

## Original Research Article

# Morphometric study of mandibular foramen and its clinical significance in inferior alveolar nerve block

Syed Insha Saify\*, Kaneez Fatima, Shaheen Shahdad, G. M. Bhat

Department of Anatomy, Government Medical College, Srinagar, Jammu and Kashmir, India

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### \*Correspondence:

Dr. Syed Insha Saify,

E-mail: [inshasaify@gmail.com](mailto:inshasaify@gmail.com)

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### ABSTRACT

**Background:** This study was done to determine the precise location of the mandibular foramen so as to lower down the percentage of the failure of the attainment of the anaesthesia of the inferior alveolar nerve during dental procedures.

**Methods:** In this cross sectional study a total of 50 dry human mandibles were examined. The measurements were taken from the anterior border of the ramus (coronoid notch) to the midportion of the MF (mandibular foramen) and from the midportion of the mandibular foramen to other landmarks such as posterior border of ramus, from inferior limit of MF to inferior border of ramus and the midpoint on symphysis menti.

**Results:** The comparison of data was done using student's t-test. The mandibular foramen was positioned at a mean distance of 18.26 mm (with a standard deviation of 1.77) from the anterior border of the ramus. The mean distance from posterior border of the ramus to the mid point of mandibular foramen was 13.5 mm with a SD of 2.16.

**Conclusions:** The present study gives a fair knowledge of the position of mandibular foramen and provides information for successful local anesthesia of inferior nerve block to maxillofacial surgeons, ENT surgeons and onco-surgeons.

**Keywords:** Inferior alveolar nerve, Mandibular foramen, Vernier calliper

### INTRODUCTION

The mandible, or the lower jaw, is the largest and the strongest bone of the face (Figure 1). It develops from the first pharyngeal arch. It has a body and a pair of rami.<sup>1</sup> The mandibular foramen (MF) is an irregular foramen located above the center on the medial surface of the ramus. There is a canal called as mandibular canal which descends into the body of the mandible and opens into the mental foramen. The contents of the canal include the inferior alveolar branch of the mandibular division of the trigeminal nerve, which in turn emerges as the mental nerve supplying the mandibular teeth. The position of the mandibular foramen (MF) is an important landmark for effective anesthesia in the field of dentistry procedures that include dental extraction from the lower jaw and placing mandibular implants.<sup>2</sup>



**Fig 1: Human mandible with arrow showing mandibular foramen.**

The uncertainty in the location of the mandibular foramen (MF) has been seen to be the main factor for the high failure rate of anesthesia and complications of

orthodontic procedures.<sup>3</sup> It has been reported by different researchers that the main complications encountered during sagittal split osteotomies are hemorrhage, injury to neurovascular bundle, undesired fractures and bone necrosis when the proper location of mandibular foramen is not clear. So, it is important to have a thorough knowledge of mandibular foramen (MF) and ramus for orthodontic surgeries.<sup>4</sup> Inferior alveolar nerve block is one of the most common nerve block techniques used in dental practice. The success of the procedure mainly depends on placing the needle tip close to the mandibular foramen. Thus, the variations in the position of mandibular foramen may be one of the causes for the failure rates of the inferior alveolar nerve block.<sup>5</sup> The success of the inferior alveolar nerve block highly depends on the proximity of the needle tip to the mandibular foramen at the time of the anesthetic injection.<sup>6</sup> Inferior alveolar nerve block failure is not uncommon and it can occur even with experienced hands.

Various studies have shown racial differences in the anatomy of mandible. The study of various literatures has shown conclusive evidences that significant metric, morphological and biological differences exist among the three major racial phenotypes, Caucasoid, Mongoloid and Negroid. The mandibular and mental foramen are often chosen as reference points because of their stable relation with base of mandible, in paleoanthropological studies of the facial skeleton in different populations and for identification of human remains.<sup>7</sup> The lack of proper observance of the location of mandibular foramen must be generally the reason for the failure of the attainment of the anesthesia of the inferior alveolar nerve.

The aim of this study was to determine the precise location of the mandibular foramen in relation to the borders of mandibular ramus.

### **Aims and Objectives**

The purpose of this study was to determine the precise location of the mandibular foramen so as to bring down the percentage of the failure of the attainment of the anesthesia of the inferior alveolar nerve during dental procedures.

### **METHODS**

The present cross-sectional study, was conducted on 50 dry adult human mandibles procured from the department of anatomy of Government Medical college Srinagar, Kashmir, India.

We selected only adult mandibles depending on the presence of third molar tooth and excluded old and damaged mandibles. The gender and exact age of each mandible was unknown.

All the measurements were taken with the help of vernier caliper in mm. The position of mandibular foramen from

various anatomical landmarks was measured and recorded on both right and left mandibular rami for each bone (total 100 sides).

