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Morphometric Localization of Mandibular Foramen with Reference to Various Anatomical Landmarks in Dry Human Mandibles and its Clinical Implications

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ABSTRACT

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 purpose of this study was to examine and analyze the position of the MF relative to various anatomical landmarks. The different parameters were measured in 55 dry human mandibles. The data were tabulated and statistically analyzed. The mean distance between the MF and the respective landmarks was noted and they are 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. On the left side, these distances were 16.27 ± 3.9 for the anterior border, 10.28 ± 5.24 for the posterior border, 20.15 ± 3.8 for superior border, 24.86 ± 4.04 for inferior border 32.48 ± 4.73 for condyle, and 10.93 ± 4.06 for the inferior oblique ridge. 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: Morphometry, Mandible, Mandibular foramen, Lingula, Gonial angle, Local anaesthesia, Inferior alveolar nerve block

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INTRODUCTION

The mandibular foramen (MF) is an irregular foramen located a little above the centre of the medial surface of the mandibular ramus [1]. 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 [2]. 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% [3]. The commonest cause for inferior alveolar nerve block failure is inaccurate localization of the MF [4]. The main complications during this technique are haemorrhage, injury to the neurovascular bundle, fractures, and necrosis of mandibular ramus [5]. Hence, thorough knowledge of the mandibular ramus is very essential.

Gombos et al. [6], 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, Nicholson et al. 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 [6,7]. Studies have conclusively proved that there are significant morphological differences in the mandibular anatomy among the three major racial groups—Caucasoid, Mongoloid, and Negroid [8].

Accessory MF is any opening in the mandible other than the MF, mental foramen, lingual

foramen, and sockets of teeth [9]. 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 [10]. The accessory MF has also been reported to be the site for the spread of tumours following radiotherapy in the lateral surface of mandible [10,11]. So the knowledge of accessory MF is imperative to radiotherapists when planning for radiation therapy in the lateral mandibular region [12].

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, base of the ramus, third molar tooth and retromolar trigone 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.

MATERIALS AND METHODS

The study was conducted in 55 dry human mandibles of unknown sex and age collected from the bone bank of Department of Anatomy, 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. All the bones were arranged and numbered serially to avoid confusion and also to avoid repetition of same bone evaluation.

To precisely locate the mandibular foramen, the following parameters were measured on both sides of the mandible with a sliding vernier callipers of 0.1 mm accuracy.

Localization of mandibular foramen in anteroposterior and superoinferior axis of the ramus of mandible

The distance from the mid-point of mandibular foramen to the anterior margin (MF-AM), distance from the mid-point of mandibular foramen to the posterior margin (MF-PM), distance from the mid-point of mandibular foramen to the superior margin (MF-SM), and the distance from the mid-point of mandibular foramen to the inferior margin (MF-IM) were measured.

The angle of the mandible: Using a simple protractor the angle of the mandible was measured on the right and left side.

RESULTS AND DISCUSSION

Distance of mandibular foramen from various landmarks on the right and left sides were measured and the mean values were calculated. The minimum, maximum, average, and standard deviation values of the various parameters which were studied on either side of the mandible are shown in Figure 1.

The percentile of the distance from anterior border of ramus to midpoint of mandibular foramen in relation to the distance from anterior

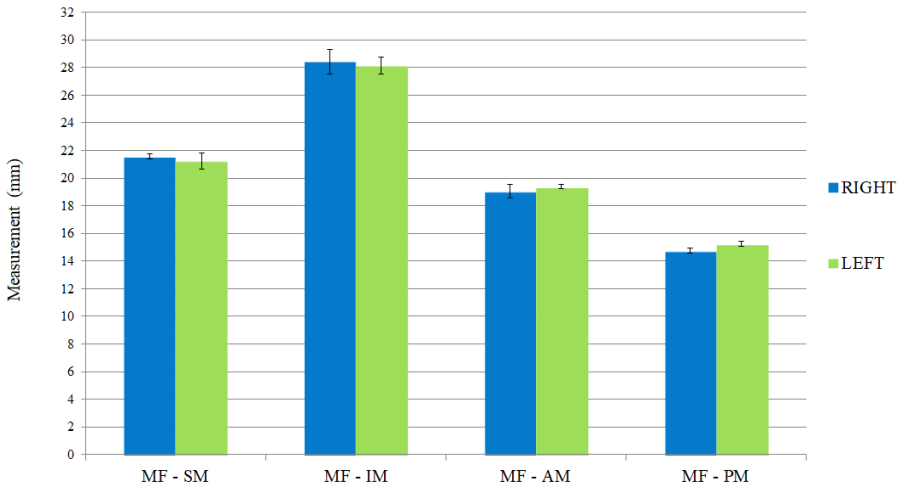

Figure 1: Shows the mean distance between the various landmarks in the mandible with reference to mandibular foramen. X - axis represents parameters of mandibular foramen and Y axis represents the measurements (mm). Blue colour depicts right side and green colour depicts left side of mandible. There was no much difference between the mean distance from the mid-point of mandibular foramen to various points on the mandible between the right and left side.

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 localised 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 localised at the junction of second and third quadrant in the superoinferior axis of the mandibular ramus. There was no much difference in the location of mandibular foramen on the right and left sides in both the anteroposterior axis and superoinferior axis.

The angle of the mandible was 117.47° ± 4.95° on the right side and 117.47° ± 5.88° on the left side. There was no 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 [13]. Oth et al. have reported great variability in the position of mandibular foramen from Non-Asian hemi mandibles. They have also emphasised that the knowledge of the location of the mandibular foramen would assist in performing a proper sagittal split of the mandibular ramus [14].

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 [15].

There are significant differences in the localization of mandibular foramen in different ethnic groups. Prado et al. in his study on adult black Zimbabweans has 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 [16].

Oguz et al. have tried to localize the mandibular foramen in Turkish mandibles [17]. Ennes et al. [18] and Prado et al. [16] have studied the location of mandibular foramen in Brazilian population. Samanta et al. [19] have tried to localize the mandibular foramen in Indian mandibles.

Sultana et al. have reported that mandibular foramen was within 25 mm from the third molar tooth [5]. Khan et al. 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. Ghorai et al. 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 [20]. The results of the present study are similar to Sultana et al as the measurements were 22.84 ± 2.13 mm on the right side and 23.23 ± 4.21 mm on the left side.

Prado et al. 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 [16].

Ennes and Medeiros have reported the average gonial angle to be 125.6° with a standard deviation between 6.2° and 9.2° [18]. Oguz et al. 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 [17]. 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 [21].

Sultana 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 [20]. In the present study bilateral symmetry of distance of mandibular foramen from various landmarks of the mandibular ramus ranged between 13% to 20% only [22].

CONCLUSION

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. Accessory mandibular foramina will serve as a route for spread of infection and tumour cells. The present study on the morphometry of the mandibular foramen and the incidence of accessory mandibular foramen will provide useful information to dental surgeons for planning and conducting dental and maxillofacial surgeries in the south Indian population. This study will also help radiologists and oncologists in localizing the mandibular foramen in the south Indian population.

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CONFLICTS OF INTEREST

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

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