Original Research Article

Anatomical study of mandibular foramen in dry adult human mandibles

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Abstract

Background: The morphological knowledge of the mandibular foramen is very important during dental procedures involving lower jaw, as structures that pass through this foramen are at risk. Inferior alveolar nerve (IAN) block is the most frequently used nerve block technique in dental practice. Location of mandibular foramen is clinically important in Inferior alveolar nerve (IAN) block, dentoalveolar surgery planning, and various endodontic treatments. Present study aimed to locate the precise location of mandibular foramen in relation to the borders of the mandibular ramus, its distances from different bone landmarks on internal surface of ramus of dry mandible and incidence of occurrence of accessory mandibular foramen in local population. **Material and Methods:** Present study was a cross-sectional study of dry adult human mandibles, obtained from the dissection room of the department of Anatomy of our institute. Location of MF from various parameters was determined with digital Vernier calipers. The presence of accessory mandibular foramen in and around mandibular foramen on the medial surface of mandibular ramus was by simple visual observation with the help of a magnifying lens and their prevalence rate was noted. All the above parameters were carefully documented and statistically analysed. Statistical analysis was done using SPSS version 23. Student's t test was used as test of significance to compare the mean values of right and left sides and a P-value less than 0.05 was taken to be statistically significant. **Results:** Total 120 dry adult human mandibles were studied; all have bilateral mandibular foramen. Accessory mandibular foramen was present in 17 (14%) mandibles. Number and side of accessory mandibular foramen is shown in Table 1. Bilateral double accessory mandibular foramen was noted in 5 mandibles only. The mean distance of mandibular foramina to anterior border of ramus was 16.37 ± 2.43 (R) mm and 17.03 ± 2.82mm(L), to posterior border was (R): 13.83 ± 2.38 mm and (L): 14.17 ± 2. 19mm, to mandibular notch was (R): 20.54 ± 2.14mm and (L): 20.11 ± 2.83mm and to inferior border was (R): 26.93 ± 3.89mm and (L): 26.32 ± 4.02 mm. We noted that there was no significant difference in the values on the right and left sides (p>0.05) . **Conclusion:** Present study provides valuable information regarding distances between mandibular foramen and surgically encountered anatomical landmarks, which is very useful to dental surgeons.

Key words: Inferior alveolar nerve, mandibular foramen, anaesthesia, Mandible

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INTRODUCTION

The morphological knowledge of the mandibular foramen is very important during dental procedures involving lower jaw, as structures that pass through this foramen are at risk. The mandibular foramen is a bony canal formed within the mandible. Mandibular foramen opens on the inner side of the mandibular ramus, inferior to the mandibular notch and ends at the mental foramen. [1] Mandibular foramen follows the shape of the mandible. The mandibular foramen contains inferior alveolar nerve (branch of the trigeminal nerve, fifth cranial nerve), the inferior alveolar artery (branch of the maxillary artery) and the inferior alveolar vein. Mandibular foramen ends at the mental foramen and the inferior alveolar nerve and artery becomes the mental nerve and artery.[2] Mandibular foramen of the mandible is an important anatomic landmarks. Mandibular foramens have clinical significance for the maxillofacial surgeon, due to their relation to the inferior alveolar nerve. Inferior

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alveolar nerve (IAN) block is the most frequently used nerve block technique in dental practice. Location of mandibular foramen is clinically important in Inferior alveolar nerve (IAN) block, dentoalveolar surgery planning, and various endodontic treatments.[3] The most frequent reasons for failure/inadequate anesthesia of the inferior alveolar nerve are inappropriate setting of the needle (too high, too superficial or too deep), due to the inaccurate location of anatomic structures mandible foramen or possibility of an anatomical variant location of the mandibular foramen.[4,5] Studies on the location of the mandibular foramen provides awareness of mandibular foramen location to practitioners, thus, lowers the risk of having the inferior alveolar nerve injury, as well as improves efficacy of inferior alveolar nerve block.[6] The location of mandibular foramen has considerable variation among different populations, age groups in same population and even in the same individual on two sides. These variations occur due to racial differences, craniofacial growth and anatomical variability.[7] Detailed anatomical knowledge of the mandibular foramen is useful to increase the effectiveness of inferior alveolar nerve blocks, for surgical planning, especially in the function or esthetic restoration of the dentofacial deformities. Present study aimed to locate the precise location of mandibular foramen in relation to the borders of the mandibular ramus, its distances from different bone landmarks on internal surface of ramus of dry mandible and incidence of occurrence of accessory mandibular foramen in local population.

