Mental Foramen and Mandibular Canal in Dry Human Mandibles: A Cross-Sectional Morphometric Analysis

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ABSTRACT

Introduction: The mandibular foramen portrays a cardinal anatomical landmark for the repositioning of the mandible during sagittal split osteotomies performed to correct structural deformities like prognathism and retrognathia. These landmarks are crucial for adequate anaesthesia while performing the inferior alveolar nerve block. The mental foramen is an important landmark in carrying out invasive procedures like a mental or incisive nerve block.

Objectives: To observe the shape, position and distance from various mandibular anatomical landmarks of the mental foramen, and the length of the mandibular canal.

Methods: This cross-sectional study included 41 human mandibles, which were available in the department. After applying the inclusion and exclusion criteria, thirty dried adult human mandibles with an intact alveolar margin of unknown gender were used.

Results: The shape of mental foramen was found oval in 80 per cent and circular in 20 per cent of the mandible irrespective of side. The mean distance of mental foramen from symphysis menti, posterior border of the ramus, alveolar crest, and lower border of the body of mandible was found 24.38 ± 1.91 mm, 63.62 ± 2.5 mm, 13.15 ± 1.64 mm, and 14.15 ± 1.58 mm on the right side. Whereas on the left side mean distance was 24.01 ± 1.86 mm, 63.49 ± 2.22 mm, 13.23 ± 1.65 mm, and 14.06 ± 1.69 mm, respectively, from the above parameters.

Conclusions: Mental foramen's usual position was below the second premolar. Since it is not possible to palpate the MF clinically, it is necessary to know its accurate place. This will reduce the chances of inadvertent injury during invasive dental procedures like various pre-prosthetic operations and implant insertion.

Key Words: Human Mandibles, Mental Foramen, Mandibular Canal, Morphometric Analysis, Nerve block

INTRODUCTION

The mandible is the strongest bone of the skull and movable bone of the viscerocranium other than the ear ossicles. It bears sockets for the lower teeth and provides attachment to muscles of mastication and facial expression.¹ The Meckel's cartilage arising from the first pharyngeal arch or the mandibular arch forms framework of the mandible. The gross anatomy of the mandible is composed of two parts: the body and the ramus. The body lies in a horizontal plane, and its superior border consists of sockets for upper teeth. The two vertical bony part is known as rami. The mandible's body and ramus unite at an angle that varies with age and shows sexual dimorphism in a population. The superior aspect of each ramus has coronoid and condylar processes that articulate with

the temporal bone to form the temporomandibular joint.² The external surface of the body shows mental foramen, and the inner surface of the ramus shows mandibular foramen. The bony canal extending between these two foramina is named a mandibular canal running downward and forward in the body. The inferior alveolar vessels and nerves enter through the Mandibular Foramen, and then it traverses the mandibular canal. Here it gives branches to all lower teeth and finally exits through the mental foramen as mental nerve and vessel.³ The mandibular foramen portrays a cardinal anatomical landmark for oral maxillofacial surgeons in the repositioning of the mandible during sagittal split osteotomies performed to correct structural deformities like prognathism and retrognathia.⁴ Furthermore, these landmarks are crucial for adequate anaesthesia in dentistry while performing the inferior

