

A Morphometric Study of the Mandibular Foramen and Its Clinical Implications

Rajkumari Kshemitra¹, Khundrakpam Nganba², Kongkham Budhachandra³

¹Assistant Professor, Dept. of Anatomy, Churachandpur Medical College, Imphal, Manipur, India

²Assistant Professor, Dept. of Dentistry, Churachandpur Medical College, Imphal, Manipur, India

³Senior Resident, Dept. of Anatomy, Churachandpur Medical College, Imphal, Manipur, India

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Corresponding author: Dr. Rajkumari Kshemitra

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Abstract

Introduction: The mandibular foramen an important anatomical landmark for inferior alveolar nerve anaesthetic block which is a widely practiced technique in dentistry and maxillofacial surgery. Considering the pivotal clinical importance, accurate location of the mandibular foramen is essential, therefore the present study was conducted to determine the precise position and variations of the mandibular foramen from various anatomical landmarks.

Aims & Objectives: To determine the morphometric parameters of mandibular foramen in 60 dry adult mandibles.

Methods and Materials: A cross-sectional study was conducted on 30 dry adult mandibles of unknown sex and age in the Department of Anatomy, Churachandpur Medical College, Manipur from November 2024 to May 2025. Distances were measured from (1) Anterior border of ramus to Mandibular Foramen (AB-MF) (2) Posterior border of ramus to Mandibular foramen (PB-MF) (3) Mandibular notch to Mandibular Foramen (MF-MN) and (4) Mandibular base to Mandibular Foramen (MF-MB). Descriptive statistics of data obtained was analysed using SPSS software.

Results: A total of 60 mandibular foramens (30- right; 30-Left) was studied. The mean distance of 1) Anterior border of the ramus to mandibular foramen is 16.8 ± 1.82 mm (Left side) and 16.67 ± 1.74 mm (Right side) 2) Posterior border of the ramus to mandibular foramen is 11.11 ± 1.20 mm (Left side) and 11.08 ± 1.06 mm (Right side) 3) Mandibular notch to mandibular foramen is 22.14 ± 2.61 mm (Left side) and 21.71 ± 2.76 mm (Right side) 4) Mandibular base to mandibular foramen is 22.44 ± 2.16 mm (Left side) and 21.86 ± 2.14 mm (Right side).

Conclusion: Determining the location of the mandibular foramen for successful inferior alveolar neurovascular block is essential for performing various dental surgeries and reducing failure rate.

Keywords: Mandibular Foramen, Inferior Alveolar Nerve Block, Dental Anaesthesia, Dry Mandible.

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Introduction

The mandibular foramen is sited as an irregular foramen on the medial surface of the mandibular ramus midway between the anterior and posterior borders of the ramus at the level with the occlusal surfaces of the teeth.

It leads to mandibular canal through which inferior alveolar nerve and vessels and comes out through the mental foramen as mental vessels and nerve to innervates the lower jaw, teeth, periodontal tissues and buccal soft tissues of the premolars and anterior teeth, the skin of the chin and the mucosa of the lower lip. [1]

The location of mandibular foramen varies with age and racial phenotypes; it may be at the level of the occlusal plane in primary dentition and at higher position in permanent dentition. [2] The inferior

alveolar nerve block is widely used technique use in dentistry has reported a failure rate of 20-25%. [3]

The most frequent technique failure in anaesthesia of the inferior alveolar nerve lies in the inappropriate setting of the needle, due to the inaccurate location of mandibular foramen. [4]

Therefore, the present study has been conducted to investigate the precise location of mandibular foramen and its distances from various parameters on the medial surface of mandibular ramus.

Materials and Method

The study was carried out in the Department of Anatomy, Churachandpur Medical College, Imphal, Manipur. A total number of 30 dry adult human mandibles consisting of 60 mandibular foramens (30

right and 30 left) of unknown sex and age were collected and studied. Mandibles which are damaged and with abnormalities were excluded from the study. A Digital Vernier Calliper of 0.001mm accuracy was used for taking the measurements. The position of the mandibular foramen was measured from various landmarks as shown in

Fig 1. (Observations were noted using the following: MF- Mandibular Foramen; AB – Anterior border of the mandibular ramus; PB – Posterior border of the mandibular ramus; MN – Mandibular Notch of the mandibular ramus; MB – Mandibular Base.)

1. AB-MF: Distance from AB of mandibular ramus to the centre of the MF.

2. PB-MF: Distance from PB of mandibular ramus to the centre of the MF.
3. MN-MF: A distance from the mandibular notch to the MF.
4. MB-MF: A distance from mandibular base to MF.

