ORIGINAL ARTICLE

ANATOMICAL LOCALIZATION OF MENTUAL FORAMEN BY DIGITAL PANORAMIC RADIOGRAPHY OF THE FACE IN ADULTS

LOCALIZAÇÃO ANATÔMICA DO FORAME MENTUAL ATRAVÉS DE RADIOGRAFIA PANORÂMICA DIGITAL DE FACE EM ADULTOS

Danielle Cristiny Gonçalves Pereira[1], João Cesar Guimarães Henriques[2], Fabio Franceschini Mitri[3]

ABSTRACT

The mental foramen (MF) is a stable and constant anatomical landmark, located at the level of the root apices of the lower premolars (PMs), through which the mental nerve passes. Its clinical identification by palpation may be challenging; however, it is easily detected in imaging exams. The aim of this study was to identify, through digital panoramic radiographs (DPRs), the bilateral location of the MF in relation to the roots of the PMs. One hundred DPRs of adults were analyzed, and the MF position was bilaterally classified as follows: (I) anterior to the first PM, (II) at the first PM, (III) between the first and second PMs, (IV) at the second PM, and (V) posterior to the second PM. The results showed a higher prevalence in position III (49.5%), followed by positions IV (46.0%), II (2.5%), V (1.5%), and I (0.5%), with a predominance of bilateral symmetry (79.5%). Positions III and IV were also more frequent in mandibles with symmetry (25.3% and 22.8%, respectively) and in those with asymmetry of the foramina (42.9%). We conclude that the clinician's knowledge of the mandibular region between the PMs apices or at the level of the second PM ensures a safer clinical approach, increasing the effectiveness of anesthesia and reducing the risk of injury to the mental nerve. The side of the mandible is not a determining factor for the position of the MF.

Keywords: Mandible; Mental foramen; Location; Panoramic radiography.

RESUMO

O forame mentual (FM) é uma referência anatômica estável e constante, ao nível dos ápices radiculares de pré-molares (PM) inferiores, e nobre pela passagem do nervo mentual. A sua identificação clínica pode ser complexa através da palpação, mas facilmente identificada por meio de exames de imagem. O objetivo desta pesquisa foi identificar através de radiografias panorâmicas digitais (RPDs) a localização bilateral do FM em relação às raízes dos dentes PM. Foram observadas 100 RPDs de adultos e identificada a posição do FM bilateralmente, considerando as posições (I) anterior ao primeiro PM, (II) no primeiro PM, (III) entre primeiro e segundo PMs, (IV) no segundo PM e (V) posterior ao segundo PM. Os resultados revelaram uma maior prevalência na posição III (49,5%), seguida da IV (46,0%), II (2,5%), V (1,5%) e I (0,5%), com prevalência na simetria (79,5%). As posições III e IV também prevaleceram nas mandíbulas com simetria (respectivamente 25,3% e 22,8%) e com assimetria da localização dos forames (42,9%). Concluímos que o conhecimento do cirurgião-dentista sobre a região mandibular entre os ápices dos PMs ou ao nível do segundo PM torna a abordagem clínica segura, aumentando a efetividade de anestesia e diminuindo o risco de injúria ao nervo mentual. O lado da mandíbula não é um fator determinante para a posição do FM.

Palavras-chave: Mandíbula; Forame mentual; Localização; Radiografia panorâmica.

[1] School of Dentistry, Federal University of Uberlândia, Uberlândia, MG, Brazil.
[2] Department of Stomatological Diagnosis, School of Dentistry, Federal University of Uberlândia, Uberlândia, MG, Brazil.
[3] Department of Human Anatomy, Institute of Biomedical Sciences, Federal University of Uberlândia, Uberlândia, MG, Brazil.

How to cite this article: Pereira DCG, Henriques JCG, Mitri FF. Anatomical localization of mentual foramen by digital panoramic radiography of the face in adults. Nav Dent J. 2025;52(2):1-8.

Received: 03/31/2025
Accepted: 06/06/2025

DOI: https://doi.org/10.22491/1983-7550-52-2-01

INTRODUCTION

Mental foramen (MF) is a stable anatomical landmark in the mandible for dental anesthesia techniques or invasive and surgical procedures (1,2). However, repeated failures observed in the mental anesthetic block suggest variation in the location of this structure. The MF is a funnel-shaped opening of the mandibular canal on the lateral aspect of the mandible body and, anatomically, it is an eminent reference located in the apical premolar (PM) region, through which a neurovascular bundle containing the mental nerve emerges (3,4).

