

Original communication**MORPHOMETRIC ANALYSIS OF MANDIBULAR FORAMEN AND INCIDENCE OF ACCESSORY MANDIBULAR FORAMINA IN ADULT HUMAN MANDIBLES OF AN INDIAN POPULATION****Prajna Paramita Samanta, Poonam Kharb***Department of Anatomy, School of Medical Sciences & Research, Sharda University, Greater Noida, India***RESUMEN**

El foramen mandibular es un importante hito anatómico. Para procedimientos como el bloqueo alveolar inferior del nervio, el tratamiento con implantes y osteotomías mandibulares, un profundo conocimiento de la ubicación del foramen mandibular (MF) y el foramen mandibular accesorio (AMF) es un requisito previo. Hay pocas referencias en la literatura con respecto a la localización anatómica exacta del foramen mandibular. Por lo tanto, el presente estudio tuvo como objetivo identificar la ubicación exacta de la MF y la incidencia de la AMF alrededor MF en una población india. Sesenta (60) mandíbulas humanas adultas fueron estudiadas para determinar la distancia del LV de la los anteriores, bordes posteriores de la rama mandibular, maxilar inferior categoría y el ángulo de la mandíbula. AMF todo el MF también fueron estudiados por su presencia y números. La distancia media de MF del borde anterior de rama mandibular fue $15,72 \pm 2,92$ mm (lado derecho), $16,23 \pm 2,88$ mm (lado izquierdo), de borde posterior fue $13,29 \pm 1,74$ mm (lado derecho) y $12,73 \pm 2,04$ mm (a la izquierda lado). La MF se encuentra $22,70 \pm 3$ mm (lado derecho) y $22,27 \pm 2,62$ mm (lado izquierdo) de la muesca mandibular. La distancia de MF de ángulo de la mandíbula fue $21,54 \pm 2,92$ mm (lado derecho) y $21,13 \pm 3,43$ mm (lado izquierdo). AMF estuvieron presentes en el 16,66% de las mandíbulas. En 10% de las mandíbulas una sola AMF estaba presente y en el 6,66% hubo dos agujeros presentes. La ubicación del MF y AMF es importante para evitar complicaciones como hemorragia y parestesia durante los procedimientos quirúrgicos orales y también para los radioterapeutas en la planificación de la radioterapia.

Palabras clave: Foramen mandibular, foramen mandibular accesorio, bloqueo nervioso, diseminación del tumor.

ABSTRACT

The mandibular foramen is an important anatomical landmark. For procedures like inferior alveolar nerve block,

implant treatment and mandibular osteotomies, a thorough knowledge of the location of the mandibular foramen (MF) and accessory mandibular foramina (AMFs) is a prerequisite. There are few references in the literature regarding the exact anatomical location of the mandibular foramen. Therefore, the present study was aimed to identify the precise location of the MF and the incidence of AMFs around MF in an Indian population. Sixty (60) adult human mandibles were studied to determine the distance of the MF from the anterior, posterior borders of the mandibular ramus, mandibular notch and angle of the mandible. AMFs around the MF were also studied for their presence and numbers. The average distance of MF from the anterior border of mandibular ramus was 15.72 ± 2.92 mm(right side), 16.23 ± 2.88 mm(left side), from posterior border was 13.29 ± 1.74 mm(right side) and 12.73 ± 2.04 mm(left side).The MF was located 22.70 ± 3 mm (right side) and 22.27 ± 2.62 mm(left side) from mandibular notch. The distance of MF from angle of mandible was 21.54 ± 2.92 mm (right side) and 21.13 ± 3.43 mm (left side). AMFs were present in 16.66% of mandibles. In 10% mandibles a single AMF was present and in 6.66 % double foramina were present. Location of MF and AMF is important to avoid complications like hemorrhage and paresthesia during oral surgical procedures and also for radiotherapists in planning radiation therapy.

Keywords: Mandible foramen; accessory mandible foramen; nerve block; tumor spread.

