the lower boundary of the lower jaw, i.e., mandible, tends to be higher in male gender as compared to the females, which indicates that in females, the MF is in closer proximity to the mandible's lower border. Moreover, in some populations, such as the Indian and Thai, the MF position or location shows gender differences in both horizontal and vertical planes.[19,20] These differences underscore the significance of gender-related knowledge and factors and their impact in general dental

***Table 1.*** *Comparison of mental foramen position by age, gender and jaw side using CBCT.*

| Characteristic | Demographics | | Distance Mean±SD | *p*-value |
|---|---|---|---|---|
| Distance from alveolar crest to MF (mm) | Age | 18-30 years | 8.99 ± 4.60 | 0.009 |
| | | 31-45 years | 7.21 ± 4.69 | |
| | Gender | Male | 9.35 ± 5.06 | <0.001 |
| | | Female | 6.07 ± 3.36 | |
| | Side | Left | 8.63 ± 4.40 | 0.130 |
| | | Right | 7.60 ± 4.91 | |
| Distance from lower border to MF (mm) | Age | 18-30 years | 13.50 ± 4.54 | 0.500 |
| | | 31-45 years | 13.93 ± 4.90 | |
| | Gender | Male | 15.05 ± 5.06 | <0.001 |
| | | Female | 11.77 ± 3.36 | |
| | Side | Left | 14.33 ± 4.40 | 0.135 |
| | | Right | 13.30 ± 4.91 | |

*p*-values were obtained using the independent sample *t*-test.

practice and surgical practices to ensure effective and safe clinical outcomes.

The age-related differences in the closeness of MF to the crest to the alveolar-bone in the lower jaw, reported that the younger individuals (18-30 years) were showing greater distances, which may indicate changes in mandibular anatomy with age.[21] However, the lack of significant differences in between age groups suggests that this measurement remains relatively stable with age. Some earlier studies have reported that age-related positional changes in the MF are due to continuous remodeling of the mandible over time. According to a study by Dehghani and Ghanea,[22] the MF tends to be located in between the premolars in younger individuals and shifts slightly posteriorly with age. It also moves closer to the alveolar crest as individual ages due to bone resorption.[22] In the Japanese male population, the direction of opening of mental foramen changes with age, moving superiorly until the early 50s and then inferiorly.[23] In the Indian population, the MF is positioned amid the premolars, with no statistically significant correlation between its position and age. However, the foramen shifts posteriorly with age.[24] Variations in the position of the MF can aid in forensic age estimation.[25] Moreover, knowledge of age-related positional changes of the MF is vital for avoiding nerve damage during dental and maxillofacial surgeries.[2]

The use of CBCT in this study showed promising results as being highly effective in identifying the MF with precision. CBCT's ability to provide three-dimensional images allowed for more accurate measurements compared to traditional two-dimensional imaging techniques such as panoramic radiographs, which often suffer from geometric distortions and superimpositions.[7] Previous literature has highlighted the limitations of 2D imaging in accurately locating the MF, emphasising the superior diagnostic capability of CBCT.[26] For example, Naitoh et al. [27] demonstrated the enhanced accuracy of CBCT over panoramic radiography in identifying the MF and its anatomical variations.

The findings of this study are significant for clinical practice, especially in planning dental implant placements and performing surgeries that involve the MF. The observed gender differences in MF positioning underscore the necessity for personalised treatment plans that consider anatomical variations. In males, the greater distances might require adjustments in surgical approaches to avoid injuring the neurovascular bundle emerging from the MF. Similarly, in females, the closer proximity of the MF to the crestal-bone in the lower-jaw necessitates careful surgical planning to prevent nerve injury.[28]

The lack of significant age-related differences in MF positioning suggests that age may not necessitate different clinical approaches. However, it remains important for clinicians to consider individual anatomical variations and use advanced imaging techniques like CBCT to ensure precision in diagnosis and treatment planning.[5,22]

The current study contributes to the knowledge of the anatomical variations of the MF, highlighting the importance of gender-specific considerations in dental procedures. The use of CBCT has proven to be a valuable tool in accurately locating the MF, thereby enhancing the safety and efficacy of dental treatments.[5] Future research is recommended to further explore the implications of these findings in clinical practice and investigate other elements, such as genetics and environmental factors, that may influence MF positioning.[29]

## Limitations of the study

This study has a few limitations like the sample size which although adequate for the scope of this research, is not representative of the broader population. Moreover, the cross-sectional design of this study limits the ability to ascertain causal relationship or observe changes in the MF positioning over time. These findings underscore the importance of individualised treatment approaches in dental practice, incorporating anatomical variations to optimise patient outcomes. Further research is recommended to explore additional factors influencing MF positioning and their clinical implications.

## Conclusion

There was a significant gender-based variation in the anatomical positioning of the MF with males exhibiting greater distances from both the alveolar crest and the lower border of the mandible. The diagnostic accuracy of CBCT imaging was evident, facilitating precise localisation of the MF and contributing to safer surgical planning.

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### List of abbreviations

| | |
|---|---|
| 2D | Two-dimensional |
| 3D | Three-dimensional |
| CBCT | Cone-beam computed tomography |
| CMH | Combined military hospital |
| IRB | Institutional review board |
| MF | Mental boramen |
| SPSS | Statistical Package for the Social Sciences |

### Conflict of interest

None to declare.

### Grant support and financial disclosure

None to disclose.

## Ethical approval

Ethical approval of the study was taken from the Institutional Review Board of Institute of Dentistry CMH Lahore Medical College, Lahore, Pakistan, vide Letter No: 640/ERC/CMH/LMC dated 6th Aug, 2023.

## Authors' Contributions

**MA:** Conception and design, drafting of the article, interpretation of data, statistical analysis, and critical intellectual input.

**AS, SG, and HH:** Conception and design, collection of data, drafting of article, and critical intellectual input.

**HH and AH** Data interpretation, statistical analysis, critical intellectual input, and drafting of manuscript.

**ALL AUTHORS:** Approval and responsibility of the final version of the manuscript to be published.

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