Journal of Research in Medical and Dental Science
2021, Volume 9, Issue 2, Page No: 150-155

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Morphological and Morphometric Analysis of Mandibular Foramen and Lingula with Reference to Gonial Angle in Dry Human Mandibles

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ABSTRACT

The purpose of this study was to examine and analyze the position of the MF and linguala with Gonial angle in dry human mandibles. The position of mandibular foramen (MF) is an important anatomical landmark for effective anesthesia in dentistry for many procedures, including dental extraction from the lower jaw and putting mandibular implants. Several causes have been examined in this context, and the uncertainty in the location of the MF has been examined to be a major factor for the high failure rate of anesthesia and complications of the orthodontic procedure. The different parameters were measured in 100 dry adult's mandibles that were obtained from the Department of Anatomy. The data were tabulated and statistically analyzed. The mean distance between the MF and the respective landmarks was noted as 16.00 ± 3.50 mm for the anterior border, 10.21 ± 2.34 mm for the posterior border, 20.48 ± 3.89 mm for the superior border, 24.15 ± 4.97 mm for the inferior border, 33.46 ± 6.08 mm for the condyle, and 12.31 ± 4.88 mm for the internal oblique ridge for the right side. The precise localization of mandibular foramen is very important to achieve a successful inferior alveolar nerve block, prior to dental surgeries in the lower jaw like osteotomy, orthognathic reconstruction surgeries of the mandible and dental implant procedures, and also to avoid injury to the neurovascular contents passing through it.

Key words: Human mandibles, Mandible, Mandibular condyle, Mandibular foramen, Linguala

HOW TO CITE THIS ARTICLE: Ditty J Mary, Karthik Ganesh Mohanraj, Morphological and Morphometric Analysis of Mandibular Foramen and Lingula with Reference to Gonial Angle in Dry Human Mandibles, J Res Med Dent Sci, 2021, 9 (2): 150-155.

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Received: 23/09/2020

Accepted: 22/01/2021

INTRODUCTION

The correct identification of mandibular foramen (MF) is important to avoid complications not only during the performance of surgical procedures involving the region of lingula, but also in the inferior alveolar nerve anesthesia. The knowledge of position of mandibular foramen is necessary while anaesthetizing palate during periodontal procedures, tooth extractions and maxillofacial surgeries [1,2]. The MF corresponds to the opening of the mandibular canal through which it penetrates the inferior alveolar vascular-nervous bundle, which is situated inferiorly and posteriorly to the greatest prominence of the lingula. The gonial angle can also be a handy tool in near age assessment in extreme situations like mass disaster, remains of human dead exhumed and murderous mutilations, missing individuals, etc. [3,4].

The mandibular foramen (MF) is an irregular foramen located a little above the center of the medial surface of the mandibular ramus. The inferior alveolar nerve and vessels pass through the MF and traverse the mandibular canal and divides into mental and incisive branches to supply the mandibular teeth and participates in the formation of the anterior loop [5,6]. Inferior alveolar nerve block is a common local anaesthetic technique used in dental practice. But the failure rate of this technique is reported to be as high as 20%–25% [7]. The commonest cause for inferior alveolar nerve block failure is inaccurate localization of MF [8]. The main complications during this technique are hemorrhage, injury to the neurovascular bundle, fractures, and necrosis of mandibular ramus [9]. Hence, thorough knowledge of the mandibular ramus is very essential.

Sutton et al. [10], have reported that the position of the MF is 1cm above the occlusal plane of the lower molars, and is also at the same height of

the gingival papillae of the upper teeth when the individual is with his mouth closed. But, Samanta et al. [11], has said that, there is variability of the two mandibular rami in the same person, and it is not possible to standardize the foramen identification. Studies have conclusively proved that there are significant morphological differences in the mandibular anatomy among the three major racial groups—Caucasoid, Mongoloid, and Negroid.

Accessory MF is any opening in the mandible other than the MF, mental foramen, lingual foramen, and sockets of teeth [12,13]. The presence of accessory MF and additional branches of inferior alveolar nerve may lead to increased rates of failure of inferior alveolar nerve blocks as all the branches may not be anaesthetized [14]. The accessory MF has also been reported to be the site for the spread of tumours following radiotherapy in the lateral surface of the mandible [15]. So the knowledge of accessory MF is imperative to radiotherapists when planning for radiation therapy in the lateral mandibular region.

Therefore, the present study aims to determine the precise location of the MF from various anatomical landmarks such as anterior and posterior borders of the mandibular ramus, mandibular notch, and base of the ramus, third molar tooth and retro molar trig one from mandibles of South Indian population. This study aims to identify the MF location in relation to the limits of mandibular ramus and to the quadrant of the ramus, taking horizontal and vertical directions. The presence of accessory MF was also noted. Lingula was first described by Johannes – Baptist as 'Spix ossicle or spine' in 1815 [16]. Nicholson reported variation of height and shape of lingula upon examination of adult mandibles of East Indian ethnic origin, but no description was mentioned [17]. Tuli et al., studied adult mandibles of Indian origin and first described different morphological shapes of lingula as triangular, truncated, nodular and assimilated types [18]. Previous study was also conducted to identify the position of lingula using structures present on the external surface of mandibular ramus known as 'anti-lingula', though it might not be always present [19]. The variant shape of lingula can also be used as anthropological marker to assess different population along with other non-metric variants of skull [20].

