



RESEARCH ARTICLE

SEX DETERMINATION BY ANALYSIS OF MENTAL FORAMEN IN SOUTH INDIAN POPULATION – A RADIOGRAPHIC STUDY

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ABSTRACT

Introduction: The strongest bone in the human body is mandible as it persists in a well-preserved state. The forensic dentist commonly uses the morphological features of the mandible in the determination of sex. Among many anatomical landmarks, the mental foramen is a stable landmark on the mandible. It is a small funnel-like opening in the antero- lateral aspect of the mandible at the terminus of the mental canal near the apices of premolars.

Aim: The purpose of this study is to determine the gender from the analysis of mental foramen on panoramic radiographs in South Indian population.

Materials and Methods: The study was conducted on 300 orthopantomograms for analysis of mental foramen in population with chronological age range 18-60 years

Results: The average values of S-L and I-L were significantly higher in males than in females, while the distances for the right side is higher than the left side both the male and the females group, and the results were significant.

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INTRODUCTION

Analyzing the morphological characteristics of mandible in distinguishing males from females has its own importance in forensic anthropology. The strongest bone in human body is mandible as it persists in a well-preserved state than any other bone (Hu *et al.*, 2006). Therefore, determination of sex by using morphological characteristics of the mandible has been a common approach used by forensic dentists (Sweet *et al.*, 2001). Osteologic analysis of the skeletal remains is an important aspect in determination of sex of an individual in a given population (Amay-de-la-rosa *et al.*, 2006). In mandible, the mental foramen is a stable landmark (Mahima *et al.*, 2009). It is a funnel-like opening at the terminus of the mental canal on the antero-lateral aspect of the body of the mandible and 28mm away from midline.

It is situated near the apices of premolars and transmits mental nerves and vessels (Haghanifar *et al.*, 2009). Radiographs are indispensable tools used in forensic dentistry. Mental foramen is well depicted on panoramic radiographs. The image quality of the panoramic radiograph is increased by the digital panoramic radiography (Xie *et al.*, 1997). Panoramic radiography provides the ability to visualize the entire body of the mandible and allow more accurate location of the mental foramen in horizontal as well as in vertical dimensions (Phillips *et al.*, 1992). The aim of the present study is to signify the average measurements from the superior and the inferior borders of the mental foramen to the lower border of the mandible on digital panoramic radiographs in determining the gender in south Indian population.

MATERIALS AND METHODS

A retrospective study was performed on the digital panoramic radiographs of patients aged between 18 and 62 years, which

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were obtained for different purposes in outpatient department of different dental institutions. All the radiographs were taken using the KODAK 8000 machine with tube potential 70-80 KV, tube current 10-12 mA, total filtration 2.5 mm Al, focal spot 0.3 and time 15 s (Mahima *et al.*, 2009). 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. 300 radiographs were selected for the analysis in which the mental foramen was identified. 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. A calibrator was used for the measurements.

Measurements

- The distances were measured from the superior border of the mental foramen to the lower border of the mandible (S-L)
- The inferior border of the mental foramen to the lower border of the mandible (I-L). (FIG 1)

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 14.92 mm, whereas it was 13.58 mm in females. On the left side, it was 12.09 mm in males and 10.93 mm in females, (Table 1 and 2).

Table 1. Showing S-L in Males

S-L in Males	Right	Left	Combined
N	150	150	300
Mean	14.92	12.09	13.50
Std. Deviation	2.00	1.66	2.32
Std. Error	0.16	0.14	0.13
95% Confidence Interval for Mean	14.59-15.24	11.82-12.36	13.24-13.77
Minimum	0.00	8.20	0.00
Maximum	19.10	16.20	19.10

Table 2. Showing I-L in Males

I-L in Males	Right	Left	Combined
N	150	150	300
Mean	14.61	11.83	13.22
Std. Deviation	1.56	1.70	2.14
Std. Error	0.13	0.14	0.12
95% Confidence Interval for Mean	14.36-14.86	11.56-12.10	12.98-13.46
Minimum	11.30	8.30	8.30
Maximum	18.20	15.60	18.20

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 14.61 mm, whereas it was 13.24 mm in females. On the left side, it was 11.83 mm in males and 10.95 mm in females (Table 3 and 4). The comparison of S-L between males and females showed a very high significant difference 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 on both sides, Table 6).

