

Gender-based Morphometric Analysis of Mandibular Foramen in Dry Adult Human Mandibles in the Tertiary Care Centre, Dehradun: A Cross-sectional Cadaveric Study

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ABSTRACT

Introduction: The knowledge of the location of the Mandibular Foramen (MF) is important for effective local anaesthesia in dental surgeries and mandibular implants. The location of the foramen can vary in different populations, but very few studies have explored the differences between males and females.

Aim: To estimate the morphometric parameters of the MF in male and female dry adult mandibles.

Materials and Methods: A cross-sectional cadaveric study was conducted in the Department of Anatomy at Shri Guru Ram Rai Institute of Medical and Health Sciences, Dehradun (Uttarakhand) India, from October 2019 to December 2022. The location of MF in 75 dry adult male mandibles and 50 dry adult female mandibles was measured. All the anatomical parameters (MF to Anterior Border of mandibular ramus (MF-AB), MF to Posterior Border of mandibular ramus (MF-PB), MF to Mandibular Notch (MF-MN), MF to Angle of Mandible (MF-AG), MF to Inferior Border of mandibular ramus (MF-IB), MF to Mandibular Condyle (MF-MC), MF to apex of Retromolar Trigone (MF-RT), and AB of mandibular ramus to PB of mandibular ramus (AB-PB)) were measured using a sliding digital vernier caliper in both genders, based on the right and left mandibular foramina from different bony landmarks. Continuous data obtained was expressed as mean±Standard Deviation (SD).

Analysis was done by applying an independent t-test via Statistical Package for Social Sciences (SPSS) version 23.0.

Results: MF-IB was 26.09 mm±3.52 mm (RT) and 25.31 mm±3.24 mm (LT) in males, while it was 24.29 mm±3.27 mm (RT) and 24.12 mm±3.21 mm (LT) in females. The difference was found to be statistically significant ($p<0.05$), implying that the distance is larger in males as compared to females. MF-MC was 35.59 mm±4.44 mm (RT) and 34.89 mm±4.91 mm (LT) in males and 32.39 mm±4.11 mm (RT) and 32.52 mm±4 mm (LT) in females. The difference between the two was found to be statistically significant ($p<0.05$). MF-RT in males was 11.41 mm±2.19 mm (RT) and 11.87 mm±2.57 mm (LT), while in females, it was 11.40 mm±2.05 mm (RT) and 11.30 mm±2.09 mm (LT). The difference between these two was statistically significant ($p<0.001$) on the left-side. AB-PB was longer on the right-side in males (32.31 mm±3.05 mm) than in females (21.66 mm±3.0 mm), and the difference was statistically significant ($p<0.001$). Therefore, the results imply that the MF is located lower and slightly more anteriorly in males as compared to females.

Conclusion: The results indicate significant differences in the location of the male and female MF. The present study provides useful information for successful inferior alveolar nerve blocks during dental surgeries and maxillofacial surgeries.

Keywords: Dental surgery, Head and neck anatomy, Inferior alveolar nerve block

INTRODUCTION

Mandible, the strongest bone of the lower jaw in humans, has a horseshoe-shaped body facing anteriorly and two vertically oriented rami posteriorly [1]. The mandibular ramus bears two processes: the coronoid process and the condylar process. The condylar process articulates with the mandibular fossa on the temporal bone to form the temporomandibular joint [2]. The mandibular ramus comprises four borders: anterior, superior, inferior, and posterior, and two surfaces: a medial (inner) surface and a lateral (outer) surface [3]. An irregular foramen called mandibular foramen (MF) is located on the medial surface of the mandibular ramus. This foramen gives passage to the inferior alveolar nerve and vessels, which pass through the mandibular canal anteroinferiorly and emerge through the mental foramen on the lateral surface, becoming the mental nerve and vessels [4]. The location of the MF may vary based on age and gender [5]. A local anaesthetic technique used in dental practice is called the inferior alveolar nerve block. The common cause for the failure of the inferior alveolar nerve block is the inability to palpate the landmarks in patients [6]. Localisation of the MF is essential for facial surgeries involving the lower jaw, especially for dental and maxillofacial injuries [7].