The MF location is usually described at the level of the apex of the lower PM, but it has also been described between the PMs or variably in the canine or mandibular second molar (5-9). There is evidence that the MF position may vary according to the ethnic group observed, but this is not a consensus in the anatomical literature (10-12). Clinical identification and palpation of MF are difficult because there is no anatomical structure available as a reference to guide us to accurate location (12). Failure to identify MF may result in trauma to the artery, vein, or mental nerve resulting in hematoma or post-anesthetic paresthesia of the lower lip and gingiva.

In dentistry, panoramic radiography is frequently used to provide an excellent overview of the maxillomandibular complex, in addition to being economically feasible and easy to perform and interpret. The image is substantially improved with the use of digital panoramic radiography (DPR) (13-16).

Therefore, this study aimed to identify, using DPRs, the bilateral location of MF in relation to the roots of PM teeth in adults. To this end, this investigation will provide parameters for the localization of MF in individuals, linking clinical practice with scientific evidence, contributing to the didactic teaching in facial anatomy and other clinical disciplines and to professional training, and updating protocols for clinical and surgical procedures in the mental region, aspects that will result in greater comfort and safety for the patient.

MATERIALS AND METHODS

This investigation is a retrospective analysis of the bilateral MF position in 100 DPRs, a number that is also recommended in other investigations, regardless of age and gender (5,16-19). The DPRs of adult individuals (18 to 59 years) were obtained using the Orthopantomograph OP 200 D Instrumentarium Dental at the Dental Hospital of the Faculdade de Odontologia, Universidade Federal de Uberlândia (FOUFU). Thus, considering 100 mandibles in DPRs, 200 MFs were analyzed bilaterally. No vertical analyses were performed.

Five MF positions were considered in relation to the root apex of the mandibular teeth (Figure 1): (I) Anterior to the first lower PM (1PM); (II) At the level of the root apex of the first lower PM (1PM); (III) Between the two lower PMs (1PM and 2PM); (IV) At the level of the second lower PM (2PM); and (V) Posterior to the second lower PM (2PM).

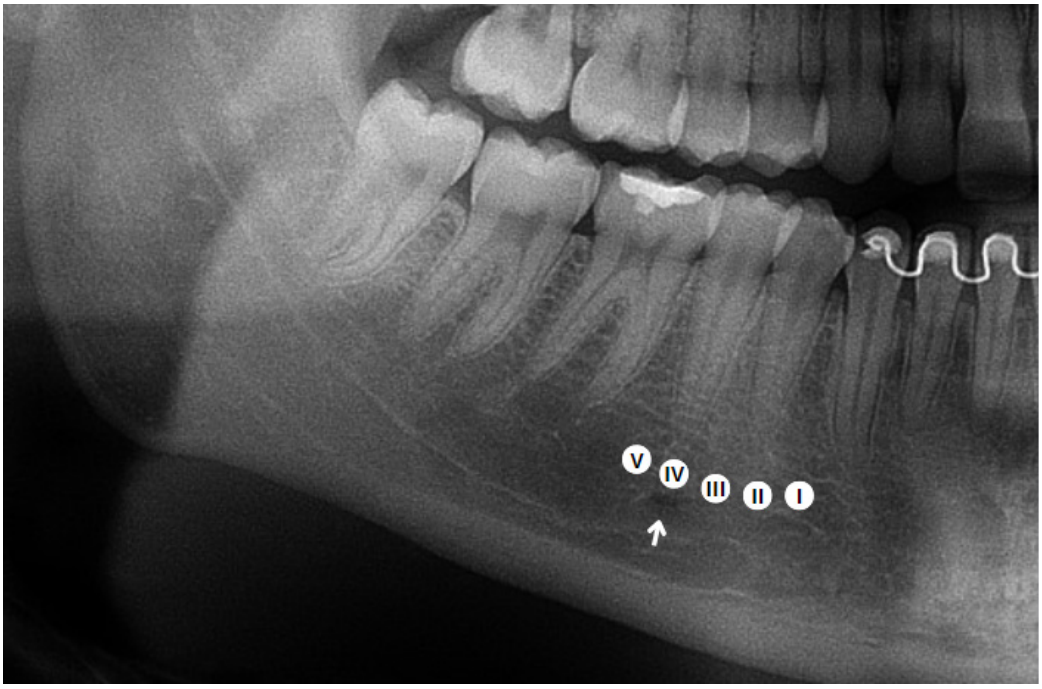

Figure 1 - Digital panoramic radiography showing the body of the mandible with the predetermined positions (I-V) for the location of the mental foramen (arrow).

