

MORPHOMETRIC ANALYSIS AND VARIATIONS OF THE MENTAL FORAMEN IN HUMAN MANDIBLES IN INDIAN POPULATION

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ABSTRACT

Background: The mental foramen is a crucial anatomical landmark on the anterolateral aspect of the mandible. Variations in its morphology and morphometry require precise anatomical knowledge to prevent neurovascular complications. This study aimed to analyse the position and dimensions of the mental foramen in dry adult human mandibles and to determine its clinical significance. **Materials and Methods:** Thirty-two dry human mandibles with intact teeth of unknown sex and age were studied. The mental foramen position was classified based on its relationship to adjacent teeth, following Tebo and Telford's (1950) classification. Its dimensions were measured using a digital vernier calliper on the right and left sides of the mandible and recorded in an Excel spreadsheet. **Result:** The most common position of the mental foramen was in line with the second premolar (31.25%), followed by a location between the second premolar and the first molar (29.68%). The mean distance from the alveolar crest to the superior margin of the mental foramen was approximately 10.75 mm on the right and 10.59 mm on the left. The vertical diameter averaged 2.96 mm on the right and 2.78 mm on the left. Other measured distances from key mandibular landmarks were also recorded. **Conclusion:** Understanding the variability in the mental foramen position is crucial for effective nerve blocks in dental and surgical procedures.

INTRODUCTION

The mental foramen is an important anatomical landmark located on the anterolateral surface of the mandible. It usually sits below the space between the premolars and carries the mental nerve, artery, and vein.^[1-4] The mental nerve, a terminal branch of the inferior alveolar nerve, provides sensation to the chin, lower lip, and gums of the mandibular anterior teeth and premolars. Understanding the shape and position of the mental foramen is crucial for dental, maxillofacial, and anaesthetic procedures.^[1] Previous studies have shown variations in its location. It can range from near the canine to the first molar area and can differ in shape and size.^[3] Sometimes, there are extra openings known as accessory mental foramina, which carry additional branches of the mental nerve.^[3] The mental foramen is a key landmark during implant placement, osteotomy, periapical surgeries, and managing fractures of the mandible.^[5-7] Properly locating the mental foramen helps prevent complications like numbness, tingling, and pain in the lower lip and chin area. Additionally, an anterior loop of the mental nerve near the foramen makes this area more at risk during invasive dental

procedures. Detailed morphometric analysis of the mental foramen is vital for in-depth anatomical knowledge related to mandibular openings. This information is essential for successful nerve blocks and surgical planning.^[5] Although many studies have examined different racial and ethnic groups, variations still exist, stressing the need for data specific to certain populations.^[1,3] Thus, this study aims to assess the morphology, position, shape, and size of the mental foramen and its relation to nearby landmarks. This information may help clinicians, dental surgeons, and anatomists provide safer and more effective care.

MATERIALS AND METHODS

32 dry adult human mandibles with complete teeth were sourced from the Department of Anatomy at Government Medical College, Bhavnagar, Gujarat, India. The age and sex of the mandibles were not identified. The positions and morphometry of the Mental Foramen were analysed on both the right and left sides of the mandibles.

The location of the mental foramen was identified based on the Tebo and Telford classification as

follows: Type I – located between the canine and first premolar, Type II – aligned with the first premolar, Type III – positioned between the first and second premolars, Type IV – aligned with the second premolar, Type V – situated between the second premolar and first molar, and Type VI – aligned with the first molar.

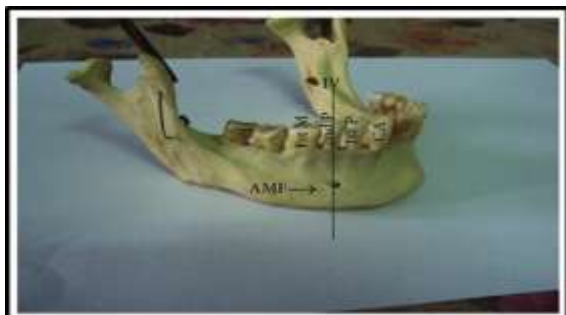


Figure 1: Showing Type IV-Align With 2nd Premolar tooth type of Mental Foramen Position



Figure 2 Vernier Calliper

Morphometric measurements were obtained with a digital vernier calliper. The parameters assessed consisted of the distance from the alveolar crest to the mental foramen (AM), the distance from the lower

border of the mandible body to the mental foramen (LM), and the distance from the alveolar crest to the lower border of the mandible body (AL). The vertical diameter of the mental foramen was determined using the equation: $VD = AL - (AM + LM)$. All measurements were taken in millimetres and examined on each side of the mandible.