Previous studies have noted considerable morphometric differences in the location of the MF among different populations in various geographical regions [8-10] and races [11]. However, few studies have explored the differences between male and female mandibles [11,12]. There is a lack of evidence regarding gender-based differences between male and female mandibles in the population of Uttarakhand, a hilly state located in the Himalayan region of India.

In view of the aforementioned facts, a study was conducted in a tertiary care teaching hospital located in the hilly state of Uttarakhand to estimate the morphometric parameters of the MF in male and female dry adult mandibles. A part of the study on different parameters was published [6], in which it was observed that the foramen is located lower and slightly more posteriorly in the study population compared to other areas.

MATERIALS AND METHODS

The present study was a cross-sectional cadaveric study conducted in the Department of Anatomy at Shri Guru Ram Rai Institute of Medical and Health Sciences, Dehradun (Uttarakhand) from October 2019 to December 2022. The study examined dry adult human

mandibles available in the Department of Anatomy after obtaining ethical clearance from the Institute Ethics Committee (IEC) with the number SGRR/IEC/02/22.

Inclusion criteria: A total of 75 dry adult male mandibles and 50 dry adult female mandibles that showed no apparent deformities and had complete ossification were included in the study.

Exclusion criteria: Mandibles that were damaged, disfigured, or diseased, and those where gender couldn't be determined, were excluded from the study.

Study Procedure

Male mandibles were identified based on morphological parameters such as gonial flaring, everted AG, smaller mental eminence compared to females, a higher symphysis menti, and broader ascending ramus [13,14].

The study focused on measuring and analysing several parameters related to the morphometric anatomy of the mental foramen (MF) on both the right (RT) and left (LT) sides:

- MF to Anterior Border of the mandibular ramus (MF-AB)
- MF to Posterior Border of the mandibular ramus (MF-PB)
- MF to Mandibular Notch (MF-MN)
- MF to Angle of Mandible (MF-AG)
- MF to Inferior Border of the mandibular ramus (MF-IB)
- MF to Mandibular Condyle (MF-MC)
- MF to apex of Retromolar Trigone (MF-RT)
- AB of the mandibular ramus to PB of the mandibular ramus (AB-PB)

Data collection involved measuring these parameters on both sides using a well-calibrated digital Vernier caliper with an accuracy of 0.01 mm [Table/Fig-1]. The distances between the foramen and the closest points on the AB, PB, IB, MN, AG, apex of RT, and MC were measured. Additionally, the horizontal distance between the anterior and PB of

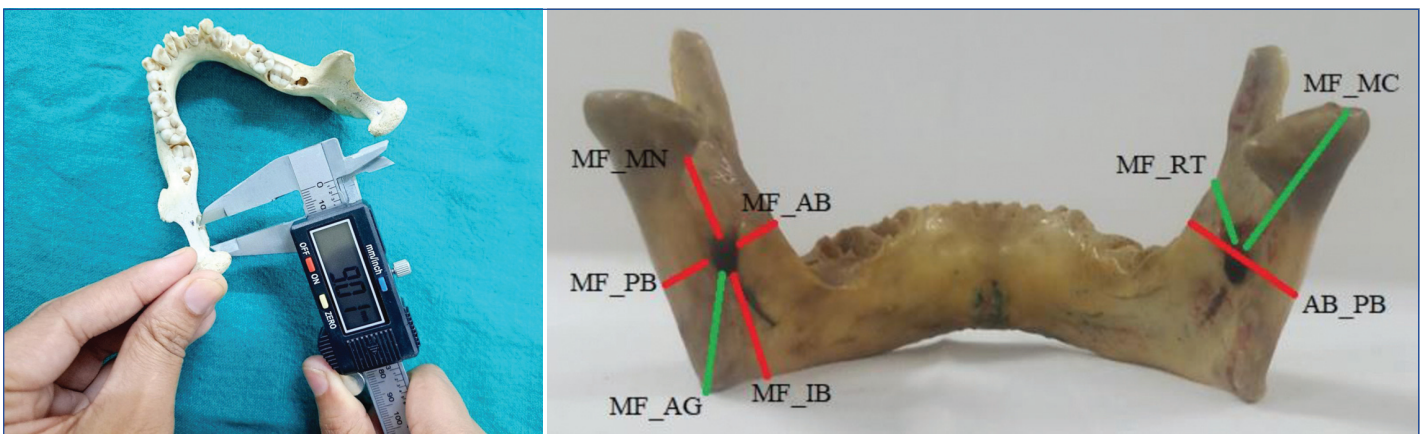
the mandibular ramus was measured using an imaginary line passing through the MF. The measurements can be found in [Table/Fig-2].

