



RESEARCH ARTICLE

Morphometric Study of Mandibular Foramen and Its Clinical Importance

Ashwani Kumar Sharma¹, Rachna Magotra², Shahnaz Chaudhary³

ABSTRACT

Background: The mandibular foramen is an important anatomical landmark located on the medial surface of the ramus of the mandible through which the inferior alveolar nerve and vessels enter the mandibular canal. Accurate knowledge of its position, dimensions, and anatomical variations is essential for successful inferior alveolar nerve block and for avoiding neurovascular injury during mandibular surgery. Considerable variation in the location of the mandibular foramen has been reported among different populations.

Aim: To evaluate the morphometric characteristics and anatomical position of the mandibular foramen and assess their clinical importance in relation to inferior alveolar nerve block and mandibular surgical procedures.

Methods: A retrospective observational morphometric study was conducted in the Department of Anatomy, Government Medical College, Jammu, over a period of three months. Fifty adult mandibles available in the departmental osteological collection were evaluated. Mandibles with adequate preservation of the ramus and identifiable mandibular foramina were included, while damaged or pathological specimens were excluded. Measurements were obtained bilaterally using a digital vernier caliper. The distances of the mandibular foramen from the anterior and posterior borders of the ramus, mandibular notch, and inferior border of the mandible were recorded. The vertical and horizontal diameters and the shape and presence of accessory mandibular foramina were also documented.

Results: In the study, the mean distance of the mandibular foramen from the anterior border of the ramus was 17.2 ± 2.8 mm on the right and 17.5 ± 2.9 mm on the left. The mean distance from the posterior border was 10.4 ± 2.1 mm and 10.1 ± 2.0 mm, respectively. The mean distance from the mandibular notch was 22.1 ± 3.0 mm on the right and 22.4 ± 3.1 mm on the left, while the mean distance from the inferior border was 23.6 ± 3.4 mm and 24.0 ± 3.6 mm. The mandibular foramen was predominantly oval in shape. Accessory mandibular foramina were identified in a small proportion of specimens. No statistically significant right-left difference was observed for the major morphometric parameters.

Conclusion: The mandibular foramen demonstrates measurable anatomical variability, although its location remains relatively consistent in relation to major ramus landmarks. Knowledge of these morphometric relationships can improve the accuracy of inferior alveolar nerve block and assist surgeons during mandibular osteotomy, fixation, and other maxillofacial procedures. **Background:** The mandibular foramen is an important anatomical landmark located on the medial surface of the ramus of the mandible through which the inferior alveolar nerve and vessels enter the mandibular canal. Accurate knowledge of its position, dimensions, and anatomical variations is essential for successful inferior alveolar nerve block and for avoiding neurovascular injury during mandibular surgery. Considerable variation in the location of the mandibular foramen has been reported among different populations.

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Keywords: Mandibular foramen; inferior alveolar nerve; morphometry; mandible; nerve block; ramus; anatomy.

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¹Associate Professor, Department of Anatomy, GMC Jammu, India

²Professor, Department of anatomy, GMC Jammu, India

³Associate Professor, Department of anatomy, GMC Jammu, India

Corresponding Author: Ashwani Kumar Sharma, Associate Professor, Department of Anatomy, GMC Jammu, India E-mail: dra.shwanisharma@gmail.com

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INTRODUCTION

The biggest and strongest bone in the face, the mandible provides a crucial anatomical foundation for speech, mastication, dental implantation, and a number of maxillofacial surgical procedures. On the medial surface of the mandibular ramus is a noticeable anatomical opening called the mandibular foramen. It indicates where the inferior alveolar neurovascular bundle enters the mandibular canal. Through this foramen, the inferior alveolar nerve, a branch of the mandibular nerve's posterior division, enters and provides sensory innervation to the mandibular teeth and surrounding structures. As a result, precise mandibular foramen localisation is crucial from a therapeutic standpoint (1).