Table 3. Showing S-L in Females

S-L in Females	Right	Left	Combined
N	150	150	300
Mean	13.58	10.93	12.25
Std. Deviation	1.52	1.73	2.10
Std. Error	0.12	0.14	0.12
95% Confidence Interval for Mean	13.34 -13.83	10.65 - 11.20	12.02-12.49
Minimum	10.70	7.30	7.30
Maximum	17.60	15.90	17.60

Table 4. Showing I-L In Females

I-L in Females	Right	Left	Combined
N	150	150	300
Mean	13.24	10.95	12.10
Std. Deviation	1.35	1.53	1.84
Std. Error	0.11	0.12	0.11
95% Confidence Interval for Mean	13.03 - 13.46	10.71 - 11.20	11.89-12.31
Minimum	10.60	8.10	8.10
Maximum	16.50	14.70	16.50

Table 5. Comparison of S-L between Males and Females

S-L	Males And Females		
	t value	P value	Significance
Right	6.505	0.000	Highly Significant
Left	5.939	0.000	Highly Significant
Combined (Right + Left)	6.913	0.000	Highly Significant

Statistical Analysis: Unpaired t test. Statistically significant if $P < 0.05$

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

I-L	MALES AND FEMALES		
	t value	P value	Significance
Right	8.088	0.000	Highly Significant
Left	4.712	0.000	Highly Significant
Combined (Right + Left)	18.925	0.000	Highly Significant

Statistical Analysis: Unpaired t test. Statistically significant if $P < 0.05$

The comparison of S-L and I-L between the right and the left sides in males described a highly significant difference ($P = 0.00$ and $P = 0.00$), 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 ($P = 0.00$ and $P = 0.00$) (Table 8).

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

The right and left sides in males	t value	P value	Significance
S-L	13.314	0.000	Highly Significant
I-L	14.758	0.000	Highly Significant

Statistical Analysis: Unpaired t test. Statistically significant if $P < 0.05$

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

The right and left sides in females	t value	P value	Significance
S-L	14.134	0.000	Highly Significant
I-L	13.764	0.000	Highly Significant

Statistical Analysis: Unpaired t test. Statistically significant if $P < 0.05$



Fig 1. Photograph of OPG showing I-L and S-L calibrations

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 (Hu, 2006). Panoramic radiography (PR) shows greater part of maxillofacial skeleton as a continuous image, thus allowing for a more accurate localization of both mental foramina in both vertical and horizontal dimensions. On other hand, periapical radiograph may not reveal the position of the mental foramen if it is below the edge of the film (Phillips *et al.*, 1992). Agthong *et al.* in 2005 analyzed the position of the mental foramen in several populations by using panoramic radiography (Agthong *et al.*, 2005). 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 (Wical *et al.*, 1974). 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 (Lindh *et al.*, 1995 and Guler *et al.*, 2005).

Because of the stability of the basal bone and mental foramen, these landmarks were selected as a point of reference for the present study. 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 (Yosue *et al.*, 1989 and Yosue and Brooks, 1989). The separate type is easy to identify on panoramic radiograph and so only this type was selected for the present study. 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 Catovie *et al.* (Mahima *et al.*, 2009 ; Thomas *et al.*, 2014 and Catovie *et al.*, 2002). On the contrary, Vodanovic *et al.* found that the mean value of I-L does not exhibit sexual dimorphism. (Vodanovic *et al.*, 2006) 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.* (2009). The distances (S-L and I-L) for the right and left sides of an individual showed that the values with significant difference in our study, and this applies for both the

male and the female groups. In the present study, the 95% confidence interval range analysis described that the S-L in males comes within the range of 13.24-13.77mm, and in females it fall within the range of 12.02-12.49 mm. The I-L in males ranges between 12.98 and 13.46 mm and in females it comes within the range of 11.89 and 12.31 mm.

Conclusion

Based on the results of this study, it is possible to conclude that the distances from the mental foramen to the lower border of the mandible exhibit sexual dimorphism in the south Indian population. Panoramic radiography is efficient for making the measurements and can be considered as an additional radiographic method to determine males and females from the skeletal remains. The method is particularly important in mass disaster.

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