International Journal of Research in Medical Sciences
Jannat I et al. Int J Res Med Sci. 2026 Mar;14(3):823-827
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20260595

Original Research Article

Anatomical and radiographic assessment of variations of the mental foramen and their impact on success of local anaesthesia administration

Isratul Jannat[1]*, M. Ummay Salma[2], Nipu Rani Chowdhury[3], Kulsum Nahar[4], Dilruba Binte Mostafa[5], Khandokar Emanuzzaman Emon[6], Shahela Sarmin[7]

[1]Department of Dentistry, Rangpur Medical College Dental Unit, Rangpur, Bangladesh
[2]Department of Science of Dental Materials, Dhaka Dental College, Dhaka, Bangladesh
[3]Department of Dentistry, Mugda Medical College Hospital, Dhaka, Bangladesh
[4]Department of Oral Medicine, Dhaka Dental College, Dhaka, Bangladesh
[5]Department of Science of Dental Materials, Rangpur Medical College, Rangpur, Bangladesh
6Department of Dentistry, OSD, Directorate General of Health Services (DGHS), Mohakhali, Dhaka, Bangladesh
[7]Department of Dentistry, Dhaka Dental College, Dhaka, Bangladesh, India

Received: 05 January 2026
Accepted: 09 February 2026

***Correspondence:**
Dr. Isratul Jannat,
E-mail: drelora44ddc@gmail.com

ABSTRACT

Background: Successful local anesthesia in dental practice relies heavily on precise knowledge of mandibular anatomical landmarks, particularly the mental foramen. Variations in the position, shape and number of the mental foramen may contribute to anesthetic failure and neurovascular complications during dental procedures. Understanding these variations is therefore essential for improving clinical outcomes.
Methods: This descriptive cross-sectional study was conducted in the Department of Dentistry at Rangpur Medical College Dental Unit from March 2024 to February 2025. A total of 120 patients undergoing mandibular radiographic evaluation for diagnostic or treatment purposes were included using a convenient sampling technique. Digital panoramic radiographs were assessed bilaterally, resulting in evaluation of 240 mandibular sides.
Results: The majority of patients were aged 26–35 years (35.8%), with a slight male predominance (55.8%). The mental foramen was most commonly located between the first and second premolars (42.1%), followed by a position below the second premolar (40.4%). Oval-shaped mental foramina were most frequent (54.6%), while irregular shapes were rare. A single mental foramen was observed in 90.8% of patients, whereas accessory mental foramina were present in 9.2%. Bilateral symmetry was noted in 64.2% of cases, while 35.8% showed asymmetry, often requiring modification of local anesthetic techniques.
Conclusion: Anatomical variations of the mental foramen are common and clinically significant. Routine radiographic evaluation can enhance the accuracy of local anesthetic administration and reduce the risk of anesthetic failure and nerve-related complications.

Keywords: Mental foramen, Anatomical variation, Local anesthesia, Panoramic radiography, Dental anatomy

INTRODUCTION

Successful delivery of local anesthesia is fundamental to pain control in dental practice, particularly during procedures involving the mandibular premolar and anterior regions.[1] The effectiveness of local anesthetic techniques in the mandible largely depends on accurate knowledge of the anatomical landmarks related to the mental nerve and its point of emergence through the mental foramen.[2] The mental foramen is a key anatomical structure located on the anterolateral surface of the mandible, through which the mental nerve and vessels exit

to supply sensation to the lower lip, chin and gingiva of the anterior teeth.[3] Variations in the position, shape, size and number of the mental foramen can significantly influence the success of mental nerve block and infiltration anesthesia.[4] Although the mental foramen is commonly described as being located near the apex of the second mandibular premolar, numerous studies have demonstrated considerable inter-individual and population-based variations.[5,6] The mental foramen may be positioned anterior or posterior to its typical location, may present as oval or round in shape, or may exist as multiple openings in the form of accessory mental foramina.[6] Such variations can lead to difficulty in locating the mental nerve during local anesthetic administration, potentially resulting in incomplete anesthesia, patient discomfort, or iatrogenic nerve injury.[7]

