

Determination of sex by radiographic analysis of mental foramen in North Indian population

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Abstract

Aim: Identification and determination of sex of unknown human skeletal remains has been one of the most challenging tasks for forensic dentistry. The purpose of this study was to determine the gender from the analysis of mental foramen on panoramic radiographs in a north Indian population. **Materials and Methods:** One hundred radiographs were selected for the analysis of mental foramen. Tangents were drawn to the superior and inferior borders of the foramen and perpendiculars were drawn from the tangents to the lower border of the mandible (S-L and I-L). The data obtained were tabulated and subjected to statistical analysis. **Results:** The average values of S-L and I-L were significantly higher in males than in females, while the distances for the right and left sides of an individual were almost similar in both the male and the females group, and the results were non-significant. **Conclusion:** The distances from the mental foramen to the lower border of the mandible exhibit sexual dimorphism in the north Indian population.

Key words: Mental foramen, panoramic radiograph, sex determination

Introduction

Distinguishing males from females and the differences in ethnic groups by analyzing the morphological characteristics of bone is important in the fields of physical and forensic anthropology. The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone.^[1] Therefore, the use of morphological features of the mandible is a common approach used by anthropologists and forensic dentists in the determination of sex.^[2]

Skeletal characteristics vary by population; therefore, there is a need for population-specific standards.^[3] Among many anatomical landmarks in human skull, the mental foramen is a stable landmark on the mandible.^[4] It is a funnel-like opening in the lateral surface of the mandible at the terminus of the mental canal. It lies near the apices of premolars and transmits mental nerves and vessels. The opening is directed outward, upward and posteriorly.^[5]

The radiographs are indispensable tools that can also be used in forensic anthropology. The accuracy of measurements on radiographs is based on the quality of the radiographs. The mental foramen is fairly well depicted on panoramic radiographs.^[4] It provides the ability to view the entire body of the mandible and allow a more accurate location of the mental foramen in both horizontal as well as in vertical dimensions.^[6]

The aim of the present study was to signify the average measurements from the superior and the inferior borders of the mental foramen to the lower border of the mandible

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on panoramic radiographs in determining the gender in a north Indian population.

Materials and Methods

A retrospective study was performed on the panoramic radiographs of patients aged between 18 and 62 years, which were obtained for orthodontic, periodontic and endodontic purposes.^[4] The radiographs were taken between January 2011 and June 2011 within a duration of 6 months.

All the radiographs were taken using the Planmeca Proline 2006 EC machine with tube potential 60-80 KV, tube current 6-8 mA, total filtration 2.5 mm Al, focal spot 0.3 and time 18 s.^[5]

Only high-quality radiographs with correct positioning were included in the study. The exclusion criteria for the radiographs were: Distortion of images, presence of artefacts, surgical interventions, presence of any pathology, patient under 18 years and non-visualization of mental foramen.^[5]

Of the total 220 screened radiographs, 100 radiographs were selected for the analysis in which the mental foramen was identified as a separate type. The tangents were drawn to the superior and inferior borders of the foramen and perpendiculars were drawn from tangents to the lower border of the mandible bilaterally. An indelible pencil was used for marking the tangents and perpendiculars and a Vernier calliper was used for the measurements.^[4]

The distances were measured from the superior border of the mental foramen to the lower border of the mandible (S-L) and the inferior border of the mental foramen to the lower border of the mandible (I-L). Statistical analysis was performed that included mean values in males and females on both the right and the left sides, confidence interval test at 95% and *t*-test and *P* values.

Statistics and Results

The mean distance from the upper border of the mental foramen to the lower border of the mandible (S-L) on the right side in males was 17.650 mm, whereas it was 16.150 mm in females. On the left side, it was 17.475 mm in males and 15.787 mm in females [Tables 1 and 2].

The mean distance from the lower border of the mental foramen to the lower border of the mandible (I-L) on the right side in males was 12.670 mm, whereas it was 11.462 mm in females. On the left side, it was 12.583 mm in males and 11.250 mm in females [Tables 3 and 4].

The comparison of S-L between males and females showed a

very high significant difference ($P < 0.001$) on both the right and the left sides [Table 5]. Similarly, the comparison of I-L between males and females suggested a highly significant difference ($P = 0.0022$) on both sides [Table 6].

The comparison of S-L and I-L between the right and the left sides in males described a non-significant difference ($P = 0.67$ and $P = 0.84$) [Table 7]. In the same way, the comparison of S-L and I-L between the right and left sides in females also showed a non-significant difference ($P = 0.57$ and $P = 0.76$) [Table 8].