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INTRODUCTION

The mandibular foramen (MF) is an irregular foramen located a little above the center of the mandibular ramus on its medial surface. The inferior alveolar nerve (IAN) and vessels pass through the MF and traverse the mandibular canal to supply the mandibular teeth (Williams et al, 1995; Datta, 1999). One of the commonest local anaesthetic technique used in dental practice is IAN block. Unfortunately the failure rate of this technique is high and commonest cause being inaccurate localization of mandibular foramen (Oguz and Bozkir, 2002; Ennes and Medeiros, 2009). References in the literature are scarce regarding the anatomical location of the mandibular foramen. Therefore, the present study aims to determine the precise location of the MF from various anatomical landmarks such as anterior, posterior borders of mandibular

ramus, angle of mandible and from mandibular notch in an Indian population.

Any openings in the mandible other than the sockets of the teeth, mandibular foramina, mental foramina and lingual foramen are referred as accessory mandibular foramina (AMFs) (Sutton, 1974). The Presence of AMFs and additional branches of IAN may lead to failure of a block injection as anaesthetic solution may not be deposited around them. However, AMFs may also only be associated with blood vessels and devoid of sensory elements which would explain why their presence is not always associated with difficulty in mandibular anesthesia (Lew and Town, 2006). AMFs also provide an easy route for the spread of infection and tumor cells following radiotherapy (Fanibunda and Matthews, 1999). The objective of the present study was also to determine the incidence of AMFs around MF in an Indian population.