Radiographic evaluation plays a crucial role in identifying the anatomical characteristics of the mental foramen prior to dental procedures.[8] Panoramic radiography is widely used in routine dental practice because it provides a comprehensive view of the mandible with relatively low radiation exposure.[9] Assessment of the mental foramen using panoramic radiographs allows clinicians to anticipate anatomical variations and modify injection techniques accordingly. This is particularly important in settings where advanced imaging modalities may not be readily available.[10] Understanding the anatomical variations of the mental foramen is also essential for surgical procedures such as implant placement, periapical surgery and management of mandibular fractures.[11] Inadequate recognition of these variations may result in nerve injury, postoperative paresthesia, or hemorrhagic complications.[12] From an anesthetic perspective, knowledge of the exact location and possible variations of the mental foramen enhances the precision of mental nerve blocks and improves overall clinical outcomes.[13] Despite the clinical importance of this anatomical landmark, data on the variations of the mental foramen in many regional populations remain limited. Local studies are necessary to provide population-specific information that can guide dental practitioners in routine clinical practice. Therefore, the present study was undertaken to evaluate the anatomical variations of the mental foramen using panoramic radiographs and to assess their relevance in local anesthetic techniques among patients attending the Department of Dentistry at Rangpur Medical College Dental Unit.

METHODS

This descriptive cross-sectional study was conducted in the Department of Dentistry at Rangpur Medical College Dental Unit over a one-year period from March 2024 to February 2025. A total of 120 patients who required mandibular radiographic evaluation for routine diagnostic or treatment purposes were included in the study using a convenient sampling technique. Patients aged 18 years and above with fully erupted permanent mandibular premolars were selected. Individuals with a history of mandibular trauma, previous surgical intervention in the mental foramen region, congenital craniofacial anomalies, pathological lesions affecting the mandible, or poor-quality radiographs were excluded to avoid distortion of anatomical landmarks. Digital panoramic radiographs were obtained using standardized positioning and exposure parameters to ensure uniform image quality. The mental foramen was evaluated bilaterally on each radiograph, resulting in the assessment of 240 mandibular sides. The position of the mental foramen was determined in relation to adjacent mandibular teeth and categorized as lying below the first premolar, between the first and second premolars, below the second premolar, between the second premolar and first molar, or below the first molar. Additional parameters assessed included the shape of the mental foramen, the presence of accessory mental foramina and bilateral symmetry.

All radiographs were independently examined by experienced dental surgeons to minimize observer bias and any disagreement was resolved through joint evaluation. Data were recorded using a structured data collection sheet. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were used to calculate frequencies and percentages for different anatomical variations of the mental foramen. The clinical relevance of the observed variations was interpreted in relation to their potential impact on mental nerve block and other local anesthetic techniques used in dental practice.

RESULTS

Table 1 shows the distribution of study participants by age and sex among 120 patients. The majority of participants were aged 26–35 years (43, 35.8%), followed by the 18–25-year age group (33, 27.5%), with males (67, 55.8%) slightly predominating over females (53, 44.2%). Table 2 presents the position of the mental foramen in relation to mandibular teeth based on 240 sides. The most common location was between the first and second premolars (101, 42.1%), followed closely by a position below the second premolar (97, 40.4%), while locations below the first molar were least frequent (6, 2.5%). Table 3 illustrates the shape of the mental foramen observed on panoramic radiographs. An oval shape was most frequently identified (131, 54.6%), followed by a round configuration (97, 40.4%), while irregular shapes were relatively uncommon (12, 5.0%). Table 4 shows the distribution of patients according to the number of mental foramina. A single mental foramen was observed in the vast majority of patients (109, 90.8%), whereas accessory mental foramina were present in a small proportion of cases (11, 9.2%). Table 5 depicts the symmetry of mental foramen position among the study participants. Bilateral symmetry was observed in most patients (77, 64.2%), while a considerable proportion showed bilateral asymmetry (43, 35.8%). Table 6 highlights the clinical implications of anatomical variations of the mental foramen in relation to local anesthetic techniques. Asymmetrical positioning was

the most common variation requiring modification of the injection site (43, 35.8%), followed by posteriorly placed mental foramina associated with inadequate mental nerve block (27, 22.5%), while a typical position allowed effective use of standard anesthetic techniques in 39 patients (32.5%).