MATERIAL AND METHODS

Present study was conducted at Vilasrao Deshmukh Government Institute of Medical Sciences. This study was a cross-sectional study of dry adult human mandibles, obtained from the dissection room of the department of Anatomy of our institute. Study approval was taken from institutional ethical committee. Details such as origin, exact age and sex of mandibles were not known. Bones which had deformities, asymmetries, external pathological changes and fractures were excluded from the present study. A metallic wire was introduced in the foramen to ascertain its presence. Size was determined by measuring vertical and horizontal diameter of mandibular foramen (MF). Location of MF from following parameters was determined with digital Vernier calipers.

a. MF-MN: was measured from the lowest limit of mandibular notch to upper limit of mandibular foramen,
b. MF-AB : measured from nearest anterior border (external oblique line) of mandibular ramus to the midpoint of anterior margin of mandibular foramen.,
c. MF-IB : Was measured from upper border of mandibular foramen to the nearest lower border of base of mandible and
d. MF-PB : measured from the midpoint of posterior point of the mandibular ramus to the nearest point on posterior border of mandibular ramus.

The presence of accessory mandibular foramen in and around mandibular foramen on the medial surface of mandibular ramus was by simple visual observation with the help of a magnifying lens and their prevalence rate was noted. All the above parameters were carefully documented and statistically analysed. Statistical analysis was done using SPSS version 23. Student's t test was used as test of significance to compare the mean values of right and left sides and a P-value less than 0.05 was taken to be statistically significant. Present study was conducted at XXX Medical College, XXX. This study was a cross-sectional study of dry adult human mandibles, obtained from the dissection room of the department of Anatomy of our institute. Study approval was taken from institutional ethical committee. Details such as origin, exact age and sex of mandibles were not known. Bones which had deformities, asymmetries, external pathological changes and fractures were excluded from the present study. A metallic wire was introduced in the foramen to ascertain its presence. Size was determined by measuring vertical and horizontal diameter of mandibular foramen (MF). Location of MF from following parameters was determined with digital Vernier calipers. Nearest distance was considered.

a. MF-MN: was measured from the lowest limit of mandibular notch to upper limit of mandibular foramen,
b. MF-AB : measured from nearest anterior border (external oblique line) of mandibular ramus to the midpoint of anterior margin of mandibular foramen.,
c. MF-IB : Was measured from upper border of mandibular foramen to the nearest lower border of base of mandible and
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RESULTS

Total 120 dry adult human mandibles were studied; all have bilateral mandibular foramen. Accessory mandibular foramen was present in 17 (14%) mandibles. Number and side of accessory mandibular foramen is shown in Table 1. Bilateral double accessory mandibular foramen was noted in 5 mandibles only.

Table 1: General findings of present study on mandibular foramen.

Finding	Number	Percentage
Bilateral mandibular foramen	120	100%
Right side–single accessory foramen	16	13%
Right side–double accessory foramen	7	6%
Left side–single accessory foramen	13	11%
Left side–double accessory foramen	6	5%
Bilateral single accessory foramen	8	7%
Bilateral double accessory foramen	5	4%
Absent–accessory foramen	91	76%

The mean and standard deviation values for distance (in millimeters) between various points (MF – MN, MF- IB, MF-AB, MF-PB) are shown in Table 2. We noted that there was no significant difference in the values on the right and left sides (p>0.05).

Table 2: Distance of mandibular foramen (MF) from various mandibular landmarks

Landmarks	Distance ± Standard Deviation (in mm)	
	Right	Left
MF – MN	20.54 ± 2.14	20.11 ± 2.83
MF- IB	26.93 ± 3.89	26.32 ± 4.02
MF-AB	16.37 ± 2.43	17.03 ± 2.82
MF-PB	13.83 ± 2.38	14.17 ± 2. 19
Foramen-width	4.03 ± 1.81	4.18 ± 1.75