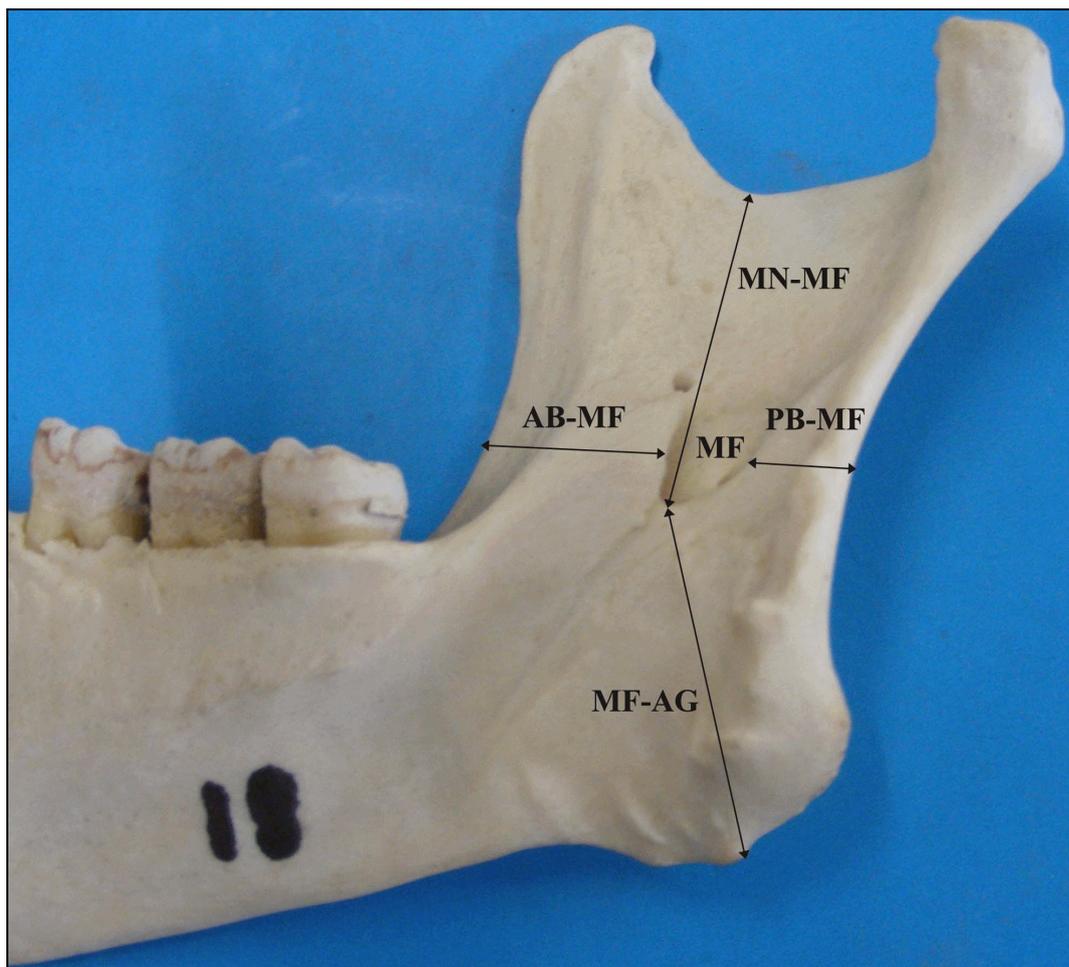


Figure 1: Picture showing measurements of mandibular foramen from various mandibular landmarks (a) anterior border (AB- MF), (b) posterior border (PB-MF), (c) lowest point of mandibular notch (MN-MF), (d) angle of the mandible (MF-AG). AB- anterior border, PB- posterior border, MN-mandibular notch, AG-angle of mandible

MATERIALS AND METHODS

The study was conducted on sixty adult Indian mandibles (Indian subcontinent) which were procured from the bone bank of Anatomy department of School of Medical Sciences & Research and Krishna Dental College. The gender and exact age of each mandible was not known. The mandibles which had sockets for third molars were selected for the study. To precisely locate the mandibular foramen, the following parameters were studied for both the sides of mandibles [Figure 1] a. distance from midpoint of the anterior margin of MF (AB-MF) to the nearest point on the anterior border of mandibular ramus b. distance from the midpoint of the posterior margin of MF (PB-MF) to the nearest point on the posterior border of mandibular ramus c. distance from the lowest point of mandibular notch to the inferior limit of

MF (MN-MF) and d. distance from inferior limit of MF to the furthest point on the angle of the mandible (MF-AG) i.e., where inferior border of mandibular ramus meets its posterior border. All the measurements were made using a divider with two fine tip ends and then transferred to a sliding caliper. The distances from the MF to various landmarks were recorded as an average of two measurements which were measured independently by two different people. The mean and standard deviation for each distance were calculated separately for right and left sides. The comparison of mean values of the right and left sides was made by using student's t- test.

The mandibles were further observed for the presence of AMFs around MF on the medial surface of mandibular ramus by means of a simple visual observation with the help of a magnifying glass and if present, their prevalence rate was analyzed [Figure 2].