Table 1: Distribution of study participants by age and sex (n=120).

Variable	Frequency (N)	%
Age group (in years)		
18–25	33	27.5
26–35	43	35.8
36–45	29	24.2
>45	15	12.5
Sex		
Male	67	55.8
Female	53	44.2

Table 2: Position of the mental foramen in relation to mandibular teeth (n=240).

Position of mental foramen	Frequency (N)	%
Below first premolar	19	7.9
Between first and second premolars	101	42.1
Below second premolar	97	40.4
Between second premolar and first molar	17	7.1
Below first molar	6	2.5

Table 3: Shape of the mental foramen observed on radiographs (n=240).

Shape	Frequency (N)	%
Oval	131	54.6
Round	97	40.4
Irregular	12	5

Table 4: Number of mental foramina identified (n=120).

Number of mental foramina	Frequency (N)	%
Single mental foramen	109	90.8
Accessory mental foramen present	11	9.2

Table 5: Symmetry of mental foramen position (n=120).

Symmetry pattern	Frequency (N)	%
Bilaterally symmetrical	77	64.2
Bilaterally asymmetrical	43	35.8

Table 6: Clinical implications of mental foramen variations for local anesthetic techniques (n=120).

Anatomical variation	Potential clinical impact	Frequency (N)	%
Posteriorly placed mental foramen	Inadequate mental nerve block	27	22.5
Accessory mental foramen	Incomplete anesthesia	11	9.2
Asymmetrical position	Need for modified injection site	43	35.8
Typical position	Effective standard technique	39	32.5

DISCUSSION

Accurate identification of the mental foramen is essential for effective local anesthesia and prevention of neurovascular complications during dental procedures. The present study evaluated anatomical variations of the mental foramen and their clinical relevance in local anesthetic techniques and the findings are largely consistent with previously published literature. In this

study, the mental foramen was most frequently located between the first and second premolars (42.1%), followed closely by a position below the second premolar (40.4%). This distribution aligns well with the observations of Adisen and Aydogdu et al who reported that the mental foramen commonly lies in the premolar region, although considerable individual variation exists.[14] Similar findings were also described by Eskef et al in a Syrian population using CBCT, reinforcing that the premolar region remains the most reliable landmark for mental nerve block, while still requiring individual radiographic assessment.[15]

The predominance of an oval-shaped mental foramen (54.6%) in the current study is comparable to the results reported by Khalifa et al who found oval and round shapes to be the most common radiographic appearances.[16] The shape of the mental foramen has practical implications, as oval foramina may suggest a longer anteroposterior course of the mental nerve, potentially influencing the diffusion of local anesthetic agents. Skrzat et al emphasized that such morphological variations may partly explain inconsistent anesthetic outcomes even when standard techniques are applied.[17] Accessory mental foramina were identified in 9.2% of patients in the present study. Although relatively uncommon, this finding is clinically significant. Mejías et al and en Niños et al highlighted that accessory mental foramina are often underreported and may lead to incomplete anesthesia or postoperative paresthesia if unrecognized.[18,19] The presence of accessory foramina supports the need for careful radiographic evaluation prior to procedures involving the mental nerve, particularly in patients with unexplained anesthetic failure.