The anterior and posterior margins of the ramus, the mandibular notch, the inferior border of the ramus, the lingula, and the occlusal plane are some of the significant anatomical features that are closely associated with the mandibular foramen. Age, sex, ethnicity, dental health, mandibular shape, and population can all affect its precise location. Clinical localisation may be challenging due to these changes, especially if anatomical landmarks are not clearly established. The mandibular foramen's size and placement vary significantly, according to recent morphometric research. The inferior alveolar nerve block (IANB) is one of the most significant therapeutic uses of mandibular-foramen anatomy (2).

The traditional method relies on the physician precisely determining the foramen's location using intraoral markers. Incomplete anaesthesia is frequently caused by the anaesthetic solution not being deposited close enough to the nerve before it enters the mandibular canal. Three-dimensional localisation of the mandibular foramen can

offer helpful reference measurements for enhancing the accuracy of IANB, according to studies utilising CBCT. Mandibular ramus osteotomy, sagittal split osteotomy, fracture fixation, implant-related procedures, and other maxillofacial surgeries all depend on the anatomical position of the mandibular foramen. Haemorrhage, postoperative sensory abnormalities, and other problems might arise from damage to the inferior alveolar neurovascular bundle (3).

For oral and maxillofacial surgical treatments, a thorough understanding of inferior alveolar nerve architecture is crucial, according to a recent meta-analysis. The existence of duplicate or auxiliary mandibular foramina is another factor to take into account. These anatomical variations may cause unanticipated bleeding during surgery or the failure of local anaesthesia by transmitting accessory branches of the inferior alveolar nerve or related arteries. Duplicate mandibular foramina have been reported in recent anatomical studies, which highlight the significance of identifying these variants prior to surgery. Direct morphometric investigations of skeletal specimens are still useful because they provide accurate anatomical measures without radiographic distortion, even though contemporary imaging techniques like CBCT provide three-dimensional evaluation of the mandibular foramen (4).

Mandibular-foramen measurements continue to show population-specific variations in recent Indian research. In order to assess the morphometric features and position of the mandibular foramen in 50 mandibles that were accessible at Government Medical College, Jammu, and to analyse their significance for inferior alveolar nerve block and mandibular surgery, the current retrospective study was conducted.

AIM

To study the morphometric characteristics and anatomical location of the mandibular foramen and assess its clinical importance.

OBJECTIVES

- To measure the position of the mandibular foramen in relation to major anatomical landmarks.
- To determine the vertical and horizontal dimensions of the mandibular foramen.
- To assess the shape and anatomical variations of the mandibular foramen.
- To compare morphometric measurements between the right and left sides.
- To discuss the clinical implications of these measurements for inferior alveolar nerve block and mandibular surgery.

MATERIALS AND METHODS

Study Design

A retrospective observational morphometric study was conducted to evaluate the anatomical characteristics of the mandibular foramen.

Study Setting

The study was conducted in the Department of Anatomy, Government Medical College, Jammu, Jammu and Kashmir, India.

Study Duration

The study was conducted over a period of three months.

Sample Size

A total of 50 adult mandibles available in the departmental osteological collection were included for morphometric assessment.

Sampling Technique

The available specimens fulfilling the predefined inclusion and exclusion criteria were retrospectively evaluated.

Inclusion Criteria

- Adult human mandibles available in the departmental osteology collection.
- Mandibles with an intact ramus.
- Clearly identifiable mandibular foramina on both sides.
- Specimens in which the relevant anatomical landmarks could be identified adequately.

Exclusion Criteria

- Mandibles with fractures involving the ramus.
- Specimens with severe erosion or damage around the mandibular foramen.
- Mandibles with pathological lesions or major deformities.
- Specimens in which accurate measurements could not be obtained.

Morphometric Parameters

The following parameters were measured bilaterally

- Distance from the mandibular foramen to the anterior border of the ramus.
- Distance from the mandibular foramen to the posterior border of the ramus.
- Distance from the mandibular foramen to the mandibular notch.
- Distance from the mandibular foramen to the inferior border of the ramus/mandible.
- Vertical diameter of the mandibular foramen.

- Horizontal diameter of the mandibular foramen.
- Shape of the mandibular foramen.
- Presence or absence of accessory mandibular foramina.

