Anthropometric Analysis of Mental Foramen in Dry Human Mandibles in Karnataka

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Abstract

Background and Objectives The mental foramen which is located on the anterior surface of the mandible is a bilateral opening transmitting mental nerves and vessels that supply important structures around. However, it is reported that the location of mental foramen varies across different races and genders, the awareness of which is vital in surgical interventions, anesthetic applications, and various other invasive procedures. Hence, the objectives of the present study were to study the location, size, and shape of mental foramina in dry human mandibles and to study the incidence of accessory mental foramina in human mandibles.

Materials and Methods One hundred eighty dried mandibles were observed for the location, size, and shape of mental foramen. Digital Vernier calipers were used to measure the distance of right and left mental foramen from various locations like alveolar crest, symphysis menti, lower border of mandible, and posterior border of the ramus of mandible. The data were analyzed using SPSS 20 software. The position and number of accessory mental foramen were determined.

Results The various positions of mental foramina studied revealed the most common type to be type IV as per the Tebo and Telford classification. The average horizontal diameter was slightly higher than the average vertical diameter in majority of the bones. Accessory mental foramina were observed in 3 mandibles.

Conclusion The mental foramen was most commonly situated along the longitudinal axis of second premolar tooth and the shape of the mental foramen was found to be oval in 95% of the bones studied.

Keywords
- mental nerve
- mental vessels
- premolar teeth
- molar teeth
- anesthetic block
- osteotomy

Introduction

The mental foramen is located midway between the upper and lower borders of the body of the mandible, usually between the two premolar teeth or at the level of second premolar tooth. The mental foramen in its posterior border is smooth with the mental nerve emerging posterolaterally. As the mental foramen transmits mental nerve and vessels, the position of the mental foramen is very important with respect to the structures it transmits. The mental nerve emerging through the mental foramen supplies the mucous membrane, soft tissues of chin, lower lip, and gums and the mental vessels supplies blood to the above structures. Thus, mental foramen becomes a vital anatomical landmark to facilitate anesthetic, surgical, and other invasive procedures for oral and maxillofacial surgeons in the mental region of mandible.

Anatomical variations have been reported in terms of position, shape, and size of mental foramen in various groups.1-4 Although the most common position of the mental foramen is reported to be along the longitudinal axis of second premolar tooth, Green et al1 in his study reported that the Caucasoid had their position more anterior to the longitudinal axis of the second premolar tooth. However, in Melanesians, Mongoloids, and Negroids it was reported to be more posterior to the longitudinal axis of the second premolar tooth. Similarly, the most commonly observed shape is reported to be oval in majority of the
Indian studies. However, in their study Singh et al have noted circular shaped foramen in Indian origin mandibles. Another study from Zimbabwe reports almost equal incidence of oval and circular shapes. It is critical to be aware of these anatomical variations of mental foramen while preparing surgical procedures in that area to avoid nerve injury.

Despite the significance of mental foramen in terms of its landmark and the presence of anatomical variations across different population groups, little consideration has been given to the study of the most common location of foramen, morphological characteristics and its variations in Southern India. Not many studies have been reported in this context in Karnataka. Hence, the present study focuses on determining the location, size, and shape of mental foramina in Karnataka. Further, the incidence of accessory mental foramina was also determined in the present study.

Methodology

In a cross-sectional observational study done in Department of Anatomy, Sri Devaraj Urs Medical College, Kolar, Karnataka, using human dry mandibles, the positions and shapes of the mental foramen were observed. Institutional ethics committee cleared the study before the beginning of the study.

Sample size was estimated based on the mean diameter of mental foramen reported from a previous study by Udhaya et al. Considering standard deviation of 0.68 for the diameter of mental foramen, with 5% α error and at 95% confidence level, sample size of 177 was obtained and ~180 samples were considered for the study. Thus, 180 dried mandibles, edentulous and dentate, of both sexes, were procured from Department of Anatomy of Sri Devaraj Urs Medical College and studied. The location, size, and shape of mental foramen were observed. Digital Vernier calipers were used to measure the distance of mental foramen from various bony prominences consisting of alveolar crest, symphysis menti, posterior border of the ramus of mandible, and lower border of mandible.

The location of the mental foramen with reference to the borders were measured based on Tebo and Telford classification of position of mental foramina (Fig. 1).

The size of the mental foramen was calculated in terms of horizontal and vertical diameters. This also determines the shape of the mental foramen which is noted as oval or round. The parameters mentioned earlier were measured on both left and right mental foramina of mandible.

The location of the mental foramen were measured by using digital Vernier calipers wherein various parameters like the distance of the mental foramen from the symphysis menti, the posterior border of the mandible, the base of the mandible, and the alveolar margins (as shown in Fig. 2) were noted.