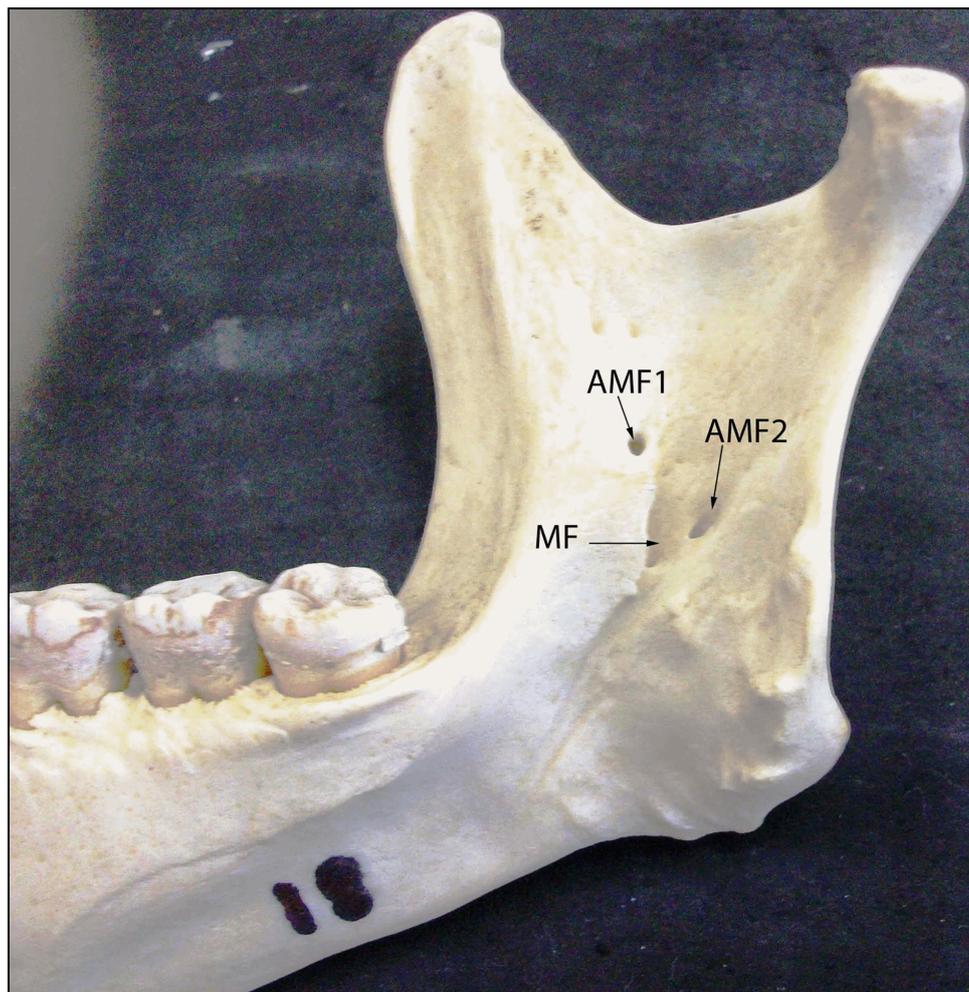


Figure 2: Medial surface of mandibular ramus showing mandibular foramen (MF) and accessory mandibular foramina (AMF1 and AMF2).

RESULTS

The mean and standard deviation (SD) values of the distance of MF from the anterior and posterior borders of mandibular ramus, mandibular notch and angle of the mandible on the right and left sides of the mandibles are shown in Table 1.

The mean distance of the MF from anterior border of mandibular ramus was 15.72 ± 2.92 mm (right side), 16.23 ± 2.88 mm (left side), from posterior border was 13.29 ± 1.74 mm (right side) and 12.73 ± 2.04 mm (left side). The MF was

located 22.70 ± 3 mm (right side) and 22.27 ± 2.62 mm (left side) from mandibular notch. The distance of the MF from the angle of mandible was 21.54 ± 2.92 mm (right side) and 21.13 ± 3.43 mm (left side). Figure 3 shows the means and SDs of the distance of MF from the anterior and posterior borders of mandibular ramus, mandibular notch and angle of the mandible.

AMFs were present in 16.66% of mandibles. In 10% mandibles a single AMF was present and in 6.66 % double foramina were observed.

