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A Comparative Study of Mandibular Ramus Dimensions between Males and Females in Cadavers from Maharashtra

Shamama Farheen Shaikh[1]*, Sana Khan[2], Gautam Shroff[3], Vaishali Mandhana[4], Pawan Sonawane[5]

[1]Associate Professor, Department of Anatomy, MGM Medical College, Sambhajinagar (Aurangabad), Maharashtra
[2]Assistant Lecturer, Department of Anatomy, MGM Medical College, Sambhajinagar (Aurangabad), Maharashtra
[3]Professor and HOD, Department of Anatomy, MGM Medical College, Sambhajinagar (Aurangabad), Maharashtra
[4]Professor, Department of Anatomy, MGM Medical College, Sambhajinagar (Aurangabad), Maharashtra
[5]Assistant Lecturer, Department of Anatomy, MGM Medical College, Sambhajinagar (Aurangabad), Maharashtra

*Corresponding Author:
Shamama Farheen Shaikh, Associate Professor, Department of Anatomy, MGM Medical College, Sambhajinagar (Aurangabad), Maharashtra
E-MAIL: shaikhshamama29@gmail.com

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ABSTRACT

Background: The mandible, being a robust bone, remains intact postmortem and can be utilized for gender determination. Morphometric analysis of the mandibular ramus holds significance for anthropologists, anatomists, and prosthetists. This study aims to assess the height and breadth of the mandibular ramus and their association with gender. **Materials and Methods:** The study was conducted on 56 cadaveric mandibles (18 female and 38 male). The height and breadth of the mandibular ramus were measured.Results: The mean ± SD for ramus height and breadth on the right side for females was 41.18 ± 4.70 mm and 28.89 ± 2.28 mm, respectively, while on the left side, it was 43.03 ± 3.57 mm and 30.70 ± 7.62 mm, respectively. For males, the mean ± SD for ramus height and breadth on the right side was 47.34 ± 2.88 mm and 33.14 ± 3.26 mm, respectively, while on the left side, it was 47.39 ± 3.88 mm and 32.39 ± 3.85 mm, respectively. **Conclusion:** The mean ± SD for ramus height and breadth was greater in males than in females. Although this study was conducted on cadaveric mandibles, the mandibular ramus can be utilized for gender determination in medico-legal and forensic cases.Keywords: gender, mandible, morphometry, mandibular ramus

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INTRODUCTION

The examination of bones plays a crucial role in medico-legal investigations. Among skeletal elements, the mandible is considered significant in gender identification after the pelvis. [1, 2] The shape and size of the mandible aid in determining sexual dimorphism, with the condyle and ramus being particularly important in gender determination. [2] Male and female mandibles differ in general size, chin shape, gonial angle, and muscular markings. [3–6] The mandible, particularly its canine teeth, is a valuable tool for sex estimation in forensic contexts due to its durability and resistance to decomposition. [5, 7] The mandible features a horizontally curved body with two broad rami ascending from its posterior end, housing the coronoid and condyloid processes. A digital radiographic study in 2012 indicated that the minimum ramus breadth is the most reliable parameter for sex determination. [3] This study was conducted to evaluate the usefulness of the height and breadth of the mandibular ramus in gender determination.

MATERIALS AND METHODS

This retrospective study was conducted on 56 dissected cadaveric mandibles, comprising 18 female and 38 male specimens.Inclusion Criteria: Intact, well-formed mandibles were included in the study.Exclusion Criteria: Pathological, deformed, damaged, or broken bones were excluded. Procedure:

- Maximum Breadth of Ramus: The distance between the most anterior point on the mandibular ramus and a line connecting the most posterior point on the condyle and the angle of the mandible. See Figure 1.
- Maximum Height of Ramus: The distance between the midpoint of the mandibular notch and the angle of the mandible. See Figure 2.

Statistical Analysis: Descriptive statistics were presented as Mean ± SD. Univariate analysis was performed for

Figure 1: Measurement of breadth of ramus

Figure 2: Measurement of height of ramus

mandibular measurement with independent sample t test between male and female. A discriminant analysis was performed on a dataset comprising mandibular measurements of the cadavers. The predictor variables were Ramus height (Right), Ramus breadth (Right), Ramus height (Left), and Ramus breadth (Left), and the grouping variable was gender.