These parameters were selected because similar measurements are widely used to establish reproducible anatomical reference points for localization of the mandibular foramen.

Measurement Technique

Measurements were performed using a calibrated digital vernier caliper. Each measurement was recorded in millimetres. Measurements were taken carefully from the midpoint of the mandibular foramen to the corresponding anatomical landmark. The same measurement technique was used for both sides to minimize measurement variability.

Morphological Assessment

The mandibular foramen was classified according to its gross appearance as round, oval, or irregular. The presence of accessory mandibular foramina was recorded separately for the right and left sides.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using statistical software. Continuous variables were expressed as mean $\pm$ standard deviation. Categorical variables were

Table 1: Distribution of mandibular-foramen measurements

Parameter	Right side, Mean $\pm$ SD (mm)	Left side, Mean $\pm$ SD (mm)	p-value
Distance from anterior border	17.2 $\pm$ 2.8	17.5 $\pm$ 2.9	0.58
Distance from posterior border	10.4 $\pm$ 2.1	10.1 $\pm$ 2.0	0.47
Distance from mandibular notch	22.1 $\pm$ 3.0	22.4 $\pm$ 3.1	0.63
Distance from inferior border	23.6 $\pm$ 3.4	24.0 $\pm$ 3.6	0.59
Vertical diameter	4.1 $\pm$ 0.9	4.2 $\pm$ 1.0	0.61
Horizontal diameter	3.5 $\pm$ 0.8	3.6 $\pm$ 0.8	0.54

Table 2: Morphology of the mandibular foramen

Shape	Number of mandibles	Percentage
Oval	27	54.0
Round	19	38.0
Irregular	4	8.0
Total	50	100.0

Table 3: Presence of accessory mandibular foramen

Accessory mandibular foramen	Number	Percentage
Absent	46	92.0
Present	4	8.0
Total	50	100.0

expressed as frequency and percentage. Right- and left-sided measurements were compared using the independent/paired *t*-test as appropriate. Categorical variables were compared using the chi-square test. A *p*-value <0.05 was considered statistically significant.

Ethical Considerations

As the study involved retrospective examination of existing anatomical specimens without identifiable personal information, institutional ethical requirements applicable to osteological research were followed. The specimens were used exclusively for academic and research purposes.

RESULTS

The mean distances from the anterior and posterior borders were approximately 17 mm and 10 mm, respectively. The measurements showed close bilateral similarity, with no statistically significant difference between the right and left sides.

The oval configuration was the most frequent morphology, observed in 54% of specimens, followed by a round configuration in 38%.

Accessory mandibular foramina were identified in four mandibles (8%). This anatomical variation is clinically important because accessory foramina may transmit additional neurovascular structures.

Table 4: Anteroposterior position of mandibular foramen

Position	Number	Percentage
Near middle/central region	21	42.0
Slightly anterior to midpoint	18	36.0
Slightly posterior to midpoint	11	22.0
Total	50	100.0

Table 5: Clinical interpretation of mandibular-foramen position

Morphometric finding	Clinical implication
Mean distance from anterior border $\approx$ 17 mm	Useful reference for medial ramus localization
Mean distance from posterior border $\approx$ 10 mm	Helps estimate needle/surgical approach
Mean distance from mandibular notch $\approx$ 22 mm	Useful vertical landmark
Mean distance from inferior border $\approx$ 24 mm	Helps define vertical position
Predominantly oval foramen	Indicates anatomical variation in nerve entry site
Accessory foramen in 8%	Potential cause of incomplete anesthesia/additional neurovascular structures

The mandibular foramen was most commonly located around the central portion of the anteroposterior dimension of the ramus.

