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Research Article

Study of Sex Determination of Human Mandible Using Metrical Parameters

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ABSTRACT
Introduction: Sex determination from skeletal remains is a cornerstone of forensic anthropology and medico-legal investigations. Among cranial bones, the mandible is particularly valuable due to its dense structure, resistance to postmortem degradation, and pronounced sexual dimorphism. Its morphometric features—especially bigonial breadth and bicondylar breadth—offer measurable parameters that can aid in distinguishing male from female remains. Present study aims to evaluate the role of bigonial and bicondylar breadth in sex determination using adult dry human mandibles
Materials and Methods: Present study is a cross-sectional study. 107 adult dry, complete, undamaged human mandibles available in the Anthropology Museum of Department of Anatomy were collected. Bigonial (straight distance between two gonia) and Bicondylar Breadth (straight distance between the most lateral points on the two condyles) were calculated in all. After all the measurements were done, observations in the male and female bones were statistically analysed
Observations and Results: Out of 107 mandibles, 26 (24.3%) were classified as male based on bigonial breadth. Among these, only 17 were actually male, yielding a male sensitivity of 27.87%. Conversely, 81 mandibles (75.7%) were classified as female using the same parameter. Based on bicondylar breadth, 32 mandibles (29.9%) were classified as male. Of these, 30 were correctly identified as male, yielding a male sensitivity of 49.18%. The remaining 75 mandibles (70.1%) were classified as female, among which 44 were truly female, resulting in a female sensitivity of 95.65%.
Conclusion: The present study demonstrates that while both bigonial and bicondylar breadths exhibit sexual dimorphism, bicondylar breadth is markedly more reliable for sex determination, particularly in female classification (95.65% sensitivity).

Keywords: Bigonial and Bicondylar Breadths.

INTRODUCTION

Sex determination from skeletal remains is a cornerstone of forensic anthropology and medico-legal investigations[1]. Among cranial bones, the mandible is particularly valuable due to its dense structure, resistance to postmortem degradation, and pronounced sexual dimorphism[2]. Its morphometric features—especially bigonial breadth and bicondylar breadth—offer measurable parameters that can aid in distinguishing male from female remains[3]. Previous studies have consistently demonstrated that male mandibles tend to exhibit greater dimensions across various parameters[4]. For instance, Sikka et al. (2012) analyzed 126 mandibles and found statistically significant differences in all measured dimensions between sexes, with discriminant function analysis correctly classifying 81% of cases[5]. Similarly, Gindha et al. (2018) reported that the average bicondylar breadth was 2.22 mm greater in males than females, reinforcing the reliability of this metric in sex estimation[6]. These findings underscore the utility of mandibular measurements as supplementary tools in forensic identification, especially when other skeletal elements are unavailable[7]. The present study aims to evaluate the role of bigonial and bicondylar breadth in sex determination using adult dry human mandibles. By analyzing these parameters within a known-sex sample, the objective is to quantify the degree of sexual dimorphism and assess the diagnostic sensitivity and specificity of each measurement. The results may contribute to refining population-specific standards and enhancing the accuracy of forensic protocols.

Aims & Objectives

To assess role of Metrical Parameters like bigonial and bicondylar breadth in determination of sex of human dry mandibles

MATERIAL AND METHODS

Present study is a cross-sectional study. Institutional ethics committee permission was taken prior to commencement of study. 107 adult dry, complete, undamaged human mandibles available in the Anthropology Museum of Department of Anatomy were collected. The investigation was intended to validate the sexual dimorphism in the mandible, and the sex of the corresponding skull was known. Bigonial (straight distance between two gonia) and Bicondylar Breadth (straight distance between the most lateral points on the two condyles) were calculated in all. Bigonial breadth in males may average around 9.5 cm, while females may average 8.5 cm[8]. Bicondylar breadth may show a similar trend, with males exceeding females by 2–3 mm on average[9]. Mandibles exceeding these thresholds are statistically more likely to belong to male individuals. However, these values must be calibrated to the specific population under study, as ethnic and regional variation can influence skeletal morphology[10]. Observations in the male and female bones were statistically evaluated following the completion of all measurements. The "t" test for students was conducted. For both genders, the mean and standard deviation were computed for the ranges of each parameter. To evaluate the importance of the observations, the P value was calculated.

OBSERVATION AND RESULT

Table 1: Bigonial length Sensitivity

Sr No	Based on Bigonial length	Gender		Total n (%)
		Male n (%)	Female n (%)	
1	Male	17 (16 %)	9 (10 %)	26 (26 %)
2	Female	44 (53 %)	37 (21 %)	81 (74 %)
Total n (%)		61 (69 %)	46 (29 %)	107 (100 %)
Sensitivity for Male 27.87 % & Female 80.43 %				