The observations of the DPRs were conducted by a single observer, a dentist, on a computer screen, under good lighting conditions and in a controlled environment, free of external factors. Only DPRs from the same equipment were considered, as these are high-quality imaging exams, with no restriction on the date of performance. These were exams of dentate patients and, in partially edentulous patients, those with at least the PMs or residual roots present, as they are anatomical references for identifying the position of the MF.

The collected data were analyzed using percentage calculation Microsoft Excel, considering the positions and the side of the mandible. This study was approved by the Research Ethics Committee (REC) of the Federal University of Uberlândia, under registration number 5.544.523.

RESULTS

Table 1 shows the analysis of the total DPRs of the patients according to the distribution by sex and age.

Table 1 - Distribution of patients by age and sex regarding digital panoramic radiographs.

Age group of patients	Male	Female	Total by age group
18-20	1	4	5
21-29	19	32	51
30-39	8	13	21
40-49	3	8	11
50-59	10	2	12
Total of DPRs	**41**	**59**	**100**

DPRs (Digital Panoramic Radiographs).

Table 2 shows the results on MF location, which revealed one MF in position I (0.5%), five in position II (2.5%), 99 in position III (49.5%), 92 in position IV (46.0%), and three in position V (1.5%). All observed mandibles revealed the MFs vertically at the level of the apex of the respective teeth.

Table 3 shows that, considering the MFs on the right side in the total sample, there were two in position II (2.0%), 53 in position III (53.0%), 44 in position IV (44.0%), and one in position V (1.0%). For the MFs on the left side, one was observed in position I (1.0%), three in position II (3.0%), 46 in position III (46.0%), 48 in position IV (48.0%), and two in position V (2.0%).

Of the 100 mandibles radiographically observed, 79 (79.0%) revealed symmetry in the MF positions and 21 (21.0%) revealed asymmetry in the MF positions (Table 4).

Table 5 shows that, considering only the mandibles with symmetry in MF positions on the right and left sides, two were observed in position II (1.3%), 40 in position III (25.3%) (Figure 2), 36 in position IV (22.8%), and one in position V (0.6%) (Figure 3).

Table 2 - Percentage calculation of the position of the 200 mental foramina observed radiographically in 100 mandibles.

Rank	Mental foramen	Percentage
I	1	0.5%
II	5	2.5%
III	99	49.5%
IV	92	46.0%
V	3	1.5%

Table 3 - Position of the mental foramen in the right and left hemi-mandibles.

Rank	RS	LS
I	0 (0.0%)	1 (1.0%)
II	2 (2.0%)	3 (3.0%)
III	53 (53.0%)	46 (46.0%)
IV	44 (44.0%)	48 (48.0%)
V	1 (1.0%)	2 (2.0%)

RS (right side); LS (left side).

Table 4 - Distribution of mandibles with the mental foramina symmetrical and asymmetrical bilaterally.

Mental Foramina RS + LS	Number of Jaws	Percentage
Symmetrical	79	79.0%
Asymmetric	21	21.0%

RS (right side); LS (left side).

Table 5 - Jaws with symmetry in the bilateral position of the mental foramina.

Rank RS + LS	Jaws	Sample percentage (100 jaws)	Percentage in symmetry (79 jaws)
I	0	0.0%	0.0%
II	2	2.0%	1.3%
III	40	40.0%	25.3%
IV	36	36.0%	22.8%
V	1	1.0%	0.6%

RS (right side); LS (left side).