The measurement was taken by two individuals independently.

Measurements were recorded to the nearest millimetre.

The mean and SD were calculated separately for right and left sides and tabulated.

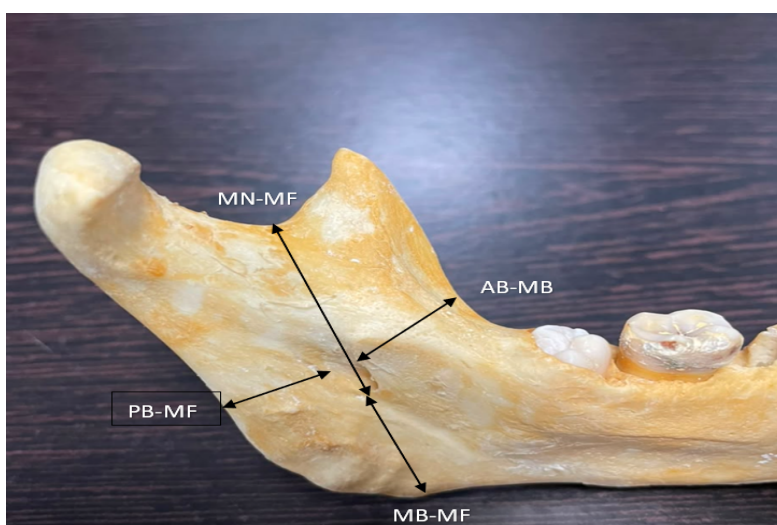


Fig 1: Showing various measurements from different landmarks on the mandible.

Results

A total of 60 mandibular foramina (30 right and 30 left) were studied for the position of mandibular foramen from various landmarks. The mean, standard deviation values and P values of various parameters studied are shown in Table 1. The mean distance of 1) Anterior border of the ramus to mandibular foramen is 16.8 ± 1.82 mm (Left side) and 16.67 ± 1.74 mm (Right side) 2) Posterior border of the ramus to mandibular foramen is 11.11 ± 1.20

mm (Left side) and 11.08 ± 1.06 mm (Right side) 3) Mandibular notch to mandibular foramen is 22.14 ± 2.61 mm (Left side) and 21.71 ± 2.76 mm (Right side) 4) Mandibular base to mandibular foramen is 22.44 ± 2.16 mm (Left side) and 21.86 ± 2.14 mm (Right side) respectively.

The study also found that the mandibular foramen is mostly located at the level or below the level of the occlusal plane.

Table 1: Parameters to locate the Mandibular Foramen (MF) from various landmarks from the medial surface of the mandibular ramus.

Parameters	Side	Mean	Sd	P-Value
AB - MF	RIGHT	16.67	1.74	0.49 ^{ns}
	LEFT	16.8	1.82	
PB - MF	RIGHT	11.08	1.06	0.30 ^{ns}
	LEFT	11.11	1.20	
MN - MF	RIGHT	21.71	2.76	0.53 ^{ns}
	LEFT	22.14	2.61	
MB - MF	RIGHT	21.86	2.14	0.28 ^{ns}
	LEFT	22.44	2.16	

(Where MF- Mandibular Foramen, AB – Anterior border of the mandibular ramus, PB – Posterior border of the mandibular ramus, MN – Mandibular Notch of the mandibular ramus, MB – Mandibular Base.)

Discussion

Inferior alveolar nerve block (IANB) is one of the most common methods used for anaesthetizing mandibular molars for different procedures such as dental extraction, placement of mandibular implants, and other procedures involving mandibles. Finding the morphometric position of the mandibular foramen with regard to neighbouring structures is essential for the success of inferior alveolar nerve block, as this technique requires the exact positioning of the needle close to the mandibular foramen [5].

The present study determines the morphometric position of the mandibular foramen from anterior ramus, posterior ramus, mandibular notch and base of the mandible. The position of mandibular foramen was mostly found at the level of the occlusal plane or below the level of the occlusal plane. There were no significant differences in the location of Mandibular foramen from different bony landmarks bilaterally. No statistically significant

differences were observed between left and right side ($p > 0.05$) suggesting a high degree of bilateral symmetry in position of mandibular foramen. This study was compared with other studies done by various authors in India to know any geographical difference as shown in Table 2.

The present study observed that the Mandibular foramen is located posterior to the centre of the ramus of the mandible on both sides. These finding matches with the finding of studies of Padmavathi et al [6], Shalini et al [3] and Sultana and Sreekanth [7] done in South Indian population.

