Section: Anatomy

Original Research Article

VARIATION IN THE POSITION OF MANDIBULAR FORAMEN: A DRY BONE MORPHOMETRIC STUDY AMONG EAST INDIANS

Tanushree Roy[1], Subhasis Chakraborty[2], Dibyendu Datta[3]

[1]*Assistant Professor, Department of Anatomy, College of Medicine & Sagore Dutta Hospital, India.*
[2]*Associate Professor, Department of Anatomy, College of Medicine & Sagore Dutta Hospital, India.*
[3]*Assistant Professor, Department of Anatomy, College of Medicine & Sagore Dutta Hospital, India.*

Received *: 12/08/2026*
Received in revised form *: 11/09/2026*
Accepted *: 24/09/2026*

Corresponding Author:
Dr. Tanushree Roy,
Assistant Professor, Department of Anatomy, College of Medicine & Sagore Dutta Hospital, India.
Email: dodi7885@gmail.com

DOI: 10.70034/ijmedph.2026.4.167

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 1104-1108

ABSTRACT

Background: The mandibular foramen is an important anatomical landmark located on the medial surface of the mandibular ramus and serves as the entry point for the inferior alveolar neurovascular bundle into the mandibular canal. Variations in its position may influence the success of inferior alveolar nerve block and mandibular surgical procedures. Population-specific morphometric data are therefore clinically relevant. **Aims:** To determine the distance of the mandibular foramen from various anatomical landmarks among adult dry mandibles and to compare the findings with observations reported from other geographical populations.

Materials and Methods: A observational study was conducted in the Departments of Anatomy of College of Medicine & Sagore Dutta Hospital, Kamarhati, Kolkata,over a period of one year. Adult dry mandibles satisfying the inclusion and exclusion criteria were selected by census sampling. The distances of the mandibular foramen from the anterior border, posterior border, mandibular notch, angle of the mandible, and posterior limit of the third molar socket were measured in millimetres.

Results: The study included 150 mandibles. The mean distance from the anterior border was 17.42 ± 2.31 mm, while that from the posterior border was 14.86 ± 2.18 mm. The mean distances from the mandibular notch, angle of mandible, and posterior limit of the third molar socket were 21.64 ± 3.12 mm, 38.72 ± 4.26 mm, and 15.38 ± 3.06 mm, respectively. No significant right-left differences were observed for any measurement ($p>0.05$).

Conclusion: The mandibular foramen demonstrates measurable positional variation but relatively symmetrical bilateral relationships. These morphometric findings may provide useful anatomical reference data for dental anaesthesia and mandibular surgical procedures.

Keywords: Mandibular foramen; Mandible; Morphometry; Dry bone; Ramus; Anatomical landmarks; East Indian population.

INTRODUCTION

The mandible is the largest and strongest bone of the facial skeleton and plays an important role in mastication, speech, and the maintenance of facial form. The mandibular ramus presents an important anatomical feature on its medial surface known as the mandibular foramen, which provides the entrance to the mandibular canal. The inferior alveolar nerve and accompanying vessels enter through this foramen and traverse the mandibular canal to supply the teeth and associated structures. The mandibular foramen is therefore an important anatomical landmark in dental, maxillofacial, and reconstructive procedures.[1,2]

The precise localization of the mandibular foramen is particularly important during administration of the inferior alveolar nerve block, which is one of the most frequently performed regional anaesthetic techniques in dentistry. Variation in the position of the foramen may result in inaccurate needle placement, incomplete anaesthesia, repeated

injections, and possible injury to the inferior alveolar neurovascular bundle.[3] The location of the mandibular foramen is also relevant during mandibular osteotomies, sagittal split ramus osteotomy, mandibular implant procedures, extraction of mandibular teeth, fracture fixation, and other surgical interventions involving the ramus.[4]

Although the mandibular foramen is generally described as being situated near the centre of the medial surface of the ramus, its exact position shows considerable individual and population-related variation. Its location may be described in relation to several readily identifiable anatomical landmarks, including the anterior and posterior borders of the ramus, mandibular notch, inferior border of the mandible, condyle, coronoid process, internal oblique ridge, and third molar region. Nicholson reported that, in adult dry mandibles of East Indian ethnic origin, the mandibular foramen was predominantly located around the anteroposterior midpoint of the ramus and demonstrated considerable variability in its vertical and horizontal position.[5] Such variation emphasizes the importance of morphometric assessment rather than reliance on a single generalized anatomical description.