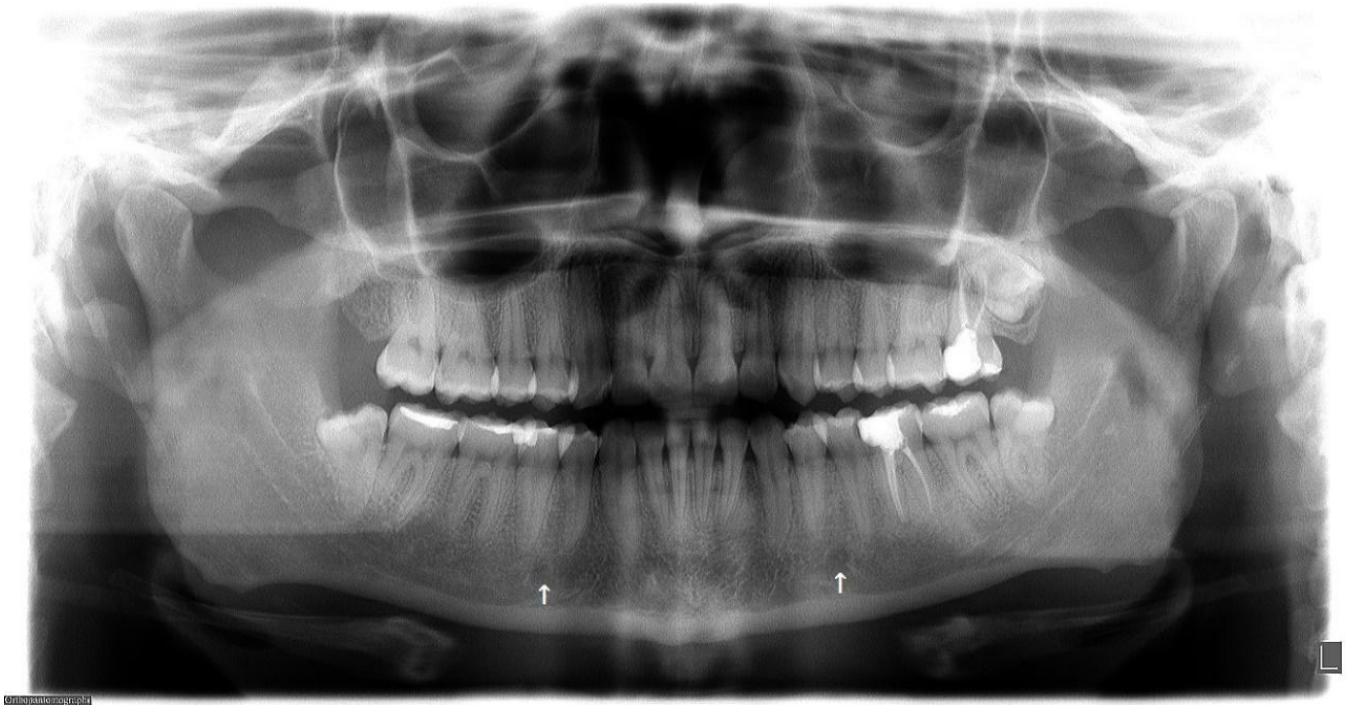

Figure 2 - Digital panoramic radiography showing the most prevalent symmetry of the mental foramen, in position III (arrows).