Table 1: S-L in males

	Right	Left	Combined
Number	60	60	120
Mean (mm)	17.65	17.475	17.5625
Standard deviation	2.376	2.208	1.5637
Standard error mean	0.3068	0.2851	0.2018
95% confidence interval range	17.036-18.264	16.9050-18.045	16.921-18.160

Table 2: S-L in females

	Right	Left	Combined
Number	40	40	80
Mean (mm)	16.150	15.7875	15.9688
Standard deviation	2.790	3.013	2.1382
Standard error mean	0.4412	0.4763	0.3181
95% confidence interval range	15.258-17.042	14.824-16.751	15.041-17.032

Table 3: I-L in males

	Right	Left	Combined
Number	60	60	120
Mean (mm)	12.670	12.583	12.6265
Standard deviation	2.615	2.499	1.7675
Standard error mean	0.3375	0.3227	0.2281
95% confidence interval range	11.991-13.342	11.938-13.229	11.944-13.281

Table 4: I-L in females

	Right	Left	Combined
Number	40	40	80
Mean (mm)	11.4625	11.25	11.3563
Standard deviation	2.921	3.189	2.2575
Standard error mean	0.4618	0.5041	0.3569
95% confidence interval range	10.528-12.392	10.230-12.270	10.424-12.384

Table 5: Comparison of S-L between males and females

	<i>t</i> value	<i>P</i> value	Significance
Right	2.88	0.0048	Highly significant
Left	3.23	0.0016	Highly significant
Combined	4.3	<0.001	Very highly significant

Discussion

The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone. Therefore, mandibular characteristics are extremely useful for determining sex.^[1]

In 1974, Wical and Swoope described that despite the alveolar bone resorption above the mental foramen, the distance from the foramen to the inferior border of the mandible remains relatively constant throughout life.^[7]

Lindh *et al.* in 1995 and Guler *et al.* in 2005 also suggested that the stability of this region does not depend on resorption of alveolar process above the foramen. Therefore, the vertical measurements in panoramic radiography are clinically applicable for the quantification of height of alveolar bone in this region.^[8,9] Because of the stability of the basal bone and mental foramen, these landmarks were selected as a point of reference for the present study.

Panoramic radiography is a curved plane tomographic radiographic technique used to depict the body of the mandible, maxilla and the lower one-half of the maxillary sinuses on a single image.^[9] The ability to view the entire body of the mandible allows a more accurate location of the mental foramen in both a horizontal and a vertical dimension on panoramic radiographs.^[6] Agthong *et al.* in 2005 analyzed the position of the mental foramen in several populations by using panoramic radiography.^[10]

Yosue and Brooks in 1989 described that the radiographic appearance of mental foramen can be classified into four types. In the continuous type, the mental canal is continuous with the mandibular canal. In the separate type, the

foramen is distinctly separated from the mandibular canal and appears as a well-defined radiolucency with a distinct border of condensing bone. In the diffuse type, the foramen has an indistinct border while in the unidentified type, the foramen cannot be seen.^[11,12] The separate type is easy to identify on panoramic radiograph and so only this type was selected for the present study.

It was suggested by Akgul and Toygar in 2002 that in comparative analyses between genders, the morphometric study by means of panoramic radiography reveals differences and inherent alterations in the evaluated groups.^[13]

In the present study, the mean values of S-L and I-L were significantly high in males as compared with females, and the results were in accordance with those of Thomas *et al.*, Mahima *et al.* and Catovic *et al.*^[4,14,15]

On the contrary, Vodanovic *et al.* found that the mean value of I-L does not exhibit sexual dimorphism.^[16] The difference may be due to racial diversity of the study population. In our study, this value was also significantly high in males, which also corresponds to the studies of Enlow *et al.* and Amorim *et al.*^[17]

The distances (S-L and I-L) for the right and left sides of an individual showed that the values were almost similar, with a non-significant difference, and this applies for both the male and the female groups. This is similar to the study of Thomas *et al.*^[14] Therefore, the distances from any of the sides can be used as a representative for gender discrimination.

In the present study, the 95% confidence interval range analysis described that the S-L in males comes within the range of 16.921-18.160 mm, and in females it fall within the range of 15.041-17.032 mm. The I-L in males ranges between 11.944 and 13.281 mm and in females it comes within the range of 10.424 and 12.384 mm.

These results suggest that if a distance above 16.921 mm for S-L and 11.944 mm for I-L is obtained on the panoramic radiograph; the gender will be male in 95% of the cases. Similarly, if a distance less than 17.032 mm for S-L and 12.384 mm for I-L is obtained, the gender will be female in 95% of the cases. The results were similar to the study conducted on a south Indian population by Mahima *et al.* in 2009, who described that if a distance above 1.7 cm is obtained for S-L and 1.48 cm for I-L, the gender is male in 99% of the cases. In the same way, if a distance is less than 1.69 cm for S-L and 1.3 cm for I-L, the gender is female.^[4]

Conclusion

Based on the results of this study, it is possible to conclude

Table 6: Comparison of I-L between males and females

	t value	P value	Significance
Right	2.16	0.033	Significant
Left	2.33	0.021	Significant
Combined	3.15	0.0022	Highly significant

Table 7: Comparison of S-L and I-L between the right and left sides in males

	t value	P value	Significance
S-L	0.42	0.67	Not significant
I-L	0.19	0.84	Not significant

Table 8: Comparison of S-L and I-L between the right and left sides in females

	t value	P value	Significance
S-L	0.56	0.57	Not significant
I-L	0.31	0.76	Not significant

that the distances from the mental foramen to the lower border of the mandible exhibit sexual dimorphism in the north Indian population. Panoramic radiography is efficient for making the proposed measurements and can be considered as an additional radiographic method to determine gender from the skeletal remains. The technique is particularly important in mass disaster events, in which the jaws are available in fragments.

Larger study groups and comprehensive assessment of various other parameters related to the mental foramen are required to further confirm the results.

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