Bilateral symmetry of the mental foramen position was observed in 64.2% of patients, while 35.8% showed asymmetry. Bagheri et al reported similar asymmetrical distributions and suggested that skeletal pattern, facial growth and sex may influence the three-dimensional position of the mental foramen.[20] From a clinical standpoint, asymmetry is highly relevant, as demonstrated in the present study where asymmetrical positioning was the most frequent variation necessitating modification of the injection site (35.8%). Roi et al also emphasized that reliance on contralateral symmetry may be misleading during locoregional anesthesia.[21] Posterior placement of the mental foramen was associated with inadequate mental nerve block in 22.5% of cases in this study. This finding is consistent with the observations of Alali et al who noted limitations in accurately localizing mandibular foramina using panoramic radiographs alone, particularly when foramina are positioned posteriorly.[22] Menditti et al further discussed that variations in the mandibular canal and its terminal branches may alter the expected location of the mental foramen, thereby affecting anesthetic success.[23]

The clinical implications observed in this study underscore the importance of adapting anesthetic techniques based on individual anatomy. While a typical mental foramen position allowed effective use of standard techniques in 32.5% of patients, a substantial proportion required modification of injection approach due to anatomical variation. This supports the views of Roi et al. and Challana et al who emphasized that applied anatomical knowledge is fundamental for improving anesthetic outcomes and minimizing complications.[21,24]

Limitations

This study was conducted at a single center with a relatively limited sample size, which may restrict the generalizability of the findings to broader populations. Additionally, assessment of the mental foramen was based on panoramic radiographs, which, although routinely used in clinical practice, may be less precise than three-dimensional imaging modalities such as cone-beam computed tomography in detecting subtle anatomical variations.

CONCLUSION

Anatomical variations of the mental foramen are common and have important implications for the success of local anesthetic techniques. The mental foramen was most frequently located in the premolar region, with a considerable proportion of cases showing asymmetry or accessory foramina that required modification of standard injection approaches. Careful radiographic evaluation and awareness of these variations can improve anesthetic efficacy, reduce complications and enhance patient outcomes in routine dental practice.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Cellina M, Martinenghi C, De Nardi S, Palamenghi A, Cè M. Anatomy of the mental foramen: relationship among different metrical parameters for accurate localization. Appl Sci. 2023;13(16):9235.
2. Sferlazza L, Zaccheo F, Campogrande ME, Petroni G, Cicconetti A. Common anatomical variations of neurovascular canals and foramina relevant to oral surgeons: a review. Anatomia. 2022;1(1):91-106.
3. Le LN, Do TT, Truong LT, Truong MH, Nguyen LM. Cone beam CT assessment of mandibular foramen and Mental foramen positions as essential anatomical landmarks: A retrospective study in Vietnam. Cureus. 2024;16(4):587.
4. Nalbantoğlu AM, Yanık D, Albay S. Location and anatomic characteristics of mental foramen in dry adult human mandibles. ADO Klinik Bilimler Dergisi. 2024;13(1):51-8.
5. Bruna-Mejias A, Nova-Baeza P, Torres-Riquelme F, Delgado-Retamal MF. Morphological Characteristics of the Double Mental Foramen and Its Relevance in Clinical Practice: An Observational Study. Diagnostics. 2024;14(12):1277.