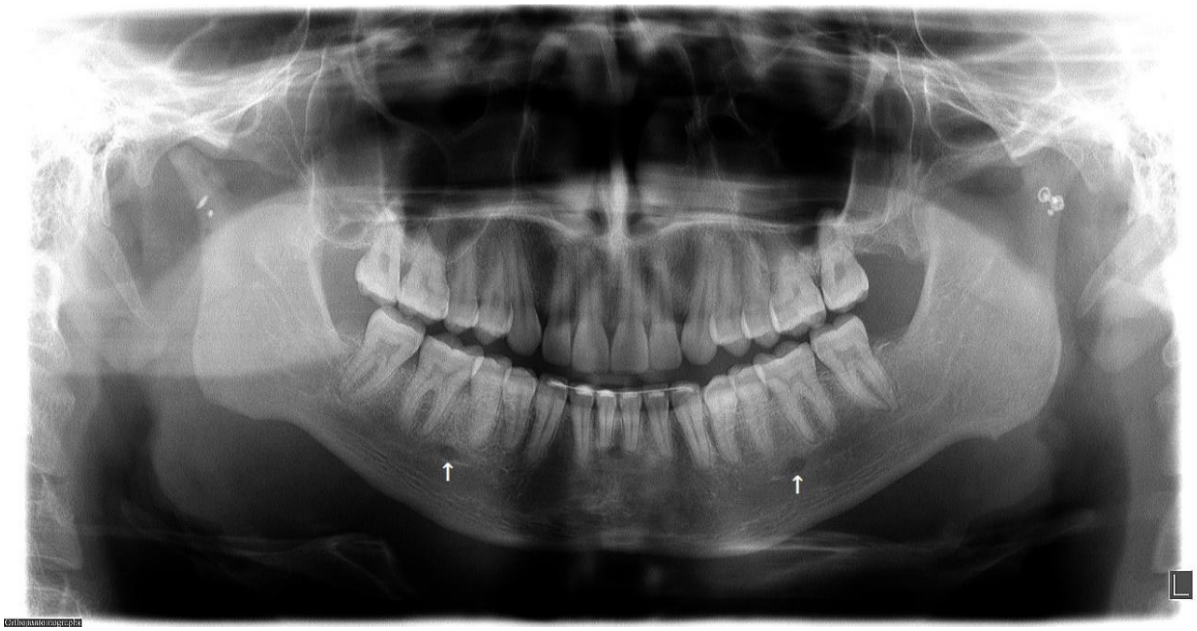

Figure 3 - Digital panoramic radiography showing the less prevalent symmetry of the mental foramen, in position V (arrows).

Table 6 shows that, considering the mandibles with asymmetry in MF positions on the right and left sides, one mandible had the foramina in positions I and IV (2.4%), one had foramina present in positions II and III (2.4%), 18 had foramina present in positions III and IV (42.9%) (Figure 4), and one mandible had foramina in positions IV and V (2.4%) (Figure 5).

Table 6 - Mandibles with asymmetry in the bilateral position of the mental foramina.

Position in the RS	Position in the LS	Jaws	Sample percentage (100 jaws)	Asymmetry percentage (21 jaws)
I	IV	1	1.0%	2.4%
II	III	1	1.0%	2.4%
III	IV	18	18.0%	42.9%
IV	V	1	1.0%	2.4%

RS (right side); LS (left side).

Figure 4 - Digital panoramic radiography showing the most prevalent asymmetry of the mental foramen, in positions III and IV (arrows).

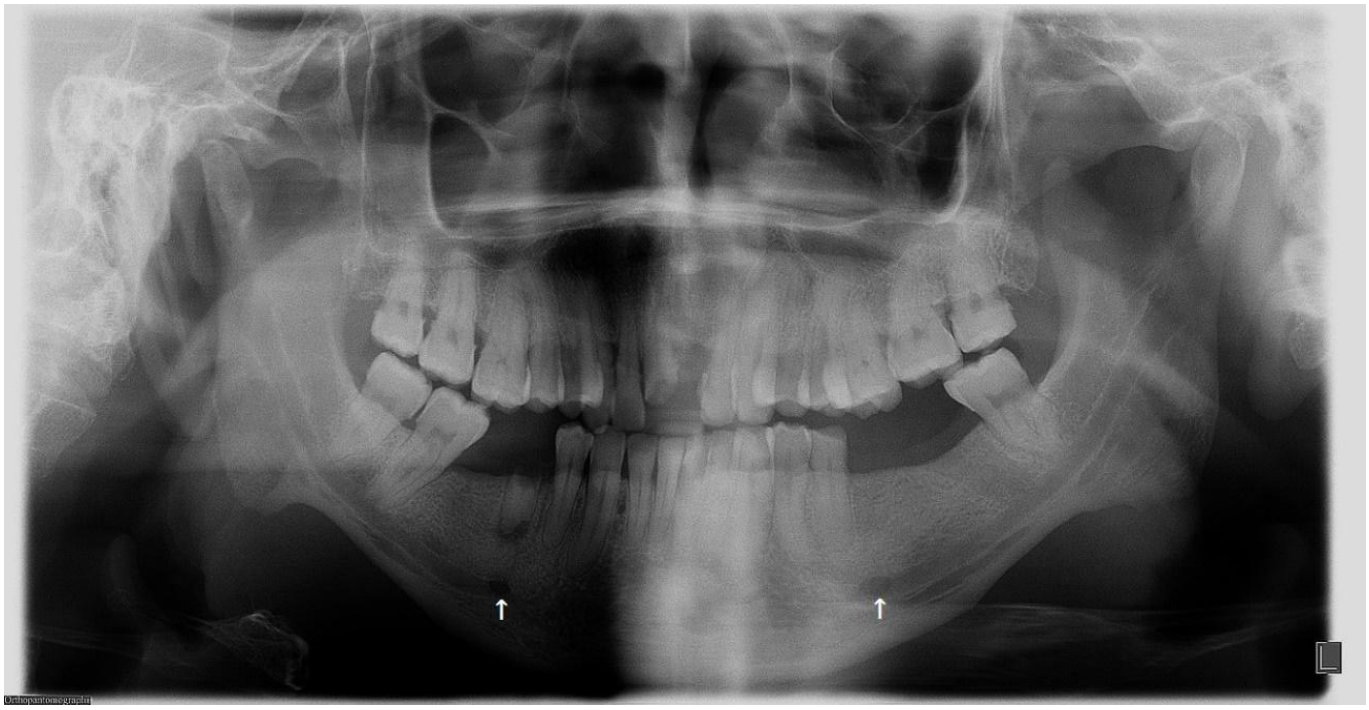

Figure 5 - Digital panoramic radiography showing the less prevalent asymmetry of the mental foramen, in positions IV and V (arrows).