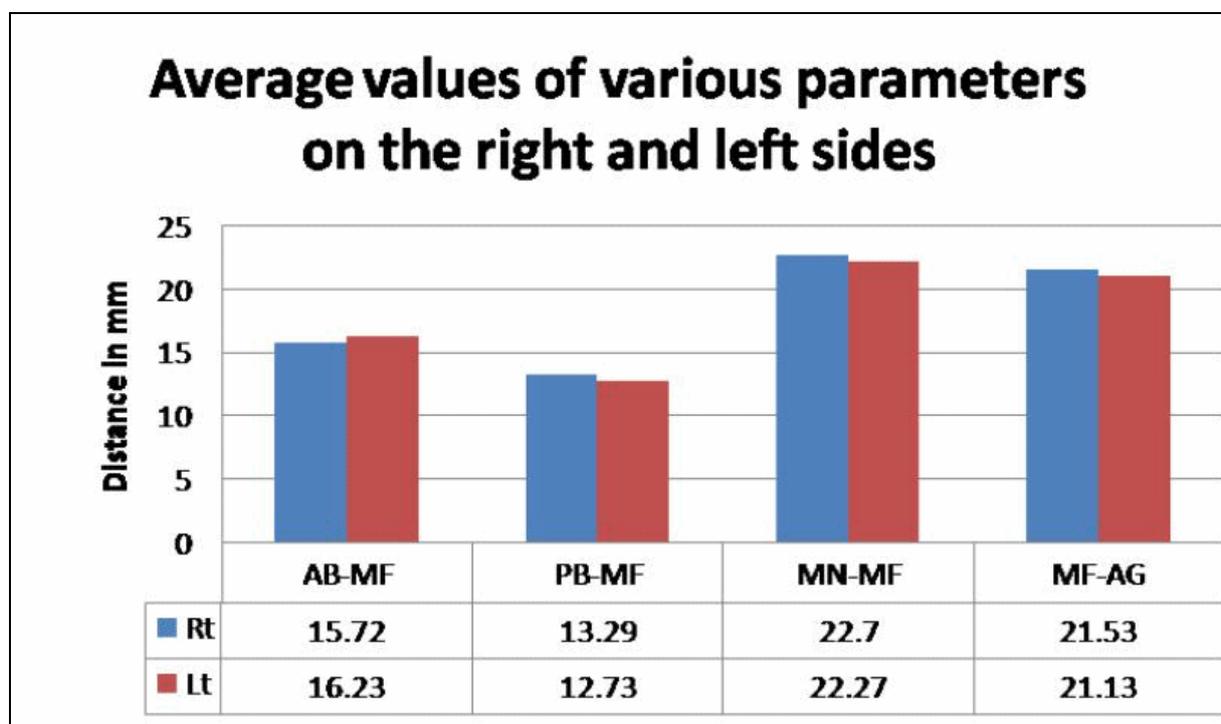


Figure 3: Bar diagram showing the distances of mandibular foramen (MF) from anterior, posterior borders of mandibular ramus, mandibular notch and angle of mandible on right and left sides of mandible.

DISCUSSION

The position of the mandibular foramen (MF) has been found to be variable. The variability of the position of the MF makes it difficult to anaesthetize the inferior alveolar nerve (IAN) (Nicholson, 1985; Afsar et al, 1998).

Various parameters have been used by different authors to locate the MF as shown in Table 2. Earlier studies conducted to locate the position of MF reported variations in the distances measured from the MF to various landmarks on the mandibular ramus which could be due to

differences in the age, sex, population and methodologies used in these studies. According to Thangavelu et al (2012), the MF was positioned at 19 ± 2.34 mm from the anterior border of ramus. In South Indian mandibles the average distance of MF was 16mm, 13mm from anterior, posterior borders of mandibular ramus and 20-25mm from mandibular notch (Verma et al, 2011). In dry mandibles of East Indian ethnic origin, the MF was found to be located at the anteroposterior midpoint of the ramus halfway between the lower surface of the mandible and the mandibular notch (Nicholson, 1985). Thai

mandibles showed the average distance of the MF and anterior border (external oblique line) and anterior border (internal oblique line) were $19.76 \pm 3.8\text{mm}$ and $14.33 \pm 6.7\text{mm}$ respectively.

The MF was located $23.60 \pm 5.6\text{mm}$ from mandibular notch and $25.01 \pm 4.5\text{mm}$ from angle of mandible (Yadaridee and Vasana, 1989).

Measurement	Side	Mean(mm)	Standard deviation(SD)	Min-Max (mm)
AB-MF	Right	15.72	2.92	10-25
	Left	16.23	2.88	9-22
PB-MF	Right	13.29	1.74	6-16
	Left	12.73	2.04	5-17
MN-MF	Right	22.70	3.00	16-29
	Left	22.27	2.92	12-27
MF-AG	Right	21.54	2.92	12-30
	Left	21.13	3.43	12-30

Table 1: Distance of Mandibular foramen (MF) from various mandibular landmarks. AB-MF (Distance of MF from anterior border), PB-MF (Distance of MF from posterior border), MN-MF (Distance of MF from mandibular notch), MF-AG (Distance of MF from angle of mandible). AB- anterior border, PB- posterior border, MN-mandibular notch, AG-angle of mandible.