STATISTICAL ANALYSIS

The data collected above were entered into Microsoft Excel 2016 (Microsoft Corp., USA). The continuous data was expressed as mean and SD for both genders to facilitate comparison. To analyse any associations between variables, an independent sample t-test was performed using SPSS version 23.0 (IBM Corp., USA). A significance test with a p-value ≤ 0.05 was considered statistically significant for all purposes.

RESULTS

The mean \pm SD of various parameters recorded in male and female mandibles are shown in [Table/Fig-3]. In males, the MF-IB was 26.09 mm \pm 3.52 mm (RT) and 25.31 mm \pm 3.24 mm (LT), while in females, it was 24.29 mm \pm 3.27 mm (RT) and 24.12 mm \pm 3.21 mm (LT). The difference was found to be statistically significant (p=0.002), indicating that the distance is larger in males compared to females. For MF-MC, the measurements were 35.59 mm \pm 4.44 mm (RT) and 34.89 mm \pm 4.91 mm (LT) in males, and 32.39 mm \pm 4.11 mm (RT) and 32.52 mm \pm 4 mm (LT) in females. The difference between the two was also statistically significant (p<0.05). Regarding MF-RT, the measurements in males were 11.41 mm \pm 2.19 mm (RT) and 11.87 mm \pm 2.57 mm (LT), while in females, they were 11.40 mm \pm 2.05 mm (RT) and 11.30 mm \pm 2.09 mm (LT). The difference between these two measurements was statistically significant (p<0.001) on the left side. On the other hand, AB-PB was longer on the right side in males (32.31 mm \pm 3.05 mm) compared to females (21.66 mm \pm 3.0 mm), and this difference was statistically significant (p<0.001). There were no statistically significant differences found in MF-AB, MF-PB, MF-MN, and MF-AG between male and female mandibles.



[Table/Fig-1]: Measurement of distance between Mandibular Foramen (MF) and Posterior Border (PB) of ramus. **[Table/Fig-2]:** Measurements of the various study parameters in relation to the Mandibular Foramen (MF).

Measurement	Right-side			Left-side		
	Male Mean \pm SD (mm)	Female Mean \pm SD (mm)	p-value	Male Mean \pm SD (mm)	Female Mean \pm SD (mm)	p-value
MF-AB	15.95 \pm 1.81	16.31 \pm 2.57	0.343	16.97 \pm 2.26	16.34 \pm 2.41	0.447
MF-PB	10.99 \pm 1.67	11.23 \pm 1.91	0.162	11.28 \pm 1.96	10.54 \pm 1.84	0.893
MF-IB	26.09 \pm 3.52	24.29 \pm 3.27	0.002*	25.31 \pm 3.24	24.12 \pm 3.21	0.089
MF-MN	19.86 \pm 2.90	18.90 \pm 2.97	0.815	19.73 \pm 3.36	19.06 \pm 3.27	0.823
MF-MC	35.59 \pm 4.44	32.39 \pm 4.11	<0.001*	34.89 \pm 4.91	32.52 \pm 4.01	0.003*
MF-AG	20.51 \pm 3.23	20.62 \pm 2.78	0.834	21.89 \pm 3.26	21.66 \pm 3.09	0.862
MF-RT	11.75 \pm 3.03	11.40 \pm 2.05	0.777	11.87 \pm 2.57	11.30 \pm 2.09	<0.001*
AB-PB	32.31 \pm 3.05	21.66 \pm 3.0	<0.001*	31.76 \pm 3.03	20.62 \pm 2.72	0.293