DISCUSSION

DPR observation is a recommended technique for the analysis of MF morphology and position (14,19). The usual position of the MF is well established at the level of the root apices between the first and second PMs teeth; however, studies also affirm the prevalence of MF location at the level of the second lower PM, with a frequency below 50%, with no differences regarding age or sex (5,10,20-22).

The vertical position of the MF in relation to the alveolar crest and the mandibular base seems to vary between men and women (9,23). The MF is the passage site of the mental nerve, which provides sensory innervation of the mucosa and skin of the lower lip and buccal gingiva up to the lower central incisors. Thus, it is an important anatomical milestone for the approach to the nerve in clinical and surgical procedures (3,4). Not so rarely, we come across dental professionals and students with difficulty in locating MF, via palpation. Failures during mental nerve block reinforce these aspects. Thus, we can elucidate that the knowledge of the location pattern of this structure enhances operator's safety and patient comfort during clinical procedures, and its observation in imaging reproduces its anatomical-clinical location accurately.

In 2022, Nimigean *et al*. showed, by means of mandible computed tomography analysis, a high prevalence of about 79.45% of the cases for the MF location below the root apex, in a vertical direction, followed by 19.23% of the cases at the apex level and 1.31% above the root apex (24). The authors also reported a mean vertical diameter of 2.77 mm and a transverse diameter of 3.43 mm (mean diameter of approximately 3.1 mm), with bilateral symmetry, and a mean distance of 12.08 mm from the base of the mandible. Gupta reported this distance at 13 mm in 2008 (5) and Al-Tamimi *et al*., in 2022, reported statistical differences in these measurements between men and women in a population of Iraq (14). Vertical and horizontal measurements in mandible DPR, from MF, were statistically higher in men than in women, in Malays and Chinese, without difference on side or ethnicity (11). The differences in the measurements mentioned above could be explained by the larger overall body height in men. Phillips *et al*., in 1990, revealed a larger MF diameter on the left side of 75 adult mandibles, regardless of gender, age, or race (25). Therefore, MF is located near the root apices of mandibular teeth, with predominantly bilateral symmetry, as revealed by our results, and that age and sex do not determine the location of MF.

Our investigation indicated a higher frequency of MF localization among the PM (49.5%) and at the level of the root apex of the second PM (46.0%), representing almost half of the samples investigated (25). The high occurrence of bilateral symmetry in the MF location was also revealed in our results, with a prevalence of 79.0%, suggesting that the side does not interfere with the position of the

foramen. Other studies have reported similar results, with the prevalence of MF between the apices of the PMs (47.2%) and at the 2PM level (46.0%) with 85% symmetry in an Iranian population; prevalence among PM (43.0%) and at the level of 2PM (39.0%) in an Indian population, with 70.5% symmetry; prevalence of 63.0% among PMs and 20.67% at the 2PM level, with symmetry of 45.7%, in an Asian population; prevalence of MF location among PMs (57.7%), followed by 2PM (33.8%), with symmetry of 64.1% in the Belarusian population; prevalence of MF location among PMs (50.1%), followed by 2PM (45.1%) with symmetry of 83.3% (4,9,10,26,27). One investigation in 134 imaging studies reported a similar distribution of 48.15% of the MF position among the PMs and the 2PM level, corresponding to 96.3% of the sample investigated in the Romanian population, with no statistical difference in relation to age and side (2). An investigation in 100 mandibles revealed a higher prevalence of MF at the level of 2PM (49.4%) with remarkable symmetry; another investigation in 80 heads of cadavers revealed a higher prevalence of MF position at the level of 2PM, corresponding to 51% of the sample, followed by the position among PMs, with a higher prevalence of MF location among PMs in White individuals and after 2PM in Black individuals. Another study cited the highest prevalence of MF at the level of 2PM (67%) in 100 panoramic radiographs, followed by the location among PMs (24%), without symmetry analysis, in an Iranian population (16,17,28). Our research did not consider age, sex, and ethnicity, variables widely discussed in the literature (25), which do not imply the MF location, and the results corroborate most of the reports in literature worldwide, as mentioned above.