Several osteological studies have attempted to establish reliable measurements for locating the mandibular foramen. Thangavelu et al., in a study of 102 dry adult mandibles, evaluated the relationship of the mandibular foramen with the anterior border, internal oblique ridge, inferior border, sigmoid notch, and condyle, demonstrating that these landmarks can provide useful guidance for its localization.[3] Similarly, Shalini et al. examined 204 South Indian mandibles and reported measurable differences in the distances between the mandibular foramen and the anterior and posterior borders of the ramus, mandibular notch, base of the mandible, third molar, and retromolar trigone.[6] These findings indicate that the position of the mandibular foramen cannot necessarily be extrapolated from one population to another.

Regional differences are particularly relevant in anthropological and clinical anatomy. A study conducted on East Indian mandibles by Sandhya et al. assessed the position of the mandibular foramen in relation to six bony landmarks and reported measurable distances from the anterior, posterior, superior, and inferior borders of the ramus, condyle, and internal oblique ridge. The authors also demonstrated substantial bilateral similarity for most of the measured landmarks, while the relationship with the condyle showed significant asymmetry.[7] Such observations suggest that population-specific morphometric data may be valuable for improving the anatomical understanding of the mandibular foramen and for facilitating safer clinical procedures.

The relationship of the mandibular foramen with the lingula is also of considerable surgical importance. The lingula is a tongue-shaped bony projection situated immediately superior to the mandibular foramen and is frequently used as an intraoperative landmark during procedures involving the mandibular ramus. Monnazzi et al. demonstrated that the mandibular foramen was located, on average, several millimetres inferior to the lingula, while the relationship between the mandibular foramen and antilingula was less predictable.[4] Therefore, identification of multiple anatomical landmarks rather than dependence on a single landmark may improve the accuracy of mandibular foramen localization.

Differences reported among East Indian, North Indian, South Indian, and other populations further highlight the importance of regional morphometric studies. Gupta et al. reported that the mandibular foramen in North Indian mandibles was not consistently situated at the exact centre of the ramus and emphasized the clinical implications of such positional variation.[8] The observed differences may reflect variations in mandibular morphology, population characteristics, developmental factors, and the dimensions of the ramus. Consequently, establishing reliable morphometric measurements in a specific geographical population can provide useful reference data for both anatomical and clinical applications.

MATERIALS AND METHODS

Study design: observational study
Place of study: Department of Anatomy, College of Medicine & Sagore Dutta Hospital.
Period of study: 1 year
Study Population: Adult dry human mandibles available in the Departments of Anatomy of the respective medical colleges
Sample size: 150 adult dry mandibles.
Inclusion Criteria:

- Adult mandibles with erupted third molar tooth sockets.
- Mandibles regular in shape.
- Mandibles devoid of any gross deformity or pathological alteration.
- Mandibles with identifiable and intact anatomical landmarks required for morphometric measurements.

Exclusion criteria:

- Mandibles with congenital or acquired deformities.
- Mandibles showing fractures, erosion, or significant damage.
- Mandibles with pathological lesions affecting the ramus or mandibular foramen.
- Mandibles with incomplete or poorly identifiable anatomical landmarks.
- Mandibles in which the mandibular foramen or relevant landmarks cannot be accurately identified or measured.