Considering the close relationship of lingula with neurovascular structures entering through mandibular foramen, lingula is often used as an important bony landmark for different maxillofacial surgical interventions and inferior alveolar nerve block anaesthesia which are commonly done in dentistry. Inadequate knowledge about structural variations of lingula leading to inaccurate localization of mandibular foramen may result in intraoperative complications like hemorrhage, fractures and even damage to inferior alveolar nerve [21,22]. Difficulty in localizing mandibular foramen resulting from variations of lingula has also been implicated as a causative factor for unsuccessful inferior alveolar nerve block anaesthesia. Failure of inferior alveolar nerve block anaesthesia has been described as high as 45% of which nearly 10-15% failure rate are attributed to structural variations of lingula [14,23]. Previous literature indicated studies which have been performed to widen the scope for better understanding of morphology and morphometric of lingula based on anthropometric location of surrounding mandibular landmarks

MATERIALS AND METHODS

The study was conducted in 104 adult dry human mandibles of unknown sex and age collected from the bone bank of Anatomy department of Saveetha Dental College and Hospital, Chennai. Mandibles with sockets for third molar teeth, those in regular shape, and devoid of deformities were selected. The damaged bones and those having pathological abnormalities were excluded. To precisely locate the mandibular foramen, the following parameters were measured on both sides of the mandible with sliding vernier calipers of 0.1 mm accuracy. Image showing the mandible and the ramus of the mandible to show the mandibular foramen and lingula with its morphometric coordinates are shown in Figures 1 & 2 below.

RESULTS AND DISCUSSION

Distance of mandibular foramen from various landmarks on the right and left sides. A total of 40 adult human mandibles were studied for the position of mandibular foramen. The minimum,

Figure 1: Photograph showing the mandible (a) And the ramus of the mandible enlarged to show the mandibular foramen and lingula (b) Various morphometric parameters of mandibular foramen and lingula with reference to gonial angle were shown.

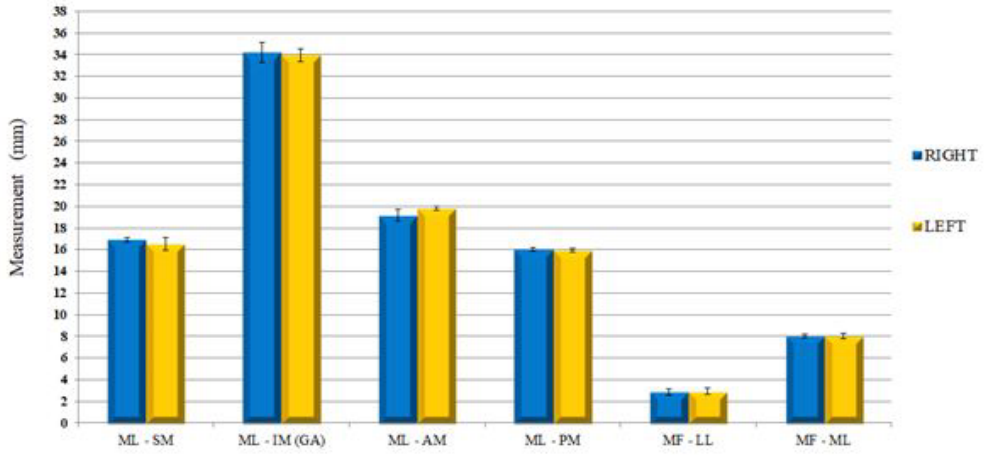

Figure 2: Bar graph representing morphometric analysis of mandibular foramen and lingula of mandible. Blue colour denotes Right side and orange colour denotes left side of ramus of mandible. X-axis represents various parameters and y-axis represents measurements in mm.

maximum, average, and standard deviation values of the various parameters which were studied on either side of the mandible .There was no statistically significant difference between the values obtained on the right and left sides. Localization of mandibular foramen in anteroposterior and super inferior axis of the ramus of mandible.

The percentile of the distance from anterior border of ramus to midpoint of mandibular foramen in relation to the distance from anterior to posterior border of ramus (AB-PB) on the right side was 56.73 ± 3.44% and it was localized in the third quadrant in the anteroposterior axis and on the left side it was 62.2 ± 2.32% and it was also localized in the third quadrant in the anteroposterior axis of the mandibular ramus. The percentile of distance MF-MN in relation to MF-MN+MF-MB was 49.68 ± 3.46% on the right side and it was localized at the junction of second and third quadrant in the superoinferior axis and 46.51 ± 5.1% on the left side and it was also localized at the junction of second and third quadrant in the superoinferior axis of the mandibular ramus. There was no statistically significant difference in the location of mandibular foramen on the right and left sides (P>0.05) in both the anteroposterior axis and superoinferior axis.