Based on our results and investigations, we can verify what most studies have indicated: the safe location of MF occurs primarily among PMs and secondarily at 2PM, with a high rate of symmetry in the mandible, without consideration for age, sex, or ethnicity.

The high symmetry indicates that this aspect is common and provides greater peace of mind for the dental surgeon. Nevertheless, the low asymmetry seems to be only an aspect of anatomical variation. Even in mandibles with asymmetry in the MF location, which represented 21.0% of our samples analyzed, the prevalent positions were III on the right side and IV on the left side, representing 18.0%, followed by positions I and IV, III and IV, IV and V, respectively on the right and left sides, each with 1.0% of occurrence. This situation reveals the low occurrence of MF localization in positions I and V, also observed in symmetrical samples.

This study was conducted with samples from a Brazilian population and it seems coherent to state that age, sex, ethnicity, and side are not factors that determine the MF location, with a higher frequency of MF location similar to those of our results (5,9,28,29,30), that is, between PM apices and at the apex of the second lower PM. Perhaps a broad comparative investigation between the various populations and ethnicities of all continents could clarify a probable hypothesis of interference of this variable in the MF position, which we believe to be very unlikely. No specific anatomical structure seems to determine the position of the MF, however, it is essential to know the most frequent location of the MF to avoid injury to the mental nerve and increase the efficiency of local anesthesia, making other invasive or surgical procedures safe. Our results become directly relevant to didactics and clinical practice.

CONCLUSIONS

The highest frequency of MF position in the mandible was observed between the apices of PM, followed by the apex of the second PM and, rarely, in a position before or after the PM teeth. There was a high prevalence of bilateral symmetry in the MF position, and, in cases of asymmetry, the most frequent localization also occurred between the PM teeth. The DPR proved to be a safe method for analyzing the location of MF, due to its high image quality. Knowledge about the location of MF is essential to prevent iatrogenic injury to the mental nerve and ensure the efficacy of local anesthesia, providing comfort and safety to the patient.

The authors declare no conflict of interest.

Corresponding author:
Danielle Cristiny Gonçalves Pereira.
Rua Amaral Gurgel, nº 159 – Juscelino Kubitschek, Paracatu – MG, 38607-140.
E-mail: daniellecristiny834@gmail.com

REFERENCES

1. Naroor N, Shenai P, Chatra L, Veena KM, Rao PK, Shetty P. Gender determination using the mental foramen. J Cranio Max Dis. 2015 Jul;4(2):144-7.
2. Gherghiţă OR, Csiki IE, Bordea EN, Pellegrini A, Cismaş SC, Motaş N, *et al*. Morphometric study for determining the anteroposterior position of the mental foramen in dentate human subjects. Rom J Morphol Embryol. 2021;62(2):517-23.
3. Parnami P, Gupta D, Arora V, Bhalla S, Kumar A, Malik R. Assessment of horizontal and vertical position

