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MORPHOMETRIC ANALYSIS OF MENTAL AND MANDIBULAR FORAMEN IN GENDER DETERMINATION AMONG LUCKNOW POPULATION: A CROSS – SECTIONAL DIGITAL PANORAMIC STUDY

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ABSTRACT

The morphometric dimensions of the mental foramen and mandibular foramen are critical in planning surgical approaches in clinical and forensic dentistry. These anatomical landmarks aid in human identification and have applications in medico-legal contexts. This study aimed to determine the differences in the vertical positions of the mental foramen and mandibular foramen between genders using digital panoramic radiographs and linear measurements. A total of 500 subjects were included in this study. Radiographs were taken using the Planmeca Proline XC Panoramic and Cephalometric machine on Agfa radiographic film under standardized conditions. Linear measurements were conducted using Romexis dental software. ***Results:*** *The mean value of D1, D2, D3, and D4 in males on the left side of the mandible showed 11.2 mm, 15.7 mm, 13.5 mm, and 45.6 mm, whereas females showed 10.2 mm, 13.4 mm, 11.6 mm, and 44.7 mm. Similarly, when the variables D1, D2, D3, and D4 were measured on the right side of the male population, it showed us 12.5 mm, 16.3 mm, 11.5 mm, and 46.6 mm width. Dimensions of all the variables of the females were 9.4 mm, 14.7 mm, 10.6 mm, and 42.8 mm*. **Conclusion**: Mandible is an efficacious tool in sex determination and would be useful to authenticate forensic databases.

INTRODUCTION

The identification of human skeletal remains plays a crucial role in forensic analysis. In adult skeletons, determining gender is the initial and most critical step in developing a biological profile, followed by establishing age and stature. The condition of the remains and the degree of sexual dimorphism are key factors in determining gender. In cases of mass disasters, sex identification largely depends on the availability of bone fragments; the more complete the skeleton, the more accurate the determination.

Mandibular bones are often chosen for study because they are dense, resilient, and least susceptible to destruction. Compared to other hard tissues, the lower jaw retains its landmarks better. Due to these characteristics, the mandible's morphological traits are frequently used for gender identification in forensic investigations. Panoramic radiography is a widely used technique as it provides a comprehensive view of the mandible on a single film, offering benefits in terms of lower exposure, time efficiency, and cost. With this background, the present study was conducted to assess whether the anatomical position of the mental foramen can be used a landmark for gender differentiation.

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MATERIALS AND METHODS

Patients aged 20 years and above who visited the Department of Oral Medicine and Radiology were included in the study.

The sample size was calculated using a formula based on sensitivity and specificity:

Sample size n based on sensitivity = Z21-α/2X S NX (1-SN)/ L2XP

Sample size n based on specificity = Z1-α/2X S NX (1-SP)/ L2X (1-P)

Where, n = required sample size, SN = anticipated sensitivity, SP = anticipated specificity, α = size of the critical region (1-α is the confidence level), Z1-α/2 = standard normal deviate corresponding to the specified size of the critical region (α), L = absolute precision desired on either side (half-width of the confidence interval) of sensitivity or specificity. Taking sensitivity and specificity both as 90% and expected maximum patient reporting for panoramic radiography as 50%, L = absolute precision as 10%, and Z = 2 (for 95% confidence interval), from the above formula, the sample size was found to be 500.

A total of 500 subjects with Type II (separate type) mental foramen were identified for the study. Panoramic radiographs were considered, with an equal number of male (n = 250) and female (n = 250) participants. After collecting demographic details, a brief history of the current disease, and previous medical or surgical history, the subjects were enrolled in the study. This study was conducted in Babu Banarsi Das collage

of Dental Sciences, Lucknow

Inclusion criteria

- Patients aged 20 years and more.
- Panoramic radiographs free of positioning and digital possessing errors.
- Panoramic radiographs showing a Type II (separate type) mental foramen.

Exclusion criteria

- Hereditary facial asymmetries.
- Previous history of maxillofacial surgical intervention including orthognathic surgeries.
- Patients with any pathologies in the mandible (radiolucent and radiopaque lesions) that could impact radiographic image interpretation.
- Patients with missing teeth in the mandible other than the third molars.
- A diffuse, unexplained, and nonvisualized mental foramen.
- A congenital defect in the mandible that could impair the radiographic image interpretation.
- Pregnant females.

All the radiographs were taken with Planmeca Proline XC Panoramic and Cephalometric machine. Agfa radiographic film. Measurement was done using Romexis dental software.

Only 500 radiographs displaying a Type II appearance of the mental foramen that met the inclusion criteria were selected for the study. On panoramic radiographs, the Type II (separated type) mental foramen is identified based on a classification system proposed by Yosue T and Brooks in 1989:

***Type I*:** The mental canal appears continuous with the mandibular canal.
***Type II*:** The mental foramen is distinctly separated from the mandibular canal.
Type III: The foramen has a diffuse appearance but maintains a distinct border.
Type IV: The mental foramen cannot be identified on panoramic radiographs under standard exposure and viewing conditions. This classification system was used to categorize the mental foramen types in the radiographs under study.

After interpreting the radiographs, a total of four vertical measurements were recorded on both the right and left sides of the mandible. These measurements were related to the mental and mandibular foramina and were taken by a single radiologist using Planmeca Proline XC dental software. All measurements were expressed in millimeters (mm).