[Table/Fig-3]: Descriptive characteristics of mean distances of MF to various landmarks on mandible bone in both the genders.

*indicates statistically significant

SD: Standard deviation; mm: Millimetre; MF: Mandibular foramen; AB: Anterior border; PB: Posterior border; IB: Inferior border; MC: Mandibular condyle; MN: Mandibular notch; AG: Angle of mandible; RT: Retromolar trigone

DISCUSSION

In the present study, the mean distance from the anterior margin of the MF to the closest point of AB on the right side was 15.95 mm, and 16.97 mm on the left side in males. In females, these values were 16.63 mm on the right side and 16.34 mm on the left side. The mean distance from the closest point of the posterior margin of the MF to PB of the mandibular ramus was 10.99 mm on the right side and 11.28 mm on the left side in males. In females, the mean values for the same were 11.23 mm on the right side and 10.54 mm on the left side. Similar findings were reported by Mohite DP et al., and Thunyacharoen S et al., [15,16]. Mohite DP et al., [15] measured the distance of the MF from the posterior, anterior, and superior border and found that the mean distance was significantly larger ($p < 0.05$) on the right side (antero-posterior 14.88 mm, posteroanterior 14.90 mm) compared to the left side (antero-posterior 14.60 mm, posteroanterior 14.62 mm) [15]. Thunyacharoen S et al., observed statistically significant differences between AB-PB ($p < 0.05$), MF-IB ($p < 0.05$), MN-IB ($p < 0.05$), and MF-PB on the right side ($p = 0.003$) in males vs. females (dimensions significantly larger in males) [16].

Shalini R et al., reported that the distance from AB to PB of the MF was 31.76 mm on the right side and 31.49 mm on the left side, which is quite similar to our study [17]. In the present study, the mean horizontal distance from AB to PB of the mandibular ramus was 32.31 mm on the right side and 31.76 mm on the left side in males, and 21.66 mm on the right side and 20.62 mm on the left side in females. The mean distance from the MF to the apex of RT was 11.41 mm on the right side and 11.87 mm on the left side in males. In females, the mean distance for the same was found to be 11.40 mm on the right side and 11.30 mm on the left side, which was found to be statistically significant. Similarly, differences in the measurements of the MF from the apex of RT have been found by Valente VB et al., who observed that the distance between the MF to RT was slightly larger on the left side (14.40 ± 2.48 mm) compared to the right side (14.23 ± 2.57 mm), although no statistical correlation could be established [18].

It is pertinent to note that the anatomical study was conducted on dry human mandibles that were processed for teaching and demonstration purposes in the department. Further studies are required in clinical settings to corroborate the findings in live individuals. Imaging techniques such as cone beam computed tomography and/or panoramic radiography can be used to conduct such clinical studies.

Limitation(s)

The results of the present study were based on the assessment of dry mandibles, and the morphology of the bone may be slightly affected depending on the processing method used for bone retrieval from the cadavers. Secondly, an imaging-based clinical study from this geographical region could help to correlate the findings from the dry mandibles with those of living participants. Such correlation could not be done in the present study due to the lack of clinical studies in this region.

CONCLUSION(S)

There are significant morphometric differences in the male and female mandibles, with the mental foramen being positioned lower and slightly more anterior in males compared to females. Therefore, such differences must be kept in mind before attempting anaesthetic techniques, such as the inferior alveolar nerve block. Failure to judge this correctly can result in the failure of the nerve block or complications, such as trauma to the neurovascular bundle.

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