RESULTS

A total of 56 dissected cadaveric mandibles were studied, comprising 18 female and 38 male specimens. The mean age for males is 56.39 years (SD = 27.65), while the mean age for females is 50.17 years (SD = 30.11). There is no statistically significant difference in the mean age between males and females cadavers in this study, p=0.44.Table 1

The mean $\pm$ SD for ramus height and breadth on the right side for females was 41.18 $\pm$ 4.70 mm and 28.89 $\pm$ 2.28 mm, respectively, while on the left side, it was 43.03 $\pm$ 3.57 mm and 30.70 $\pm$ 7.62 mm, respectively. For males, the mean $\pm$ SD for ramus height and breadth on the right side was 47.34 $\pm$ 2.88 mm and 33.14 $\pm$ 3.26 mm, respectively, while on the left side, it was 47.39 $\pm$ 3.88 mm and 32.39 $\pm$ 3.85 mm, respectively. The p-value was statistically significant ($\leq$0.001) for ramus height on both sides and ramus breadth on the right side for males and females. However, the difference in ramus breadth on the left side between genders was not statistically significant. Males tend to have higher mean values for both ramus height and breadth compared to females. This indicates a potential for these variables to discriminate between the two groups.Table 2

Age Groups (In years)	Male No. (%)	Female No. (%)	Total No. (%)
< 20	5 (13.2%)	4 (22.2%)	9 (16.1%)
21 to 40	9 (23.7%)	4 (22.2%)	13 (23.2%)
41 to 60	5 (13.2%)	3 (16.7%)	8 (14.3%)
61 to 80	10 (26.3%)	2 (11.1%)	12 (21.4%)
> 80	9 (23.7%)	5 (27.8%)	14 (25.0%)
Total	38 (67.9%)	18 (32.1%)	56 (100.0%)

Table 1: Distribution of age between male and female cadavers

Discriminant Analysis

A discriminant function analysis was conducted to evaluate whether measurements of ramus height and breadth (right and left sides) could effectively distinguish between male and female participants. The analysis used a total of 56 valid cases.

Parameter	Females (n=18)	Males (n=38)	p-value*
Ramus Height (mm) (Mean ± SD)			
Right Side	41.18 ± 4.70	47.34 ± 2.88	≤ 0.001
Left Side	43.03 ± 3.57	47.39 ± 3.88	≤ 0.001
Ramus Breadth (mm) (Mean ± SD)			
Right Side	28.89 ± 2.28	33.14 ± 3.26	≤ 0.001
Left Side	30.70 ± 7.62	32.39 ± 3.85	p=0.27

*Independent Samples t Test with df=54

Table 2: Comparison of mandibular ramus height and breadth between male and female

The analysis revealed that the discriminant function effectively discriminated between genders, as evidenced by the significant Wilks' Lambda test, Λ=0.516, χ2 (4,N=56)=34.45, p<0.001. The canonical correlation for the discriminant function was 0.696, indicating a strong relationship between the discriminant function and group membership. Group means indicated that males had higher values for ramus height and breadth compared to females as given in Table 2.

The highest correlations with the discriminant function were observed for right ramus height (r=0.851) and right ramus breadth (r=0.699). Ramus height (Right) and Ramus breadth (Right) emerged as the most important predictors in distinguishing between males and females. Table 3

The classification results demonstrated that 85.7% of the cases were correctly classified. Specifically, 86.8% of males and 83.3% of females were accurately classified according to the discriminant function.

		Predicted Group Membership		
	Gender	Male No. (%)	Female No. (%)	Total No. (%)
Original Gender	Male	33 (86.8)	5 (13.2)	38 (100)
	Female	3 (16.7)	15 (83.3)	18 (100)

85.7% of original grouped cases correctly classified.

Table 3: Classification Results of Discrimant Analysis based on mandibular measurements for sex prediction

DISCUSSION

Determining gender from the jaw and dentition is a critical aspect of forensic analysis.[8] The mandible holds significant importance in forensics due to its robustness and the scarcity of established standards for its use in gender determination.[9] Our study involved the examination of 56 mandibles, consisting of 18 female and 38 male specimens, with 14 mandibles indicating an age of over 80 years.