The following measurements were recorded:

- ***D1***: Vertical distance from the most inferior point on the mental foramen to the lowest point on the base of the mandible.
- ***D2***: Vertical distance from the most superior point on the mental foramen to the highest point of the alveolar crest.
- ***D3***: Vertical distance from the most inferior point of the mandibular notch to the highest point on the mandibular foramen.
- ***D4***: Vertical distance from the most inferior point of the mandibular notch to the lower edge of the mandibular ramus.

Additionally, the shape of the Type II mental foramen was recorded as oval, round, or irregular, and it was also noted whether the mental foramen was symmetrical or asymmetrical based on the comparison of the right and left sides.

All collected data were tabulated and subjected to statistical analysis to compare the vertical measurements of the right and left sides for both the mental foramen and the mandibular foramen. The data were also analysed to identify any correlation between the vertical measurements and gender.

Statistical analysis

Statistical calculations were conducted using Statistical Package for the Social Sciences (SPSS) software version 19 (Armonk, New York: IBM Corporation). A Student's t-test was applied to assess the statistical significance of the differences between the two groups. Additionally, correlation analysis was performed to examine the relationships between variables.

The relationship between vertical measurements and gender was assessed using correlation analysis. To evaluate the effectiveness of these linear measurements in distinguishing between male and female genders, discriminant analysis and receiver operating characteristic

(ROC) analysis were applied. A P-value of less than 0.05 ($P < .05$) was considered statistically significant, indicating the reliability of the measurements in gender differentiation.

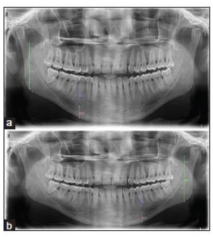

Figure 1: (a and b) Measurement on the right side in a male patient, Measurement on the left side in a male patient

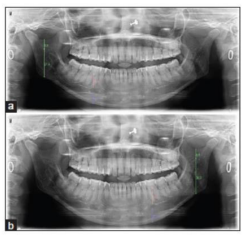

Figure 2: (a and b) Measurement on the right side in the female patient, Measurement on the left side in a female patient

RESULTS

The mean value of D1, D2, D3, and D4 in males on the left side of the mandible showed 11.2 mm, 15.7 mm, 13.5 mm, and 45.6 mm, whereas females showed 10.2 mm, 13.4 mm, 11.6 mm, and 44.7 mm. Similarly, when the variables D1, D2, D3, and D4 were measured on the right side of the male population, it showed us 12.5 mm, 16.3 mm, 11.5 mm, and 46.6 mm width. Dimensions of all the variables of the females were 9.4 mm, 14.7 mm, 10.6 mm, and 42.8 mm.

Table 1: Comparison of D1 on right and left side and D2 on right and left side in male and female population

side	variable	D1		D2	
		Mean	t & P	Mean	t& P
Male	left	11.2mm	18.231	15.7mm	53.333
	Right	12.5mm	0.035	16.3mm	0.012
Female	Left	10.2mm	23.118	13.4mm	21.615
	Right	9.4mm	0.028	14.7mm	0.029

Table 2: Comparison of D1 on right and left side and D2 on right and left side in male and female population

side	variable	D1		D2	
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DISCUSSION

Only partial remains of human corpses are often found at crime scenes, accidents, and during catastrophic disasters. When the complete skeleton is available for examination, sex determination can be nearly 100% accurate. However, in cases involving fragmented skeletal remains, accurate sex determination becomes more challenging.

A radiographic study on sex determination using the mental foramen was conducted by

Thakur M (2014). They took similar measurements from the mental foramen to the inferior

border of the mandible and found statistically significant differences between males and females, much like the findings in our study.

Similarly, Singhal K and Sharma S (2016) studied the Haryana population to evaluate the sensitivity of vertical measurements of the mental foramen in sex determination. They examined the distance from the inferior border of the mental foramen to the lower border of the mandible and observed significant differences between males and females, in line with our findings. In a 2009 study by Mahima VG et al., conducted among the South Indian population, radiographic research also supported the reliability of the mental foramen for sex identification. They measured the distances on both sides of the mental foramen and found that the distance between the upper border of the mental foramen and the lower border of the mandible was 1.84 cm and 1.87 cm on the right and left sides for males, and 1.61 cm and

1.64 cm for females. Skeletal anatomy plays a crucial role in human sexual identification. Research across various geographic regions and ethnic groups in the United States has demonstrated this relationship extensively. These prior studies align with our conclusion that measurements of the mental foramen are significantly useful in sex determination.

Limitations of the study

The limitations of the study included a small sample size that cannot give accurate evidence for the results.

Future prospects of the study

Previous studies, including those referenced in our literature review, have indicated that bone morphometric measurements can differ significantly among various populations and ethnic groups. This variability highlights the importance of conducting population-specific studies, such as ours, to establish baseline data for future research.

CONCLUSION

In forensic investigations aimed at identifying individuals, determining a person's sex is the initial step, typically followed by assessing age and ethnic origin. The human skeleton comprises various robust bones that exhibit sexual dimorphism. Previous studies have indicated that the mandible can achieve up to 92% accuracy in sex determination. This bone is characterized by well-defined features that remain stable over time. Morphometric analyses are crucial due to their objectivity, authenticity, reproducibility, and lack of bias. Based on the findings of this study, we conclude that the mandible is an effective tool for sex determination and that our research has established baseline values for this population group.

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Conflicts of interest

There are no conflicts of interest

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