Statistical Analysis: Microsoft Excel was used to enter and analyse the gathered data. Separate calculations were made for the frequency and percentage of the Mental Foramen's location on the left and right sides. For every morphometric parameter, descriptive statistical analysis was carried out. For the measures taken from both sides of the mandible, the mean and standard deviation (SD) were calculated

RESULTS

In this study Mental Foramen's most prevalent location on the right side was Type IV, according to the study's observations. The according to the second premolar, which was found in 11 mandibles (34.38%). Type V in 8 mandibles (25%), Type III in 7 mandibles (21.88%), Type VI in 5 mandibles (15.62%), and Type II in one mandible (3.12 %) came next. For Type I position on the right side, no mental foramen was seen.

On the left side Type V was the most prevalent position, occurring in 11 mandibles (34.38 %), followed by Type IV in 9 mandibles (28.12 %), Type III in 7 mandibles (21.88 %), Type VI in 4 mandibles (12.5 %), and Type II in 1 mandible (3.12 %). On the left side, type I position was not seen. [Table 1] shows all these observations.

Table 1: Showing % of Different types of mandibular Foramen based on the Tebo and Telford classification

Type according to position of mental foramen	Right side n (%)	Left side n (%)
I	0 (0 %)	0 (0 %)
II	1 (3.12 %)	1 (3.12 %)
III	7 (21.88 %)	7 (21.88 %)
IV	11 (34.38 %)	9 (28.12 %)
V	8 (25 %)	11 (34.38 %)
VI	5 (15.62 %)	4 (12.5 %)

For Morphometric analysis which was performed using a digital vernier calliper. The mean distance from the alveolar crest to the mental foramen (AM) was 10.75 ± 1.99 mm on the right side and 10.59 ± 2.11 mm on the left side. The mean distance from the lower border of the body of the mandible to the mental foramen (LM) was 10.92 ± 2.07 mm on the right side and 10.62 ± 1.51 mm on the left side. The

mean distance from the alveolar crest to the lower border of the body of the mandible (AL) measured 24.65 ± 2.61 mm on the right side and 24.00 ± 2.50 mm on the left side. The mean vertical diameter of the mental foramen calculated by the formula $AL - (AM + LM)$ was 2.97 ± 1.11 mm on the right side and 2.78 ± 1.15 mm on the left side. Table-2 shows all these observations.

Table 2: Showing Different parameters of mandibular Foramen

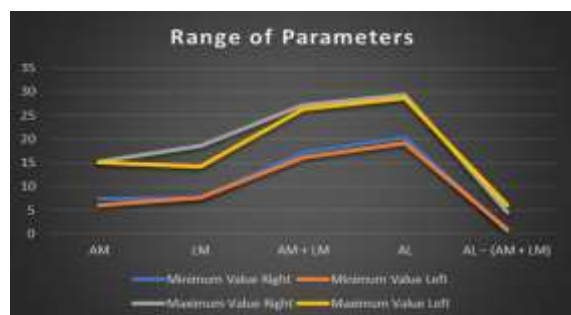
Parameter	Right Side (Mean $\pm$ SD)	Left Side (Mean $\pm$ SD)
AM	10.75 ± 1.99	10.59 ± 2.11
LM	10.92 ± 2.07	10.62 ± 1.51
AM + LM	21.68 ± 2.54	21.21 ± 2.59
AL	24.65 ± 2.61	24.00 ± 2.50
$AL - (AM + LM)$	2.97 ± 1.11	2.78 ± 1.15

Here for [Table 2],

- AM-distance from the alveolar crest to the mental foramen
- LM-the distance from the lower border of the mandible body to the mental foramen
- AL-the distance from the alveolar crest to the lower border of the mandible body
- The vertical diameter of the mental foramen was determined using the equation: $VD = AL - (AM + LM)$.

Table 3: Showing Range of different parameters mandibular Foramen

	Minimum Value		Maximum Value	
	Right	Left	Right	Left
AM	7.29	6.02	15.2	15.08
LM	7.68	7.56	18.6	14.2
AM + LM	17.1	16.11	27.14	26.32
AL	20.34	19.17	29.37	28.59
AL – (AM + LM)	0.62	0.89	4.62	6.02



The graph shows the range of all measured parameters minimum and maximum values on both the left and right sides. With maximal measurements of 29.37 mm on the right side and 28.59 mm on the left, AL had the widest range of values of any parameter. Additionally, the combined parameter AM + LM showed somewhat greater values on both sides. AL – (AM + LM), on the other hand, displayed the narrowest range of measurements. Overall, the graph shows that for most parameters, the right side typically had slightly higher minimum and maximum values than the left side.

DISCUSSION

The present study showed interesting variations in the distribution of mental foramen types which are shown in Table-4. Where it compared with earlier studies conducted in different populations. In the

current Gujarat-based population, Type 4 was found to be the most common type on both the right (34.37%) and left side (28.12%). A similar predominance of Type 4 was also observed in studies by Voljevica A,^[1] Rastogi R,^[3] Siddiqui AU,^[9] Yesilyurt H,^[11] and Balakrishnan YA,^[8] yet, the % reported in those studies was comparatively higher, ranging from about 44% to 61%.