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alveolar nerve block (IANB).⁵ There is a stoppage of nerve conduction from inferior alveolar nerves and their branches after local anaesthetic agents' infiltration. Anatomical variations of the mandible and insufficient insertion depth into the soft tissue are assumed to be the critical factors for an unsuccessful nerve block.⁶ The mental foramen is another important landmark in carrying out invasive procedures like a mental or incisive nerve block.⁷ The racial differences, age and sex variations are well observed concerning foramen's shape and position.⁸ The foramen's accurate location and the possibility of a mesial position of an anterior loop of the mental nerve to the mental foramen should be meticulously evaluated before implant surgery to avoid mental nerve injury.⁹ The oedema of the epineurium because of improper placement of the dental implant may involve the mental branch, leading to neurosensory disturbances.¹⁰ Some studies assumed that the mandibular incisive canal's large diameter might be a basis of implant failure and neurosensory dysfunction. The collection of soft tissue around the implant impairs the osseointegration and leads to implant failure.¹¹ Malpositioning of endosseous implants may compromise the anatomical structures and can affect the sensory supply in the distribution of the mental nerve.¹² The facial trauma caused by road traffic accidents is usually prevalent among young males aged between 16 and 30 years.¹³ The mandible is the second most common facial fracture site after the nasal bones and represents up to 70% of all facial fractures.¹⁴ Mandibular fracture is managed more frequently by the open reduction internal fixation (ORIF) method. In scheduling an ORIF, the detailed anatomy that occupies "danger spaces" in the mandible should be considered carefully. Care should be taken while plating between the tooth root apices and the mandibular canal, which holds the inferior alveolar nerve. Miniplates and monocortical screws typically are used in this area. In the mental foramen area, isolation and shielding of the mental nerve are essential before placing the plates. A fracture line crossing the inferior alveolar canal can cause a neurosensory disturbance, and the risk is much greater when the displacement exceeds 5 mm.¹⁵ Oral and maxillofacial surgeons must have extensive knowledge of mandibular anatomy, function, and occlusion—all of which are essential elements of diagnosis, treatment planning, and successful patient outcome. Extensive knowledge about variability in the position of these critical anatomical landmarks in different populations is required to avoid complications related to mandibular anaesthesia. For these reasons, the objectives of the present study were to observe the shape, position and distance from various mandibular anatomical landmarks of the mental foramen. We also measure the length of the mandibular canal.

MATERIAL AND METHODS

Study type and place

This cross-sectional study was done in the Department of Anatomy in the Medical College of Uttar Pradesh.

Inclusion and exclusion criteria

The mandibles not showing any deformity apparently, were included in the study. *Mandibles* of children and the elderly were excluded from the study.

Sample

A total of 41 human mandibles were available in the department. we applied the census method to recruit the human mandibles in the study. After applying the inclusion and exclusion criteria, thirty dried adult human mandibles with an intact alveolar margin of unknown gender were used in the present study.[Figure 1].

Study duration

The total duration of the study was six months.

Methodology: The shape of the mental foramen, its relation to the lower teeth and its location were recorded on both sides of the mandible by using digital Vernier callipers. The shape of mental foramen was categorized as oval or circular. [Figure 2A, 2B and 3]. The distance of mental foramen was measured concerning various parts of mandible L1- Distance of mental foramen from symphysis menti, L2- Distance of mental foramen from the alveolar crest, L3- Distance of mental foramen from the lower border of the body of mandible, L4- Distance of mental foramen from the posterior border of the ramus [Figure 4]. The mandibular canal length was also measured by marking two points perpendicular to mandibular foramen and mental foramen, respectively, and then measuring the distance between these two points. Parameters were measured by using a standard horizontal plane defined by Morront. It says that the mandible when placed on a horizontal surface, the lower border of mandible comes into the highest connection when vertical pressure is used to the second molar teeth.¹⁶

Statistical analysis

All the data were first entered in Microsoft Excel 2016 and then statistically analyzed using SPSS version 24.0 (SPSS Inc., Chicago, USA). Frequency data were presented as numbers and percentages. The means were compared using Student's t-test. A p-value less than 0.05 was considered to be statistically significant.

RESULTS

The shape of mental foramen was found oval in 80 per cent and circular in 20 per cent of the mandible irrespective of side [Table 1]. In the majority of the mandible, the Mental foramen was found 'below the second premolar' both on the right side (73.33 per cent) and the left side (66.67 per cent). The second common position of mental foramen on both right and left sides was between premolars (16.67 and 23.33 per cent, respectively) [Table 2].

The mean distance of mental foramen from symphysis menti, posterior border of the ramus, alveolar crest, and lower border of the body of mandible was found 24.38 ± 1.91 mm, 63.62 ± 2.5 mm, 13.15 ± 1.64 mm, and 14.15 ± 1.58 mm on the right side. Whereas on the left side mean distance was 24.01 ± 1.86 mm, 63.49 ± 2.22 mm, 13.23 ± 1.65 mm, and 14.06 ± 1.69 mm, respectively, from the above parameters. [Table 3] The mean length of the mandibular canal on the right and left sides were 52.34 ± 2.67 and $52. \pm 2.35$ respectively. There was no significant difference between the length of the right and left mandibular canal [Table 4].