DISCUSSION

The precise knowledge of the location of reference points in the oral and maxillofacial area and awareness of mandibular foramina is important for dental surgeons to perform nerve block in local anesthesia and maxillofacial operations. Incidence of the accessory mandibular foramina (AMF) has been found to be greater on the medial surface than on the lateral surface.[8,9] The embryological basis for the occurrence of accessory mandibular foramen has been explained as, in the embryonic stage, initially 3 inferior alveolar nerves, innervating each of the 3 groups of mandibular teeth are formed. Later, all the 3 nerves fuse and a single inferior alveolar nerve is formed. The incomplete fusion of the nerves leads to the formation of double mandibular canals.[10,11] Padmavathi *et al*.. noted 41.5% incidence of accessory mandibular foramen, unilaterally in 29.2% and bilaterally in 12.3%.[12] Gopalakrishna *et al*.. have reported the incidence of single accessory mandibular foramina to be 18%.[13] Similar results were noted in present study. The branches of the facial, mylohyoid, buccal and the transverse cervical cutaneous nerves are known to pass through these accessory foramina. These nerves can escape from local anesthesia and result in inadequate or failure to achieve nerve block.[13] Another clinical significance of accessory mandibular foramina is that, they provide a direct pathway into the cancellous bone and facilitate the tumours infiltration from the floor of the mouth, may provide a route for the spread of infections and tumor following radiotherapy. [14] Distances from different bone landmarks on internal surface of ramus of dry mandible from present study are compared with other similar Indian studies from different regions (Lalitha B *et al*..[15], Shalini R *et al*..[11] and Govindarajan S *et al*.[16].). Present study results are comparable with study results of Lalitha B *et al*.

Table 3: Comparison of distance of mandibular foramen (MF) from various mandibular landmarks

Landmarks	Distance ± Standard Deviation (in mm)							
	Right				Left			
	Present study	Lalitha B *et al*.[15]	Shalini R *et al*.[11]	Govindarajan S *et al*.[16]	Present study	Lalitha B *et al*.[15]	Shalini R *et al*.[11]	Govindarajan S *et al*.[16]
MN – MF	20.54 ± 2.14	20.14 ± 2.5	21.74 ± 2.74	22.26 ± 0.25	20.11 ± 2.83	19.85 ± 3.15	21.92 ± 3.33	22.79 ± 0.28
MF- IB	26.93 ± 3.89	27.41 ± 4.16	22.33 ± 3.32	23.5 ± 0.29	26.32 ± 4.02	26.76 ± 4.14	25.35 ± 4.5	24.1 ± 0.26
AB-MF	16.37 ± 2.43	16.52 ± 2.25	17.11 ± 2.74	17.7 ± 0.18	17.03 ± 2.82	17.77 ± 2.51	17.41 ± 3.05	17.14 ± 0.29
MF-PB	13.83 ± 2.38	14.05 ± 2.19	10.47 ± 2.11	15.86 ± 0.32	14.17 ± 2. 19	13.90 ± 2.35	9.68 ± 2.03	15.2 ± 0.17
Foramen-width	4.03 ± 1.81	---	4.19 ± 1.57	---	4.18 ± 1.75	--	4.37 ± 1.67	---

In present study in adult human dry mandibles, the position of the mandibular foramen was bilaterally symmetrical. Similar results were noted by Gopalakrishna *et al*..[13] The spread of local anaesthetic in inferior alveolar nerve blocks, depends on the drug used, its concentration and the volume of drug injected[28]. It also depends on identification mandibular foramen location, depth of injection and presence of accessory mandibular foramen. In present study, we documented the position of the MF with references to the various landmarks. Accessory mandibular

foramen was noted in 24% adult human dry mandibles. Findings from present study could be useful to dental surgeons during administering local anesthesia involving the inferior alveolar nerve for different procedures such as dental extraction, placement of mandibular implants, and other therapeutic surgical procedures involving mandibles. Limitations of present study were small number of adult human dry mandibles were examined. Large scale study, with radiological imaging help can give more precise results.

CONCLUSION

Understanding of basic landmarks for location of mandibular foramen is important for the dental surgeons for successful inferior alveolar nerve block. Present study provides valuable information regarding distances between mandibular foramen and surgically encountered anatomical landmarks, which is very useful to dental surgeons. Findings from present study will add data regarding the position of mandibular foramen from different anatomical parameters and incidence of accessory mandibular foramen.

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