Study Variable:

1. Distance of the mandibular foramen from the anterior border of the ramus (mm)

2. Distance of the mandibular foramen from the posterior border of the ramus (mm)
3. Distance of the mandibular foramen from the mandibular notch (mm)
4. Distance of the mandibular foramen from the angle of the mandible (mm)
5. Distance of the mandibular foramen from the posterior limit of the third molar tooth socket (mm)

Statistical Analysis: For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

RESULTS

Table 1: Distribution of mandibular foramina according to side

Side of Mandible	Number (n)	Percentage (%)
Right	75	50
Left	75	50
Total	150	100

Table 2: Distance of mandibular foramen from the anterior and posterior borders of the ramus

Measurement	Mean (mm)	SD (mm)	Minimum (mm)	Maximum (mm)	Median (mm)
Distance from anterior border	17.42	2.31	12.1	23.8	17.3
Distance from posterior border	14.86	2.18	9.9	20.6	14.7

Table 3: Distance of mandibular foramen from the mandibular notch and angle of mandible

Measurement	Mean (mm)	SD (mm)	Minimum (mm)	Maximum (mm)	Median (mm)
Distance from mandibular notch	21.64	3.12	14.8	29.5	21.4
Distance from angle of mandible	38.72	4.26	29.6	48.9	38.5

Table 4: Distance of mandibular foramen from posterior limit of third molar socket

Measurement	Mean (mm)	SD (mm)	Minimum (mm)	Maximum (mm)	Median (mm)
Distance from posterior limit of 3rd molar socket	15.38	3.06	8.7	23.4	15.2

Table 5: Comparison of morphometric measurements between right and left sides

Morphometric Variable	Right Side Mean ± SD (mm)	Left Side Mean ± SD (006Dm)	Mean Difference	p-value
Distance from anterior border	17.58 ± 2.28	17.26 ± 2.34	0.32	0.389
Distance from posterior border	14.94 ± 2.11	14.78 ± 2.25	0.16	0.651
Distance from mandibular notch	21.82 ± 3.06	21.46 ± 3.18	0.36	0.475
Distance from angle of mandible	38.96 ± 4.19	38.48 ± 4.33	0.48	0.481
Distance from posterior limit of 3rd molar socket	15.62 ± 3.01	15.14 ± 3.10	0.48	0.309

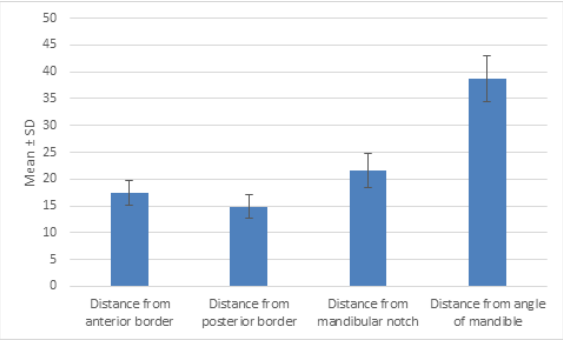


Figure 1: Morphometric Measurements of the Mandibular Foramen in Relation to Anatomical Landmarks

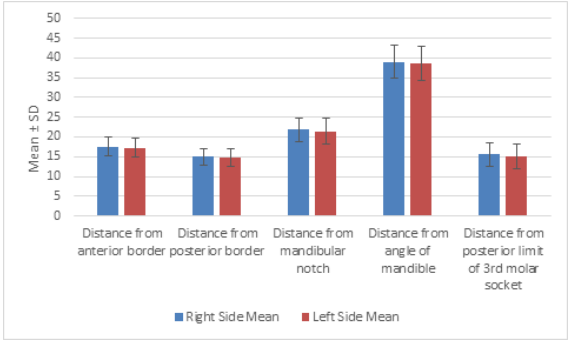


Figure 2: Comparison of morphometric measurements between right and left sides

Table 1 shows the distribution of the mandibles according to side. Among the total 150 mandibles

examined, 75 (50.0%) were right-sided and 75 (50.0%) were left-sided.