On the other hand, the present study demonstrated a noticeably higher frequency of Type 5, especially on the left side (34.37%), compared to previous studies where its occurrence was relatively low. There is higher prevalence of Type 6 in the present study, whereas most earlier researchers reported either very low values or complete absence of this type. Type 3 was observed bilaterally in 21.87% of cases in the present study, which was lower than the findings reported in South Indian and Western Indian populations where Type 3 was one of the dominant patterns.

Like most previous studies, Type 1 was absent in the present study, except for Siddiqui AU,^[9] who reported a very small percentage. These differences among studies may be related to racial, ethnic, regional, genetic, and methodological variations, as well as differences in sample size. Overall, although Type 4 remained the most frequent mental foramen type in the present study, the comparatively higher occurrence of Types 5 and 6 suggests possible regional anatomical variations in the Gujarat population.

Table 4: Show Comparison of types of mental foramen in different Studies

Study	Region / Population	Year	Type 1 (%)		Type 2 (%)		Type 3 (%)		Type 4 (%)		Type 5 (%)		Type 6 (%)	
			R	L	R	L	R	L	R	L	R	L	R	L
Voljevica A. [1]	Bosnia & Herzegovina	2015	0	0	4%	2.6%	20%	20.6%	61.3%	59.3%	14.6%	15.3%	0	2%
Rastogi R. [3]	Central India	2012	0	0	3.4%	3.4%	19.5%	18.3%	52.8%	54%	24.1%	24.1%	0	0
Balakrishnan YA. [8]	South India	2018	0	0	8%	8%	48%	24%	32%	52%	12%	12%	3.90%	2%
Siddiqui AU. [9]	Western India	2011	1.0%	1.0%	6.4%	8.6%	41.9%	35.4%	44.0%	46.2%	6.45%	8.60%	0	0
Yesilyurt H. [11]	Turkey	2008	0	0	5.7%	7.1%	34.3%	25.7%	55.7%	61.4%	4.30%	5.70%	0	0
Pandey M [12]	UP, India	2021	-	-	-	-	16.6%	23.3%	73.3%	66.6%	10%	10%	-	-
Present Study	Gujarat, India	2026	0	0	3.1%	3.1%	21.8%	21.8%	34.3%	28.1%	25%	34.3%	15.6%	12.5%

Table 5: Show Comparison of different parameters of different Studies

Study	Region	Year	AM		LM		AL		AL – (AM + LM)	
			R	L	R	L	R	L	R	L
Rastogi R. [3]	Central India	2012	10.67 ± 0.21	10.71 ± 0.18	14.59 ± 0.23	14.64 ± 0.20	28.87 ± 0.37	28.90 ± 0.32	3.58 ± 0.17	3.55 ± 0.18
Pandey M [12]	UP, India	2021	13.15 ± 1.64	13.23 ± 1.65	14.15 ± 1.58	14.06 ± 1.69	-	-	-	-
Present Study	Gujarat, India	2025	10.75 ± 1.99	10.59 ± 2.11	10.92 ± 2.07	10.62 ± 1.51	24.65 ± 2.61	24.00 ± 2.50	2.97 ± 1.11	2.78 ± 1.15

The present study shows clear differences in the morphometric measurements of the mental foramen when compared with previous studies from other regions of India. In the Gujarat population, the mean AM distance was found to be 10.75 ± 1.99 mm on the right side and 10.59 ± 2.11 mm on the left side. These values were very similar to those reported by Rastogi R,^[3] in the Central Indian population, suggesting a close resemblance in the anterior positioning of the mental foramen between the two populations. However, Pandey M,^[12] reported comparatively higher AM values in the Uttar Pradesh population, indicating slight regional variation.

The LM measurements in the present study were 10.92 ± 2.07 mm on the right side and 10.62 ± 1.51 mm on the left side, which were lower than the values reported in both previous studies. A similar trend was observed for the AL parameter, where the present study showed lower measurements bilaterally compared to the findings of Rastogi R,^[3] and Pandey M.^[12] This suggests that the mandibular dimensions in the present Gujarat population may be relatively smaller than those observed in other Indian populations.

Also, the value of AL – (AM + LM) was slightly lower in the present study compared to early studies. Although the differences were not very large, they indicate subtle anatomical variations in mandibular morphology among different regional groups.

CONCLUSION

The current study offers useful morphometric information about the types and locations of mental foramen in the Gujarati population. The most prevalent mental foramen pattern was discovered to be Type 4, while Types 5 and 6 were also found to occur more frequently, suggesting regional anatomical heterogeneity. The mental foramen's morphometric measures revealed little variations from earlier Indian research, with the current population's mandibular dimensions being comparatively lower. Regional, genetic, ethnic, and

environmental factors could all have an impact on these differences.

Because precise knowledge of the location and variations of the mental foramen can help lower the risk of neurovascular injury during surgical, implant, and local anaesthetic procedures involving the mandibular region, the study's findings are clinically significant for dentists, maxillofacial surgeons, and anaesthetists.

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