For morphometric analysis of mandibular foramen following parameters were studied:

The measurements were taken from the midpoint of mandibular foramen (MF) to the nearest point on the anterior border of ramus (AB) (MF-AB), from midpoint of mandibular foramen to the nearest point on the posterior border of ramus (PB) (MF-PB), from inferior limit of mandibular foramen to base/inferior border of ramus (MF-BM) and midpoint of mandibular foramen to the midpoint on superior border of ramus (SB-MF).



**Figure 2: Vernier calliper.**



**Figure 3: Measurement from Vernier calliper.**

### **RESULTS**

A total of 50 dry human mandibles were taken and studied for the purpose of determining the precise location of the mandibular foramen. We calculated the mean and standard deviation for the above parameters on both sides and p value to assess any significant difference between the right and left side values shown in Table 1.

The mean distance of mandibular foramen from anterior border of ramus was 18.1 mm on right side and 18.2 mm from the left side. The mean distance of mandibular foramen from posterior border of ramus was 13.6 mm on right side and 13.5 mm on the left side. The mean distance of mandibular foramen from the mandibular base/or inferior body of ramus of the mandible was 26.5 mm on the right side and 26.8 mm on the left side. The mean distance of mandibular foramen from midpoint of the superior border of ramus on right side is 20.06 mm on right side and 19.9 mm on the left side.

**Table 1: Results of the present study.**

Position of mandibular foramen	Right side mean	right side standard deviation	Left side mean	Left side standard deviation	P value
<b>MF-AB</b>	18.1	2.4	18.2	1.77	0.813
<b>MF-PB</b>	13.6	2.16	13.5	1.92	0.753
<b>MF-BM</b>	26.5	3.0	26.8	2.8	0.600
<b>MF-SB</b>	20.06	2.25	19.9	2.70	0.155

For all the above parameters we calculated the p value which is more than 0.05, which means there was no difference when the values of the two sides were compared as shown in Table 1.

## DISCUSSION

The most conventional technique used to produce anaesthesia of the mandibular teeth gingivae of the mandible and the lower lip is the inferior alveolar nerve block (IANB). In some case, however, this nerve block fails, due to some errors even when performed by the most experienced clinicians.

The inferior alveolar nerve is a mandibular branch. The inferior alveolar nerve is responsible for sensory innervation to the gingivae on the lower jaw. During dental procedures, a local nerve block may be applied. Anesthetic injected near the mandibular foramen to block the inferior alveolar nerve and the nearby lingual nerve. The location of mandibular foramen is clinically important in achieving inferior alveolar nerve block. The inaccuracy in the precise localization of the mandibular foramen will lead to the failure to locate neurovascular bundle. The mandibular foramen cannot be palpated intraorally, so various anatomical landmarks and distance of mandibular foramen from these landmarks helps us in better localization of the mandibular foramen.

In the present study the location of the mandibular foramen and its distances from different bony landmarks on mandibles was done and compared with few other studies done previously.

Our study shows that the position of the mandibular foramen varies with individuals. Mandibular foramen on an average lies at a distance of  $18.1 \pm 2.4$  mm on right side and  $18.2 \pm 1.77$  mm on left side from the anterior border of ramus of the mandible. The average distance from the posterior border of ramus was found to be  $13.6 \pm 1.6$  mm on the right side and  $13.5 \pm 1.92$  mm on the left side of the ramus. Similarly, the distance of the mandibular foramen from the base or inferior border of the ramus was found to be  $26.5 \pm 0.30$  mm and  $26.8 \pm 0.28$  mm on the right side

and left side of mandible respectively. The mean distance of the mandibular foramen from the superior border or mandibular notch was found to be  $20.6 \pm 2.25$  mm and  $19.99 \pm 1.5$  mm on the right and left side respectively. The above findings are more or less similar to the findings of different studies carried out in different groups of Indian population. Israr et al studied the position of the mandibular foramen in North Indian population.<sup>8</sup> In their study they found that the mandibular foramen was situated at a mean distance of  $16.06 \pm 1.99$  mm from the anterior border and  $12.02 \pm 1.99$  mm from the posterior border respectively. 93 edentulous mandibles of Indian origin were studied by Thangavelu et al in 2011 according to them the mandibular foramen was located at a mean distance of  $18.9 \pm 2.14$  mm on right side and  $18.88 \pm 2.34$  mm on the left side from the anterior border of ramus of the mandible.<sup>9</sup> The mean distance from posterior border of the ramus was found to be  $14.31 \pm 1.82$  mm and  $14.39 \pm 1.79$  mm on right and left sides respectively. The mean distance of mandibular foramen from mandibular notch was 20.80 mm on right side and 20.54 mm on left side and from mandibular base was  $27.62 \pm 4.2$  mm on right side and  $27.30 \pm 4.19$  mm on left side.