The angle of the mandible-Gonion was 117.47° ± 4.95° on the right side and 117.47° ± 5.88° on the left side. There was no statistically significant difference between the angles of the mandible on the right and left sides.

The location of the mandibular foramen is essential for mandibular surgeries like vertical ramus osteotomy, inverted L osteotomy and also esthetic surgeries for dentofacial deformities. The inferior alveolar nerve is at a greater risk during these surgical procedures. Malik et al. [24] have reported great variability in the position of mandibular foramen from Non-Asian hemi mandibles. They have also emphasized that the knowledge of the location of the mandibular foramen would assist in performing a proper sagittal split of the mandibular ramus.

During pterygomandibular technique of inferior alveolar nerve blockage long needles of size 33 mm and short needles of size 21.5 mm are

used. If a long needle is used in a patient with a small mandible, there is a risk of perforating the parotid gland capsule and injuring the branches of the facial nerve. If a short needle is used in a patient with a big sized mandible, there may be a fracture of the needle when it is completely introduced in the oral tissues [25].

There are significant differences in the localization of mandibular foramen in different ethnic groups. Mbajiorgu in his study [27]. Adult black Zimbabweans have reported that the mandibular foramen lie 2.56 mm behind the midpoint of the ramus width on the right side and 2.08 mm behind the midpoint of the ramus width on the left side. The mean distance from anterior border of mandibular ramus to anterior margin of mandibular foramen (AB-MF) was 18.95 ± 0.41 mm, the mean distance from posterior border of ramus to posterior margin of mandibular foramen (PB-MF) was 14.30 ± 0.35 mm, the mean distance from mandibular notch to inferior end of the mandibular foramen (MF-MN) was 22.5 ± 0.5 mm and the mean distance from the inferior end of mandibular foramen to base of the ramus (MF-MB) was 28.44 ± 0.65 mm in his study.

Oguz et al. have tried to localize the mandibular foramen in Turkish mandibles [4]. Ennes et al. [13] have studied the location of mandibular foramen in Brazilian population. G et al. and Rao et al. have tried to localize the mandibular foramen in Indian mandibles [27,28].

Kumari et al. have reported that mandibular foramen were within 25 mm from the third molar tooth [29]. Rao et al. [28] have reported that the mean distance of mandibular foramen from the third molar tooth was 15 mm on the right side and 18 mm on the left side. Modasiya et al. [28,30] have reported the distance to be 22.8 ± 4.9 mm on the right side and 21.7 ± 4.7 mm on the left side. The results of the present study are similar to Chandramohan et al. [31], as the measurements were 22.84 ± 2.13 mm on the right side and 23.23 ± 4.21 mm on the left side.

Kumari et al. [29] have measured the distance of mandibular foramen from the apex of retromolar trigone and reported it to be 14.23 ± 2.57 mm on the right side and 14.40 ± 2.48 mm on the left side. In the present study, the measurements were 12.27 ± 2.13 mm on the right side and 12.13 ± 2.35 mm on the left side.

Ennes et al. [13] have reported the average gonial angle to be 125.6° with a standard deviation between 6.2° and 9.2°. Oguz et al. [4] reported the angle of the mandible to be 120.2° ± 4.7°. In the present study, it was 117.47° ± 4.95° on the right side and 117.47° ± 5.88° on the left side. The gonial angle is inversely proportional to the anteroposterior width of the mandibular ramus and the distance between mandibular foramen and base of the mandible (MF-MB). So, in individuals with wide gonial angle, inferior alveolar nerve blockage has to be performed at a site lower than the conventional site and with a short needle and in individuals with small gonial angle, the inferior alveolar nerve block has to be performed at a site higher than the conventional site and with a long needle [32].

Rohinidevi et al. from their study have reported that the mandibular foramen maintain bilateral symmetry in dry mandibles in all ages and the foramen was found to be within 25 mm from the third molar, anterior border of ramus (AB) and mandibular notch [33]. In the present study bilateral symmetry of distance of mandibular foramen from various landmarks of the mandibular ramus ranged between 13% to 20% only.

CONCLUSION

The present study gives knowledge of the position of mandibular foramen and provides useful information for successful local anaesthesia (inferior nerve block), to the maxillofacial surgeons, radiologists and oncologists performing operations on the mandible to prevent complications and misinterpretation. This data has great clinical relevance, since it can be used as a parameter to carry out surgical procedures performed in the lingula region or inferior alveolar nerve block. It can be concluded from the study that there exists a correlation between the angle of mandible (gonial angle) and the position of MF. It was evident that with the decrease in angle of mandible there was a decrease in angle of mandibular foramen.

ACKNOWLEDGEMENT

Nil.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest in the present study.

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