Table 2 presents the morphometric measurements of the mandibular foramen in relation to the anterior and posterior borders of the ramus. The mean distance of the mandibular foramen from the anterior border was 17.42 ± 2.31 mm, with measurements ranging from 12.10 to 23.80 mm and a median of 17.30 mm. In comparison, the mean distance from the posterior border was 14.86 ± 2.18 mm, with a minimum of 9.90 mm, maximum of 20.60 mm, and median of 14.70 mm.

Table 3 demonstrates the distance of the mandibular foramen from the mandibular notch and angle of the mandible. The mean distance from the mandibular notch was 21.64 ± 3.12 mm, with a range of 14.80–29.50 mm and median of 21.40 mm. The mean distance from the angle of the mandible was considerably greater, measuring 38.72 ± 4.26 mm, with values ranging from 29.60 to 48.90 mm and a median of 38.50 mm.

Table 4 shows the distance between the mandibular foramen and the posterior limit of the third molar tooth socket. The mean distance was 15.38 ± 3.06 mm, with measurements ranging from 8.70 to 23.40 mm and a median of 15.20 mm.

Table 5 compares the morphometric measurements between the right and left sides of the mandibles. The mean distance from the anterior border was 17.58 ± 2.28 mm on the right side and 17.26 ± 2.34 mm on the left side, with a mean difference of 0.32 mm (p=0.389). The distance from the posterior border was 14.94 ± 2.11 mm on the right and 14.78 ± 2.25 mm on the left, showing a mean difference of 0.16 mm (p=0.651). Similarly, the mean distance from the mandibular notch was 21.82 ± 3.06 mm on the right and 21.46 ± 3.18 mm on the left (p=0.475). The distance from the angle of the mandible was 38.96 ± 4.19 mm on the right compared with 38.48 ± 4.33 mm on the left (p=0.481). Finally, the mean distance from the posterior limit of the third molar socket was 15.62 ± 3.01 mm on the right and 15.14 ± 3.10 mm on the left (p=0.309).

DISCUSSION

The present study assessed the position of the mandibular foramen in adult dry mandibles using five anatomical landmarks. The mean distance from the anterior border of the ramus was 17.42 ± 2.31 mm, while the mean distance from the posterior border was 14.86 ± 2.18 mm, indicating that the mandibular foramen was relatively closer to the posterior border. Shalini et al. reported anterior-border distances of 17.11 ± 2.74 mm on the right and 17.41 ± 3.05 mm on the left in South Indian mandibles, showing close agreement with the present findings.[6] Nicholson, in East Indian mandibles, also reported considerable variation in the anteroposterior position of the mandibular foramen.[8]

The mean distance of the mandibular foramen from the mandibular notch was 21.64 ± 3.12 mm in the present study. This was comparable with the findings of Shalini et al., who reported values of 21.74 ± 2.74 mm on the right and 21.92 ± 3.33 mm on the left.[6] Oguz and Bozkir reported slightly higher values of 22.37 ± 3.64 mm and 22.17 ± 4.41 mm on the right and left sides, respectively, in Turkish mandibles.[9] The close similarity suggests that the mandibular notch may serve as a relatively consistent anatomical landmark for estimating the vertical position of the mandibular foramen.

In the present study, the mean distance from the angle of the mandible was 38.72 ± 4.26 mm. This measurement was higher than values reported by Sultana and Sreekanth, who observed approximately 23.01 ± 3.92 mm on the right and 22.36 ± 3.89 mm on the left in Telangana mandibles.[10] Such differences may be related to variations in the definition of the mandibular angle, the precise point selected on the mandibular foramen, mandibular morphology, and population characteristics. Therefore, direct comparison of this parameter should be interpreted cautiously when different measurement techniques are used.