A study carried out by Kilarkaji et al on middle east Asian mandibles found that the distance from mandibular foramen to anterior border of ramus was  $18.5 \pm 1.9$  mm on right side and  $18.5 \pm 2.0$  mm on left side, this study corresponds with the present study, in the present study the distance of the mandibular foramen to the anterior border of ramus was  $18.1 \pm 2.4$  mm on the right side and  $18.2 \pm 1.77$  mm on the left side.<sup>10</sup>

Sultana et al in their study found that the distance of the mandibular foramen from the base of the mandible was  $24.38 \pm 3.86$  mm on the right side and  $24.42 \pm 2.8$  mm on the left side, whereas, in our study it was seen that the distance of the mandibular foramen from the base of the mandible was  $26.5 \pm 3.0$  mm on the right side and  $26.8 \pm 2.8$  mm on the left side, respectively.<sup>3</sup>

Our findings are more or less similar to the findings of different studies carried out in different groups of Indian populations, like Thangavela et al, Kilarkaji et al and Prado et al.<sup>11</sup>

**Table 2: Comparison of studies on mandibular foramen (MF) by various authors.**

Author		MF-AB	MF-PB	MF-SB	MF-Base
Israr et al <sup>8</sup>	Right	16.09±1.99 mm	12.02±1.99 mm	18.26±2.79 mm	25.46±3.75 mm
	left	16.13±2.10 mm	11.1±1.95 mm	18.7±2.9 mm	24.9±3.8 mm
Thangavelu et al <sup>9</sup>	Right	18.9±2.14 mm	14.31±1.02 mm		27.62±4.2 mm
	left	18.88±2.34 mm	14.39±1.79 mm		27.30±4.19 mm
Kilarkaji et al <sup>10</sup>	Right	18.5±1.9 mm		21.6±3.1 mm	25.1±4.2 mm
	left	18.5±2.0 mm		21.6±3.4 mm	24.7±4.4 mm
Zafar et al <sup>3</sup>	Right	16.67±2.73 mm	12.67±2.37 mm	21.04±2.95 mm	24.38±3.86 mm
	left	16.56±2.52 mm	13.30±2.43 mm	20.24±2.94 mm	24.42±4.44 mm
Prado et al <sup>11</sup>	Right	19.2±3.6 mm	14.2±2.4 mm	23.6±3.0 mm	
	left	18.8±3.8 mm	13.9±2.6 mm	23.1±3.0 mm	
Present study	Right	18.1±2.4 mm	13.6±1.16 mm	20.06±2.25 mm	26.5±3.0 mm
	left	18.2±1.77 mm	13.5±1.92 mm	19.9±1.5 mm	26.8±2.8 mm

The knowledge of the location of the mandibular foramen (MF) from the anterior border (AB) and posterior border (PB) of the ramus helps the dental surgeons to locate the inferior alveolar nerve entry into the foramen correctly in neurectomy surgeries and nerve block techniques (Ajlan et al).<sup>12</sup> The knowledge of distance of MF from various landmarks would be helpful in innovating new techniques for using inferior alveolar nerve block. From our study, the position of the MF was determined by the distance of the MF from the anterior border, posterior border, superior border or mandibular notch and base or inferior border of the ramus of the mandible. It was found that the variability of the distances from the given landmarks was not significant enough to produce failure of anesthesia.

This study has some limitations. The gender and exact age of each mandible could not be ascertained.

## CONCLUSION

As it is being mentioned in various other studies that the anatomical variation of the mandibular foramen is the cause for the failure of the anesthesia, but our study found out that the MF was always at a level where the injected anesthetic agent could easily reach and produce inferior alveolar nerve block. It was found in this study that mandibular foramen MF was positioned at a mean distance of 18.1 mm (with SD 2.4) from anterior border of ramus. The variability of distance from AB to MF was not significant enough to produce failure of anesthesia. Deposition of solution around 21 mm (mean 18.2±2.4 mm for posterior movement of nerve) distance from the anterior border of ramus should produce nerve block in mandibles. So the deposition of anesthetic agent if spread equally from 21 mm to 24 mm of distance will produce effective alveolar nerve block. The placement of the tip of the needle superior to the mandibular foramen on complete insertion of 22 to 24 mm needle distance from the anterior border will deposit solution above foramen and nearer to nerve that bathes the infra alveolar nerve resulting in effective nerve block. So, from our study we concluded that the failure of anesthesia of infra-alveolar

nerve block is due to the technical error during the injection of the anesthetic agent and not due to the variations in the location of the mandibular foramen.

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