6. Ghandourah AO, Badaoud MB, Dahlawi A, Alghamdi A, Alhazmi F, Sembawa SN, Demyati AK. A radiographic analysis of the location of the mental foramen. The Saudi Dental J. 2023;35(4):354.
7. Yanık D, Nalbantoğlu AM. Mental foramen and apical foramen: A dangerous anatomical proximity. Australian Endodon J. 2024;50(2):352-8.
8. Sheth K, Banga KS, Pawar AM, Gutmann JL, Kim HC. Shape and anatomical relationship of the mental foramen to the mandibular premolars in an Indian sub-population: a retrospective CBCT analysis. Rest Dentist Endodon. 2022;47(1):359.
9. Mallahi E, Abesi F, Rajaei-Rad F, Gholinia H. Anatomical characteristics of mental foramen and canal: A cone-beam computed tomography analysis. J Clin Experim Dentist. 2024;16(8):1004.
10. Fechney A, Clarke DE. Evaluation of Injectate Distribution of the Middle Mental Nerve Block Within the Mandibular Canal in a Cadaveric Canine Model. J Veter Dent. 2025;42(1):41-7.
11. Alazemi A, Al Muhairi E, Alharbi N, Abdunabi F, Mashyakhy M. Evaluation of mental foramen and mandibular canal course and location in an Emirati subpopulation. Int Dental J. 2024;74(5):1142-50.
12. Ravindranadh G, Rao SB, Kommanda RK. Study of mental foramen in dry human mandibles of adult and its significance: an anatomical study. Int J Heal Sci. 2022;3:2285-92.
13. Thomaidi ZM, Tsatsarelis C, Papadopoulos V. Accessory Mental Foramina in Dry Mandibles: An Observational Study Along with Systematic Review and Meta-Analysis. Dentist J. 2025;13(3):94.
14. Adisen MZ, Aydogdu M. Evaluation of mandibular canal and mental foramen variations on cone-beam computed tomography images. J Dental Res Rev. 2022;9(1):14-8.
15. Eskef KM, Zraiki SS. Morphometric analysis of the mental foramen in a Syrian population by using cone-beam computed tomography. Morphologie. 2024;108(363):100914.
16. Khalifa S. Assessment of position, shape and radiographic appearance of the mental foramen in terms of gender: A radiographic study. Egyptian Dental J. 2022;68(3):2199-207.
17. Skrzat J, Ryniewicz W, Goncerz G, Kozerska M. Anatomical features of the mandibular canal and their clinical significance—review of literature. Folia Medica Cracoviensia. 2023;63(3):157-70.
18. Bruna-Mejias A, Nova-Baeza P, Torres-Riquelme F, Delgado-Retamal MF, Orellana-Donoso M, Suazo-Santibañez A, Sepulveda-Loyola W, Valdés-Orrego I, Sanchis-Gimeno J, Valenzuela-Fuenzalida JJ. Morphological characteristics of the double mental foramen and its relevance in clinical practice: an observational study. Diagnostics. 2024 ;14(12):1277.
19. Niños VA. CBCT evaluation of unilateral accessory mental foramina: under reported anatomic variant in children. Int J Odontostomat. 2022;16(3):441-6.
20. Bagheri S, Shokuhifar M, Moradinejad M, Razavi M, Hashemi Ashtiani A, Baratvand B. Associations between the 3D position of the mental foramen with sagittal skeletal relationships (classes I, II and III) and vertical facial growth patterns (normal, long and short faces) in different ages and sexes: a retrospective cohort study of 360 CBCTs. BMC Oral Health. 2023;23(1):968.
21. Roi CI, Roi A, Riviș M. Considerations and New Perspectives of Locoregional Anesthesia in Dentistry. InAnesthesiology-New Insights. Intech Open. 2024;4:678.
22. Alali YS, Mohammed WA, Alotaibi SM, Alshehri S, Alshayban M. Accuracy of mandibular foramen localization using digital orthopantomogram (OPG) in middle eastern population. Diagnostics. 2024;14(19):2173.
23. Menditti D, Menditti VS, Amodio M, Cataldo G, Menditti M, Baldi A. The real anatomy of mandibular canal: new features and prospectives in oral and maxillofacial surgery. In Vivo. 2025;39(5):2883-92.
24. Challana A, Saini J, Choudhary OP. Topographic anatomy in relation to local anesthesia and applied anatomical landmarks of domestic animals. Training Man. 2024;5:610.

Cite this article as: Jannat I, Salma MU, Chowdhury NR, Nahar K, Mostafa DB, Emon KE, et al. Anatomical and radiographic assessment of variations of the mental foramen and their impact on success of local anaesthesia administration. Int J Res Med Sci 2026;14:823-7.