Results

The morphometric analysis of 180 dry human mandibles indicated that mental foramen were bilaterally present in all the bones and single in number in 98% of the bones. However, in 3 bones, accessory mental foramen was observed.
right side and 87% on left side). The next common position of mental foramen was in between longitudinal axes of first and second premolars (7.7% on right side and 6.6% on left side). The classification given earlier was based on Tebo and Telford classification of position of mental foramina\(^9\) (\textit{Table 1}).

The mean distance of the mental foramen with reference to various parameters of the mandible bone is summarized in \textit{Table 2}.

A comparison of mean values of both the sides were done and statistically analyzed by IBM SPSS statistics 20. It was found that there was no statistically significant difference in the measurements between the right and left sides of mental foramina of mandibles. The accessory mental foramina were observed in three bones along the axis of second premolar as evident in \textit{Fig. 3}.

\section*{Discussion}

The position of mental foramina is important for performing clinical and surgical procedures in the lower jaw area. The most common position of mental foramen in the present study was along the long axis of second premolar tooth. The findings of the present study are in accordance with previous studies like Agarwal and Gupta,\(^6\) Bhudhiraja et al,\(^7\) Kadel et al,\(^11\) Ilayperuma et al,\(^12\) and Shukla et al.\(^13\) Kadel et al\(^11\) in 2016 reported that the position of the mental foramen varies depending on various factors which include ossification of the human mandible, symmetry of mental triangle, bone remodeling activity, morphometrics of mandibular body, and anthropologic features of the facial skeleton in different populations. It is also reported that during early prenatal life, an interesting feature of mental foramen is that it is situated in the alveolar bone between the first molar and primary canine. Therefore, it is suggested that positions other than the most common ones are due to a lag in prenatal development.\(^14\)

In the present study, the shape of mental foramen was oval in 97.3% of mandibles and round in 2.7% mandibles on the right side and it was oval in shape in 97.8% and round in 2.2% on the left side. Majority of the studies are in accordance with the present findings in terms of shape of the mental foramen. Junior et al\(^10\) and Budhiraja et al\(^7\) reported that the shape of the mental foramen was oval in around 75% of the mandibles studied. Udhyet al\(^8\) also observed that in 75 bones (83.33%) the mental foramen was oval in shape on both sides and in the 15 mandibles (16.67%) remaining, the mental foramen was showing a round shape bilaterally. However, the present findings are contradicting with a previous study by Singh et al\(^8\) who observed that the shape of mental foramen was oval in only 6% and round in 94% of mandibles. Another study by Mbayorogu et al\(^9\) found almost equal distribution of shapes wherein the mental foramen was round in 14 mandibles (43.8%) and 18 mandibles (56.3%) were observed to be oval. Overall, it can be seen that in most of the studies the shape of the mental foramen was found to be oval as observed in the present study as well.

The morphometric measurements of mental foramina of dry mandibles obtained in the present study is being compared with the previous studies which are summarized in \textit{Table 3}.

\textit{Table 3} suggests that the findings of the present study are in accordance with the various earlier-mentioned studies. However, the values were relatively lower in the present study in all the parameters. The mean values of location of mental foramen were higher in studies conducted by Kadel et al\(^11\) at Nepal and Ilayperuma et al\(^12\) at Sri Lanka compared with the present study. This finding may be due to morphometric facial skeletal differences in different races. The morphometric measurements found in Agarwal and Gupta,\(^6\) Bhudhiraja et al,\(^7\) and Shukla et al\(^13\) conducted in mandibles belonging to population of Northern India.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|}
\hline
 & Right & Left \\
\hline
Vertical diameter (mm) & 3.69 & 3.66 \\
Horizontal diameter (mm) & 3.78 & 3.72 \\
\hline
\end{tabular}
\caption{Average diameter of right and left mental foramina}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|c|c|c|c|c|c|}
\hline
 & AB & CD & FE & GH & DA & HE \\
 & Rt & Lt & Rt & Lt & Rt & Lt & Rt & Lt & Rt & Lt \\
\hline
Mean (mm) & 9.76 & 9.76 & 10.81 & 10.83 & 62.41 & 62.43 & 23.02 & 23.07 & 24.27 & 24.27 & 89.95 & 89.95 \\
\hline
Standard deviation (mm) & 2.97 & 2.97 & 2.69 & 2.72 & 5.57 & 5.60 & 2.79 & 2.82 & 3.16 & 3.16 & 4.47 & 4.47 \\
\hline
\end{tabular}
\caption{Descriptive statistics of location of mental foramina}
\end{table}

Note: AB → distance from the alveolar crest to the upper margin of mental foramen. CD → distance from lower margin of mental foramen to lower border of mandible. FE → distance from medial margin of mental foramen to symphysis menti. GH → distance from lateral margin of mental foramen to posterior border of ramus of mandible. DA → distance from lower border of mandible to alveolar crest. HE → distance from posterior border of ramus of mandible to symphysis menti.