DISCUSSION

The most common location of mental foramen concerning lower teeth was below the second molar on both sides. Similar results were reported by Parmar 2013 (64.7% rt. and 66.7% lt.), Siddiqui et al. (2011) and Udhaya K. et al. (2013).^{17,18,19} Discordant to the present study, Gingor et al. (in 2006) reported that the location of mental foramen was between premolars in 71.5% and 22.44% lies below the second molar.²⁰ In the present study on rt. side it was 73.33% rt. and 66.67%, which was discordant to the study done by Parmar et al., Siddiqui et al., and Udhaya K. et al. where it was lying more on the left side.^{17,18,19} In the present study the most common shape of mental foramen was oval (80%) which is almost similar to study by Siddiqui et al. (2011), Western India on 93 mandible 70% oval and 30% circular mental foramen, Udhaya K. et al. (2013), South India (n=90) 75(83.3%) oval, 15 (16.7%) rounded, Fabian 2007, Tanzania (n=100) oval 54(54.0%), rounded 46(46.0%), and Prabodha 2006, Sri Lanka (n=24) 16(66.7%) oval, 8(33.3%) rounded.^{18,19,21,22} The mean distance of mental foramen in mm from Symphysis Menti, Posterior Border of the ramus, Alveolar Crest, and lower border of the body of mandible was 24.21, 63.56, 13.19, and 14.11, respectively. These findings were similar to the study done separately by Udhaya K. et al., Prabodha et al., and Singh et al.^{19,21,23} The mean Length of the Mandibular Canal was 52.17 mm with SD 2.49.

CONCLUSION

The present study reveals that the most common shape of mental foramen is, oval similar to the population of Western Indians, South Indians, Tanzania, and Sri Lanka. Its usual position was below the second premolar. Since it is not possible to palpate the MF clinically, it is necessary to know its accurate place. This will reduce the chances of inadvertent injury during invasive dental procedures like various pre-prosthetic operations and implant insertion. The knowledge of the mandibular canal's anatomic configuration will also reduce the damage during Osteotomies and placement of endosseous implant surgery. The present study also measured

the mandibular canal length that can be correlated with CT related studies of inferior alveolar nerve and vessels.

Limitations

As the study was done on a small sample size and mandibles in a college of Uttar Pradesh, the results cannot be generalized for the whole population. So, there is a need for studies with larger sample sizes and different geographical areas for the general application of the results.

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Table 1: Distribution of mandibles according to the shape of Mental Foramen

Shape	Side			
	Right		Left	
	Number	Percent(%)	Number	Percent (%)
Oval	24	80.00	24	80.00
Circular	6	20.00	6	20.00
Total	30	100.00	30	100.00

Table 2: Location and Relation of Mental Foramen with Lower Teeth

Side	Between Premolars		Below Second Premolar		Below First Molar		Total	
	No.	%	No.	%	No.	%	No.	%
Right	5	16.67	22	73.33	3	10.00	30	100.00
Left	7	23.33	20	66.67	3	10.00	30	100.00

Table 3: Location of mental foramen:

Side		Distance from Symphysis Menti	Distance from Posterior Border	Distance from Alveolar Crest	Distance from the lower border of the body of the mandible
Right	Mean	24.38	63.62	13.15	14.15
	SD	1.91	2.57	1.64	1.58
Left	Mean	24.01	63.49	13.23	14.06
	SD	1.86	2.22	1.65	1.69
Total	Mean	24.21	63.56	13.19	14.11
	SD	1.88	2.38	1.63	1.62

Table 4: Length of mandibular canal.

	Length of Mandibular canal (in millimetres)			
	Mean	SD	T	Sig. (2 tailed)
Right Side	52.34	2.67	0.529	0.599
Left Side	52.00	2.35		
Overall (Both Side)	52.17		2.49

Figure 1: Study Flow Diagram.

Figure 2B: Photograph showing shape of mental foramen: oval shape (inside red marked area).

Figure 3: Measuring position of mental foramen.

Figure 2A: Photograph showing shape of mental foramen: circular shape (inside yellow marked area).

Figure 4: Distance of mental foramen from symphysis menti, alveolar crest, lower border of the body of the mandible and from the posterior border of ramus such that; L1- Distance of mental foramen from symphysis menti (red), L2- Distance of mental foramen from alveolar crest (green), L3- Distance of mental foramen from the lower border of the body of the mandible (yellow), L4- Distance of mental foramen from the posterior border of the ramus (black).