This result also coincides with the result of study of Khan and Ansari [8], Gupta et al [9] and Singh et al [10] done in North Indian population. In the present study, the distance from mandibular notch to mandibular foramen (MF-MN) 21.71 ± 2.76 were similar to the findings of Shalini et al [3], Sultana and Sreekanth [7] and Singh et al [10].

Table 2: Showing the comparison of the findings of different authors with the present study.

Parameter	Side	Padmavathi G et al [6] (2014) (South Indian)	Shalini et al [3] (2016) (South Indian)	Khan and Ansari [8] (2016) (North Indian)	Sultana and Sreekanth [7] (2019) (South Indian)	Singh et al [10] (2025) (North Indian)	Insha et al [11] (2023) (Indian population)	Present study (Indian population)
AB MF	R	16.8 $\pm$ 2.8	17.11 $\pm$ 2.74	16.06 $\pm$ 1.99	16.67 $\pm$ 2.73	17.14 $\pm$ 1.64	18.1 $\pm$ 2.4	16.67 $\pm$ 1.74
	L	16.9 $\pm$ 2.5	17.41 $\pm$ 3.05	16.13 $\pm$ 2.10	16.56 $\pm$ 2.5	17.06 $\pm$ 2.18	18.2 $\pm$ 1.7	16.8 $\pm$ 1.82
PB MF	R	12.1 $\pm$ 2.4	10.47 $\pm$ 2.11	12.02 $\pm$ 1.99	12.67 $\pm$ 2.37	10.80 $\pm$ 1.77	13.6 $\pm$ 2.16	11.08 $\pm$ 1.06
	L	12.1 $\pm$ 2.4	9.68 $\pm$ 2.03	11.10 $\pm$ 1.95	13.03 $\pm$ 2.43	10.83 $\pm$ 2.15	13.5 $\pm$ 1.92	11.11 $\pm$ 1.20
MN MF	R	22.0 $\pm$ 3.0	21.74 $\pm$ 2.74	18.79 $\pm$ 2.79	21.04 $\pm$ 2.95	22.60 $\pm$ 4.20	20.06 $\pm$ 2.2 5	21.71 $\pm$ 2.76
	L	22.3 $\pm$ 3.4	21.92 $\pm$ 3.33	18.71 $\pm$ 2.77	20.24 $\pm$ 2.94	22.53 $\pm$ 2.85	19.9 $\pm$	22.14 $\pm$ 2.61
MB MF	R	25.0 $\pm$ 3.2	22.33 $\pm$ 3.32	-	24.38 $\pm$ 3.86	-	26.5 $\pm$ 3.0	21.86 $\pm$ 2.14
	L	24.8 $\pm$ 3.8	25.35 $\pm$ 4.5	-	24.42 $\pm$ 4.44	-	26.8 $\pm$ 2.18	22.44 $\pm$ 2.16

Various other studies have demonstrated the variability in the exact location of the mandibular foramen. Narayana et al [12] reported that the location of the mandibular foramen varies according to age.

Their study showed that the MF was approximately 4.12 mm below the occlusal plane in 3-year-old children, reached the level of the occlusal plane in 9-year-old children, and was located approximately 4.16 mm above the occlusal plane in adults. Whereas according to Patel RJ et al [13], the MF was found

below or at the level of occlusal plane of mandible teeth which is consistent with the findings of our study. Rashid et al [14] assessed the location of the mandibular foramen (MF) using panoramic images reconstructed from cone beam computed tomography (CBCT). They found that most linear measurements between the MF and adjacent anatomical landmarks did not differ significantly with age or sex.

However, the distance between the posterior border of the ramus and the MF (P-MF) showed significant

variation across different age groups and between males and females. These findings emphasize the importance of considering individual anatomical variations when planning dental procedures involving the mandibular foramen. Dental surgeons can utilize this information during the local anaesthesia involving the inferior alveolar nerve (IAN) for different procedures such as dental extraction, placement of mandibular implants, and other therapeutic procedures involving mandibles. [6]

Our findings provide parameters that may guide more precise and predictable needle placement for inferior alveolar nerve block (IANB), with the potential to improve procedural success.

Conclusion

The morphometric position of the mandibular foramen determined in the present study may provide a valuable anatomical landmark for dental surgeons during inferior alveolar nerve block (IANB), thereby facilitating more accurate needle placement, improving procedural success, and reducing complications.

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