The mean distance from the posterior limit of the third molar socket was 15.38 ± 3.06 mm in the present study, with a range of 8.70–23.40 mm. Shalini et al. reported greater distances of 22.84 ± 3.94 mm on the right and 23.23 ± 4.21 mm on the left.[6] The difference may partly be explained by variation in the anatomical landmark used, as the present study specifically measured from the posterior limit of the third molar socket. Nicholson also demonstrated considerable variation in the relationship between the mandibular foramen and the molar region in East Indian mandibles.[8]

Comparison between the right and left sides showed no statistically significant differences for any measured parameter. The anterior-border distance was 17.58 ± 2.28 mm on the right versus 17.26 ± 2.34 mm on the left (p=0.389), while the posterior-border distance was 14.94 ± 2.11 versus 14.78 ± 2.25 mm (p=0.651). Similarly, the mandibular-notch distance was 21.82 ± 3.06 versus 21.46 ± 3.18 mm (p=0.475), angle distance was 38.96 ± 4.19 versus 38.48 ± 4.33 mm (p=0.481), and third-molar-socket distance was 15.62 ± 3.01 versus 15.14 ± 3.10 mm (p=0.309). These findings are consistent with Shalini et al., who also reported no significant bilateral differences.[6]

CONCLUSION

The present dry bone morphometric study demonstrated considerable variation in the position of the mandibular foramen in adult mandibles. The mean distance from the anterior border of the ramus was 17.42 ± 2.31 mm, compared with 14.86 ± 2.18 mm from the posterior border, indicating a relatively posterior position. The mean distances from the mandibular notch, angle of the mandible, and

posterior limit of the third molar socket were 21.64 ± 3.12 mm, 38.72 ± 4.26 mm, and 15.38 ± 3.06 mm, respectively. No statistically significant bilateral differences were observed for any measured parameter. These findings provide useful regional morphometric data for East Indian mandibles and may assist in accurate localization of the mandibular foramen during inferior alveolar nerve block, dental procedures, and mandibular surgical interventions.

REFERENCES

1. Standring S, Ellis H, Healy J, Johnson D, Williams A, Collins P, Wigley C. Gray's anatomy: the anatomical basis of clinical practice. American journal of neuroradiology. 2005 Nov;26(10):2703.
2. Agur AM, Dalley AF. Moore's essential clinical anatomy. Lippincott Williams & Wilkins; 2018 Dec 18.
3. Thangavelu K, Kannan R, Kumar NS, Rethish E, Sabitha S, Sayeeganesh N. Significance of localization of mandibular foramen in an inferior alveolar nerve block. Journal of natural science, biology, and medicine. 2012 Jul;3(2):156.
4. Monnazzi MS, Passeri LA, Gabrielli MF, Bolini PD, De Carvalho WR, da Costa Machado H. Anatomic study of the mandibular foramen, lingula and antilingula in dry mandibles, and its statistical relationship between the true lingula and the antilingula. International journal of oral and maxillofacial surgery. 2012 Jan 1;41(1):74-8.
5. Nicholson ML. A study of the position of the mandibular foramen in the adult human mandible. The Anatomical Record. 1985 May;212(1):110-2.
6. Shalini R, RaviVarman C, Manoranjitham R, Veeramuthu M. Morphometric study on mandibular foramen and incidence of accessory mandibular foramen in mandibles of south Indian population and its clinical implications in inferior alveolar nerve block. Anatomy & cell biology. 2016 Dec;49(4):241-8.
7. Sandhya K, Singh B, Lugun N, Prasad R. Localization of mandibular foramen relative to landmarks in East Indian mandibles. Indian Journal of Dental Research. 2015 Nov 1;26(6):571-5.
8. Nicholson ML. A study of the position of the mandibular foramen in the adult human mandible. The Anatomical Record. 1985 May;212(1):110-2.
9. Oguz O, Bozkir MG. Evaluation of location of mandibular and mental foramina in dry, young, adult human male, dentulous mandibles. The West Indian Medical Journal. 2002 Mar 1;51(1):14-6.
10. Zafar S. A morphometric study of mandibular foramen in dry adult human mandibles of indian population in telangana state.