Reported cases of accessory mandibular foramina (AMFs) are very few. In a study conducted on south Indian population, the AMF was present in 16.4% mandibles. A single AMF was found in 9 cases and double in 2 cases (Murlimanju et al, 2011). Narayana and Prashanthi (2003) observed the incidence of large AMF in human mandibles to be 0.3%. In a Brazilian population 27.93% and 43.24% of the mandibles presented at least one mandibular accessory foramina located on the medial surface, located either below or above the mandibular foramen respectively (Freire et al, 2012). In the present study an AMF was present in 16.66% of mandibles. A single AMF was present in 10% mandibles and in 6.66 % mandibles, double AMFs were observed. All the AMF were present on the medial surface of the mandibular ramus which is in accordance with the previous authors (Haveman and Tebo, 1976; Das and Suri, 2004).

The presence of AMFs could be associated with additional branches of the inferior alveolar nerve (IAN) given before the nerve enters the MF. The additional branches of IAN may arise in the infratemporal fossa and may enter the mandible through the accessory foramina to supply molar teeth (Haveman and Tebo, 1976). Das and Suri (2004) passed a metallic wire through an AMF and examined it radiologically and found that the neurovascular bundle passing through it supplied the root of the third molar tooth. A proper understanding of the presence or absence of these foramina can provide valuable information regarding the branching pattern of the IAN. When the branches of IAN pass through these accessory foramina, they might escape local anesthesia and can result in failure of an inferior alveolar nerve block. So dentist and oro-maxillo-facial surgeons operating this area should have a prior knowledge of these foramina.

Authors	AB- MF(mm)	PB- MF(mm)	MN- MF(mm)	MF-AG(mm)
Oguz et al(2002)	Right:16.9 Left :16.78	Right:14.09 Left :14.37	Right:22.37 Left :22.17	–
Kilarkaje et al(2005)	Right:18.5±1.9 Left :18.5±2.0	–	Right:21.6±3.1 Left :21.6±3.4	Right:25.1±4.2 Left :24.7±4.4
Ennes et al(2009)	Right:9.4-20.3 Left : 6.9-20.6	Right:8.6-18.2 Left :8.4-17.7	Right:18.3-32.5 Left :17.5-33.7	–
Prado et al(2010)	Right:19.2±3.6 Left :18.8±3.8	Right:14.2±2.4 Left :13.9±2.6	Right:23.6±3.1 Left :23.1±3.0	–
Varsha Shenoy et al(2012)	Right:16.1 Left :16.3	Right:11.7 Left :11.3	Right:23.6 Left :23.6	–
Present study (Indian population)	Right:15.72±2.92 Left 16.23±2.88	Right:13.29±1.74 Left :12.73±2.04	Right:22.70±3.0 Left:22.27±2.92	Right:21.54±2.92 Left :21.13±3.43

Table 2: Showing studies on mandibular foramen by various authors. AB-MF (Distance of mandibular foramen (MF) from anterior border, PB-MF (Distance of MF from posterior border), MN-MF (Distance of MF from mandibular notch), MF-AG (Distance of MF from angle of mandible).

The branching pattern of the inferior alveolar nerve (IAN) may also show several variations within the mandibular canal. It may either run as single trunk giving branches to molar and premolar teeth or give a major and minor trunk near the MF, the major trunk after traversing through the mandibular canal comes out through mental foramen whereas the minor trunk after innervating molar and premolar teeth becomes incisive nerve. The IAN may also give branches for molar and premolar teeth, for canine and incisor teeth and for mental foramen near the MF (Rodella et al, 2008). Developmentally the presence of double mandibular canals can be

explained as the incomplete fusion of three inferior alveolar nerves that develop initially to innervate three groups of mandibular teeth (Chavez et al, 1996). Accessory foramina may provide a route for spread of infections and tumor following radiotherapy (Fanibunda and Matthews, 1999).

The precise location of the MF will help surgeons avoid injury to the neurovascular bundles followed by complications like paresthesia and haemorrhage and it will also increase the success rate of dental anesthesia. Knowledge of AMFs will help dentists and oro-maxillo-facial surgeons in avoiding damage to the neuro-

vascular structures and help oncologists in radiation therapy planning.

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