DISCUSSION

The mandibular foramen is one of the most clinically important anatomical landmarks of the ramus because it provides entry for the inferior alveolar neurovascular bundle into the mandibular canal. The morphometry of 50 adult mandibles was assessed in this study, which showed comparatively constant correlations with the inferior border, mandibular notch, and anterior and posterior margins. These parameters are especially important for mandibular ramus surgery and inferior alveolar nerve block. The mandibular foramen's mean distance from the anterior border in the current study was 17.2 mm on the right and 17.5 mm on the left, whereas the equivalent posterior-border lengths were 10.4 and 10.1 mm. The foramen was located considerably closer to the posterior boundary than the anterior border, according to these values. Previous anatomical studies have reported similar connections. Significant similarities with the current values were reported in a South Indian study, which revealed mean distances from the anterior boundary of roughly 17.1–17.4 mm and from the posterior border of roughly 9.7–10.5 mm. The results also align with previous morphometric research from India. The mean distances from the mandibular foramen to the coronoid notch were 17.60 ± 2.95 mm on the right and 17.93 ± 3.16 mm on the left, respectively, and 24.61 ± 4.32 and 24.20 ± 4.28 mm from the inferior border, according to a 2024 study of 77 dry mandibles (5, 6).

Population variance, specimen size, age distribution, methodology, and the exact designation of anatomical landmarks can all lead to differences between research. There may not have been any significant bilateral asymmetry in the current investigation, based on the comparatively tiny difference between measurements taken on the right and left sides. Other morphometric studies have revealed similar results, with no discernible side-to-side changes. Clinicians should not, however, presume that a patient's placement is the same on both sides. A recent CBCT study showed quantifiable variations in sex and anatomical landmarks, emphasising the importance of customised imaging when planning complicated treatments. Clinical relevance also stems from the mandibular foramen's shape. The most prevalent shape in the current analysis was oval, with round configurations coming in second. Similar variance in mandibular-foramen shape has been reported in recent studies (7, 8).

According to a 2025 CBCT study, foramina were primarily round and oval, with roughly 52% round and 48% oval morphology. This difference is significant because the radiological identification of the foramen's location may be impacted by its apparent size and direction. Eight percent of the current study sample had accessory mandibular foramina. Because supplementary foramina can convey accompanying vessels or accessory branches of the inferior alveolar nerve, this discovery has clinical significance. Therefore, if accessory innervation is present, an injection administered in accordance with traditional landmarks may occasionally result in insufficient anaesthesia. Duplicated mandibular foramina were found in 6.35% of mandibles, according to a recent anatomical study, which also highlighted the possible consequences for dental anaesthesia and surgery. Similarly, supplementary foramina in dry mandibles were described in a 2024 morphometric analysis, which emphasised the significance of identifying these anatomical changes (9).

The inferior alveolar nerve block is the main clinical use of these results. The local anaesthetic must be deposited near the inferior alveolar nerve before it reaches the mandibular foramen in order for traditional IANB to be successful. One of the causes of ineffective anaesthesia is anatomical variance. Because traditional methods may not always be successful, alternative IANB strategies are still being evaluated in current clinical research. Additionally, although its absolute frequency is minimal, neurosensory disruption is a known potential side effect of mandibular anaesthesia. Additionally, mandibular osteotomies and

fixation treatments can benefit from the morphometric data. Bleeding or surgical paraesthesia may result from damage to the inferior alveolar neurovascular bundle (10).

The significance of this knowledge for oral and maxillofacial surgeons was highlighted by a recent meta-analysis of inferior alveolar nerve anatomy, which offered thorough morphometric data regarding its relationship with mandibular landmarks. While direct skeletal measurements offer useful anatomical information, contemporary imaging offers a crucial supplementary method. When anatomical variation is suspected or substantial surgery is anticipated, CBCT may be preferred because it enables three-dimensional visualisation of the mandibular foramen in individual patients. The usefulness of CBCT for preoperative planning and mandibular-foramen localisation has been shown in recent research. The very limited sample size of 50 specimens and the retrospective character of the osteological evaluation are the main limitations of this investigation. For some specimens, information like as sex, precise age, dental condition, and clinical history may not be available. (11, 12).

Furthermore, the anatomical circumstances found in living patients cannot be fully replicated by measurements taken from dry mandibles. However, the study highlights the significance of taking anatomical diversity into account during clinical treatments and offers helpful population-specific morphometric data.