\textit{Fig. 3} Accessory mental foramina on right side of mandible.
although had slightly higher values, the mean values were observed to be closer to what was observed in the present study. Further, the study conducted by Udhaya et al\(^2\) in mandibles of South Indian population had certain values (FE, HE, GH as described in Fig. 2) similar to the present study. This suggests that there may be minimal morphometric variations across regions as well with respect to the location of mental foramen.

In the present study, the accessory mental foramina were observed in three bones along the axis of second premolar tooth, two on right side and one on the left side. Imada et al\(^3\) studied morphometric parameters of 100 mandibles and observed to have six accessory mental foramen, three on right and three on the left side. Various other studies\(^4-7\) also opined that the accessory mental foramen was observed in around 6 to 7% of the mandibles studied. However, Shukla et al\(^8\) reported that out of 96 mandibles only one accessory mental foramen was observed. Udaya K et al\(^9\) noted asymmetry in right and left in terms of the incidence of the accessory mental foramen which was more (3.33%) on the left side as compared with that on the right side (2.22%). Overall, the incidence of accessory mental foramen was observed to vary from 2% to 7%. The location of the accessory mental foramen also becomes important pertaining to structures emerging through it which is reported in the present study.

### Conclusion

From the present study, we can conclude that the mental foramen was most commonly located along the axis of second premolar tooth, type IV according to Tebo and Telford classification. The majority of the mental foramen was oval in shape and the morphometric analysis revealed no significant difference between the right and left side.

### Limitations

This study is conducted utilizing dry mandible bones procured from the anatomy department of unknown sex and age. Age and sex related factors may have a role in determining position, size, and shape of mental foramen.

### Advantages

Adequate sample of dry bones were available. The measurements obtained using digital Vernier calipers are accurate in dry bones. The procedure is simple and can be repeated in case of bias during data collection.

### Future Direction

This study can be upgraded to a radiological study of skull X-rays taken from orthopedics/radiology department so that clinical correlation can be established using basic morphometric data obtained from the present study.

### Conflict of Interest

None.

### References


### Table 3  Comparison of parameters across studies describing the location of mental foramina

<table>
<thead>
<tr>
<th>Study</th>
<th>AB Mean (mm)</th>
<th>CD Mean (mm)</th>
<th>GH Mean (mm)</th>
<th>FE Mean (mm)</th>
<th>DA Mean (mm)</th>
<th>HE Mean (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rt</td>
<td>Lt</td>
<td>Rt</td>
<td>Lt</td>
<td>Rt</td>
<td>Lt</td>
</tr>
<tr>
<td>Kadel et al</td>
<td>13.95 ± 1.73</td>
<td>13.75 ± 1.83</td>
<td>12.24 ± 1.30</td>
<td>12.26 ± 1.23</td>
<td>65.34 ± 4.71</td>
<td>65.68 ± 4.24</td>
</tr>
<tr>
<td>Ilayperuma et al</td>
<td>14.05 ± 3.05</td>
<td>13.82 ± 3.06</td>
<td>12.16 ± 3.04</td>
<td>12.11 ± 3.11</td>
<td>—–</td>
<td>—–</td>
</tr>
<tr>
<td>Shukla et al</td>
<td>10.84 ± 1.06</td>
<td>10.69 ± 1.02</td>
<td>15.02 ± 1.38</td>
<td>13.88 ± 1.31</td>
<td>64.61 ± 5.05</td>
<td>65.05 ± 5.19</td>
</tr>
<tr>
<td>Bhudhiraja et al</td>
<td>11.46 ± 1.33</td>
<td>11.33 ± 1.25</td>
<td>15.25 ± 1.50</td>
<td>15.40 ± 1.31</td>
<td>65.76 ± 6.13</td>
<td>66.13 ± 5.24</td>
</tr>
<tr>
<td>Udhaya et al</td>
<td>12.02 ± 1.22</td>
<td>12.21 ± 1.25</td>
<td>12.65 ± 1.27</td>
<td>12.77 ± 1.31</td>
<td>64.51 ± 6.92</td>
<td>63.92 ± 5.29</td>
</tr>
<tr>
<td>Present study</td>
<td>9.76 ± 1.97</td>
<td>9.76 ± 1.97</td>
<td>10.81 ± 1.81</td>
<td>10.83 ± 1.83</td>
<td>62.41 ± 6.43</td>
<td>62.43 ± 5.29</td>
</tr>
</tbody>
</table>