of mental foramen in Indian population in terms of age & sex in dentate subjects by panoramic radiographs: a retrospective study with review of literature. Open Dent J. 2015 Jul;9:297-302.
4. Gada SK, Nagda SJ. Assessment of position and bilateral symmetry of occurrence of mental foramen in dentate asian population. J Clin Diagn Res. 2014;8(2):203-5.
5. Gupta T. Localization of important facial foramina encountered in maxillo-facial surgery. Clin Anat. 2008;21(7):633-40.
6. Safdar S, Rashid M, Khan SH, Ijaz F, Shah SA, Riaz Z. Radiographic location of mental foramen in dentate adults visiting dental hospitals of Peshawar. J Pak Dent Assoc. 2022;31(1):5-10.
7. Currie CC, Meechan JG, Whitworth JM, Carr A, Corbett IP. Determination of the mental foramen position in dental radiographs in 18-30 year olds. Dentomaxillofac Radiol. 2016;45(1):20150195.
8. Thakare S, Mhapuskar A, Hiremutt D, Giroh VR, Kalyanpur K, Alpana KR. Evaluation of the position of mental foramen for clinical and forensics significance in terms of gender in dentate subjects by digital panoramic radiographs. J Contemp Dent Pract. 2016;17(9):762-8.
9. Lutiel A, Rimal J, Maharjan IK, Shrestha A, Tamang R. Localization of mental foramen in panoramic radiographs of 18-30 year olds: a hospital based study. Kathmandu Univ Med J. 2020;18(71):260-5.
10. Babshet M, Sandeep R, Burde K, Nandimath K. Evaluation of the position of mental foramen and its correlation with age in selected Indian population, using digital panoramic radiograph. Int J Dent Sci Res. 2015;3(4):87-91.
11. Sigali W, Khamis MFB, Ashar A, Samsudin AHZ. Digital analysis of mental foramen position reveals effects of ethnicity and gender on Malaysian population. J Int Dent Med Res. 2021;14(1):286-91.
12. Zaman S, Alam MK, Yusa T, Mukai A, Shoumura M, Rahman AS, *et al*. Mental foramen position using modified assessment system: An imperative landmark for implant and orthognathic surgery. J Hard Tissue Biol. 2016;25(4):365-70.
13. Kuzmanovic DV, Payne AG, Kieser JA, Dias GJ. Anterior loop of the mental nerve: a morphological and radiographic study. Clin Oral Implants Res. 2003;14(4):464-71.
14. Al-Tamimi AHU, Al-Khafaji TGH, Albaaj FSO, Hasan HA, Alam MK. Identification of gender by radiographic analysis of mental foramen in a sample of Iraqi patients. Bangladesh J Med Sci. 2022;21(1):79-83.
15. Thanyakarn C, Hansen K, Rohlin M. Measurements of tooth length in panoramic radiographs. 2: Observer performance. Dentomaxillofac Radiol. 1992;21(1):31-5.
16. Afkhami F, Haraji A, Boostani HR. Radiographic localization of the mental foramen and mandibular canal. J Dent (Tehran). 2013;10(5):436-42.
17. Tebo HG, Telford IR. An analysis of the variations in position of the mental foramen. Anat Rec. 1950;107(1):61-6.
18. Silva F, Reis HSM, Alonso JMSL, Souza JM. Determinação da posição radiográfica do forame mentual em subpopulação adulta brasileira no Sudeste. Braz J Periodontol. 2015;25(3):14-20.
19. Naqshi BF, Shah SB, Gupta S, Bashir A. Digital panoramic radiographs - a tool for evaluating position of mental foramen in north Indian population. Sch Int J Anat Physiol. 2021;4(7):104-6.
20. Brash JC, Jamieson EB. Cunningham's Textbook of Anatomy. 8th ed. New York: Oxford University Press; 1943.
21. Sicher H. Oral Anatomy. St. Louis: C. V. Mosby Company; 1949.
22. Song W-C, Kim S-H, Paik D-J, Han S-H, Hu K-S, Kim H-J, *et al*. Location of the infraorbital and mental foramen with reference to the soft-tissue landmarks. Plast Reconstr Surg. 2007;120(5):1343-7.
23. Apinhasmit W, Methathrathip D, Chompoopong S, Sangvichien S. Mental foramen in Thais: an anatomical variation related to gender and side. Surg Radiol Anat. 2006;28(5):529-33.
24. Nimigean V, Gherghiţă OR, Păun DL, Bordea EM, Pellegrini A, Cismaş SC, *et al*. Morphometric study for the localization of the mental foramen in relation to the vertical reference plane. Rom J Morphol Embryol. 2022;63(1):161-8.
25. Phillips JL, Weller RN, Kulid JC. The mental foramen: part I. Size, orientation, and positional relationship to the mandibular second premolar. J Endod. 1990;16(5):221-3.
26. Haghanifar S, Rokouei M. Radiographic evaluation of the mental foramen in a selected Iranian population. Indian J Dent Res. 2009;20(2):150-2.
27. Kabak SL, Zhuravleva NV, Melnichenko YM, Savrasova NA. Topography of mental foramen in a selected Belarusian population according to cone beam computed tomography. Imaging Med.2017;9(3):49-58.
28. Cutright B, Quillopa N, Schubert W. Na anthropometric analysis of the key foramen for maxillofacial surgery. J Oral Maxillofac Surg. 2003;61(3):354-7.
29. Yeşilyurt H, Aydinlioglu A, Kavakli A, Ekinci N, Eroglu C, Hacialiogullari M, *et al*. Local differences in the position of the mental foramen. Folia Morphol. 2008;67(1):32-5.
30. Saito K, Carvalho PL, Saito MT. Análise do forame mentual em tomografias computadorizadas de feixe cônico. Científica Digital. 2022;12(3):45-50.