CONCLUSION

The current morphometric analysis shows that the mandibular foramen is located on the medial surface of the mandibular ramus in a comparatively constant but varied position. The average distance from the rear boundary was about 10 mm, and the average distance from the anterior border was around 17 mm. A small percentage of specimens had auxiliary foramina, and the mandibular foramen was primarily oval in shape. The primary morphometric metrics did not show any discernible right-left difference. Because precise location of the mandibular foramen is necessary for both successful inferior alveolar nerve block and reducing neurovascular problems during mandibular surgery, our findings have direct clinical value. When difficult mandibular treatments are planned or conventional anaesthesia fails, anatomical variations, such as accessory foramina, should be taken into account. Population-specific morphometric studies remain valuable, while CBCT can provide individualized three-dimensional assessment before invasive procedures. Larger studies incorporating sex, age, and imaging-based measurements are recommended.

REFERENCES

1. Adalarasan S, Devi L, Sathvik PS. Morphometric study on the mandibular foramen. *Cureus*. 2024;16(10): e70862. doi:10.7759/cureus.70862.
2. Singh Y, Shakya P, Saba NU, Singh H, Kumar N. A morphometric study of the mandibular foramen, lingula, and the incidence of accessory mandibular foramina in dry mandibles. *Cureus*. 2025;17(3): e81087. doi:10.7759/cureus.81087.
3. Le H, et al. Cone Beam CT assessment of mandibular foramen and mental foramen positions as essential anatomical landmarks: a retrospective study in Vietnam. *BMC Oral Health*. 2024.
4. Jolly SS, Lata J, Sharma RK, Vashist R. Presence of antilingula and its relationship to mandibular foramen-an anatomical study. *Natl J Maxillofac Surg*. 2024;15(2):[page numbers]. doi: 10.4103/njms.njms_18_23.
5. Yadav M, Sharma D, Ahmed S, Kapoor G. Morphometric study of mandibular foramen and its clinical implications in inferior alveolar nerve block in western Rajasthan population. *Int J Life Sci Biotechnol Pharma Res*. 2024;13(3):240-244.
6. Insha S, Fatima K, Shahdad S, Bhat GM. Morphometric study of mandibular foramen and its clinical significance in inferior alveolar nerve block. *Int J Res Med Sci*. 2023;11(5):1600-1604. doi:10.18203/2320-6012.ijrms20231322.
7. Kaur R, Singla RK, Sharma R, Singla S. Localization of mandibular foramen - a comparison between dry bones and orthopantomogram. *J Med Life*. 2022;15(5):669-674. doi:10.25122/jml-2022-0007.
8. Jyothi Lakshmi GL, Vishma BK, Asharani SK. A morphometric study of mandibular foramen in dry skulls and its clinical implications. *Int J Health Clin Res*. 2022;5(2):89-91.
9. Suresh N, CJ S, Patil K, Suresh N, Anil S. Prevalence and morphometric analysis of retromolar canals and foramina: a cone-beam computed tomography study. *J Stomatol Oral Maxillofac Surg*. 2025;29(1):75. doi:10.1007/s10006-025-01373-z.
10. Tabrizi R, Mazidi A, Sharifzadeh H, Khanzadeh H, Azadi A. Occurrence of neurosensory disturbance after the use of articaine and lidocaine in the inferior alveolar nerve block: a double-blind randomised clinical trial. *Br J Oral Maxillofac Surg*. 2024;62(7):637-641. doi: 10.1016/j.bjoms.2024.06.006.
11. Watanabe K, Tokumine J, Nagase M, Matsumura G, Sawada R, Kinjo S, Yoroza T. A new and simplified extraoral approach for inferior alveolar nerve block: a cadaveric study and clinical case reports. *J Anesth*. 2024;38(6):806-810. doi:10.1007/s00540-024-03396-4.
12. Trzeciak M, Michalczak M, Niziolek M, Lipski M, Musiał A, Skrzat J, et al. The surgical anatomy of the inferior alveolar nerve: a meta-analysis with clinical implications. *Folia Morphol (Warsz)*. 2024;83(3):509-516. doi:10.5603/fm.97459