In our study, the maximum ramus height in males ranged from 40.35 mm to 52.97 mm on the right side and from 39.92 mm to 59.4 mm on the left side. For females, the maximum ramus height varied from 28.48 mm to 49.4 mm on the right side and from 24.68 mm to 59.49 mm on the left side, with a statistically significant difference between genders. In a study by Shivprakash et al., the maximum ramus height in males ranged from 47.76 mm to 68.64 mm, with an average of 59.21 ± 4.69 mm, while in females, it varied from 42.56 mm to 69.56 mm, with an average of 55.55 ± 4.93 mm. The values from Shivprakash et al.'s study were higher than those in our study, but both showed statistically significant gender differences.[10] Similarly, Mbajiorgu et al. found a maximum ramus height of 59.8 mm in males and 61.3 mm in females in Zimbabwe, results that align closely with our findings.[11] Other studies, such as those conducted on Croatian and Thai populations, reported higher ramus heights in both males and females.[9, 12] Karmarkar et al. reported maximum ramus heights in males of 40.3 mm (right) and 43.95 mm (left) and in females of 34.82 mm (right) and 37.04 mm (left), consistent with our findings.[13] The variation in ramus height might be attributed to differences in bone apposition at the mandibular condyle and population-specific characteristics such as overall height and racial differences.

In our study, the mean ± SD for ramus height in males was 47.34 ± 2.88 mm (right) and 47.39 ± 3.88 mm (left), while in females, it was 41.18 ± 4.70 mm (right) and 43.03 ± 3.57 mm (left). The difference in ramus height was statistically significant on both sides. A study by Damera et al. reported a higher mean ± SD for ramus height in males (66.95 ± 4.56 mm) and females (60.51 ± 4.10 mm) compared to our study.[14]

Regarding ramus breadth, our study found that in males, the maximum ramus breadth varied from 26.05 mm to 41.9 mm on the right side and from 21.52 mm to 40.94 mm on the left side. In females, the right-side breadth ranged from 20.61 mm to 31.72 mm, and the left side breadth from 24.68 mm to 59.49 mm. A single 33-year-old female exhibited a higher ramus breadth of 59.49 mm. Shivprakash et al. reported a maximum ramus breadth ranging from 28.84 mm to 42.28 mm in males and from 27.44 mm to 41.42 mm in females, values that correlate with our findings.[10] Tejavathi Nagaraj et al. found maximum ramus breadths of 40.55 mm in males and 39.44 mm in females, also consistent with our results.[15] However, Vodanović et al. reported higher values in Croatian mandibles, with a maximum ramus breadth of 44.20 mm in males and 41.23 mm in females.[9]

In our study, the mean ± SD for ramus breadth in males was 33.14 ± 3.26 mm (right) and 32.39 ± 3.85 mm (left), while in females, it was 28.89 ± 2.28 mm (right) and 30.70 ± 7.62 mm (left). The difference was statistically significant on the right side but not on the left. The lack of significance on the left side may be due to the outlier of a single adult

female with a ramus breadth of 59.49 mm. Shivprakash et al. reported a mean ± SD for ramus breadth of 35.82 ± 3.09 mm in males and 34.19 ± 3.17 mm in females, which aligns closely with our findings. [10] In contrast, Indira et al. found significantly higher mean values in a radiographic study, with a mean ± SD of 74.20 ± 6.34 mm in males and 68.98 ± 5.75 mm in females. [8] Additionally, Sharma et al. reported mean ± SD for ramus breadth in adult males and females as 30.93 ± 2.56 mm and 29.57 ± 2.86 mm, respectively, with lower values observed in the elderly population. [16]

CONCLUSION

The findings of this study indicate that the ramus of the mandible exhibits significant sexual dimorphism, particularly in terms of ramus height and breadth. The discriminant function analysis confirmed that ramus height and breadth measurements, particularly from the right side, are effective in distinguishing between males and females.

These differences can serve as reliable markers for gender determination in forensic investigations. This emphasizes the importance of incorporating mandibular metrics into forensic protocols, which could enhance the accuracy and reliability of gender determination in diverse populations. Further research is encouraged to refine these measurements across different ethnic groups and age categories to strengthen their forensic applicability.

Limitations: We have considered only ramus height and breadth as parameters. Inclusion of coronoid height would have been useful for better results. The sample size in this study was relatively small. Further research with larger and more diverse samples is needed to confirm the generalizability of these findings. Additionally, future studies may benefit from exploring the impact of other factors, such as age and geographic region, on mandibular measurements and gender prediction.

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