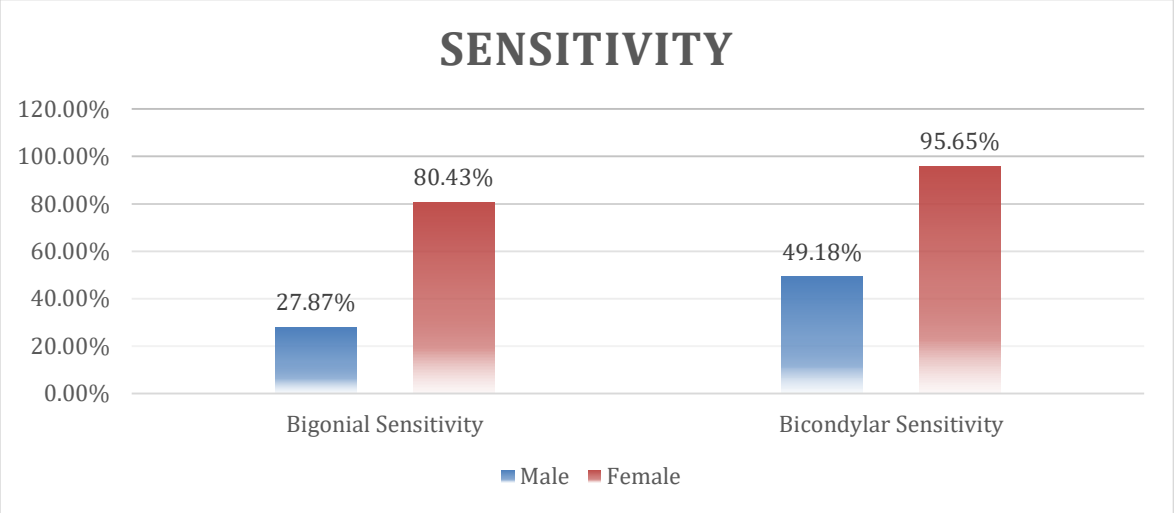
Out of 107 mandibles, 26 (24.3%) were classified as male based on bigonial breadth. Among these, only 17 were actually male, yielding a male sensitivity of 27.87%. This means that bigonial breadth correctly identified male mandibles in just over one-quarter of cases, indicating limited reliability for male sex determination. Conversely, 81 mandibles (75.7%) were classified as female using the same parameter. Of these, 37 were truly female, resulting in a female sensitivity of 80.43%. This suggests that bigonial breadth is moderately effective in identifying female mandibles, with correct classification in approximately 4 out of 5 cases. The disparity between male and female sensitivity highlights that bigonial breadth is more predictive for females and may not be suitable as a standalone metric for male identification.

Table 2: Bicondylar Length Sensitivity

Sr No	Based on Bicondylar length	Gender		Total n (%)
		Male n (%)	Female n (%)	
1	Male	30 (28 %)	2 (2 %)	31 (30 %)
2	Female	31 (30 %)	44 (40 %)	76 (70 %)
Total n (%)		61 (58 %)	46 (42 %)	107 (100 %)
Sensitivity for Male 49.18 % & Female 95.65 %				

Based on bicondylar breadth, 32 mandibles (29.9%) were classified as male. Of these, 30 were correctly identified as male, yielding a male sensitivity of 49.18%. This reflects a moderate level of accuracy, with nearly half of the male mandibles correctly classified. The remaining 75 mandibles (70.1%) were classified as female, among which 44 were truly female, resulting in a female sensitivity of 95.65%. This indicates a high level of precision in identifying female mandibles using bicondylar breadth. Compared to bigonial breadth, bicondylar breadth demonstrates superior sensitivity for both sexes, particularly for females, making it a more robust parameter for sex determination in anthropometric studies.

Graph 1: Bigonial & Bicondylar length Sensitivity



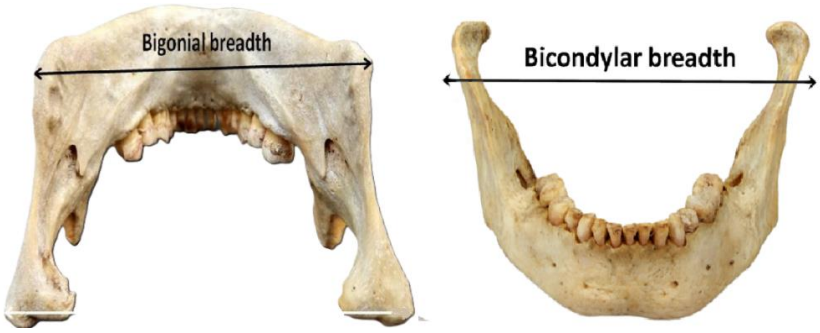


Figure 1: Bigonial & Bicondylar breadth

DISCUSSION

Sex estimation based on mandibular morphometry plays a pivotal role in forensic anthropology, particularly in cases where more sexually dimorphic skeletal elements are absent or compromised. Owing to its structural robustness and resistance to postmortem degradation, the mandible serves as a dependable anatomical landmark for analysis. Among its measurable features, bigonial and bicondylar breadths have demonstrated consistent sexual dimorphism, with males typically exhibiting greater dimensions across populations. The present study investigates these parameters in adult dry human mandibles to quantify the extent of dimorphism and evaluate their diagnostic utility in forensic sex determination.

In present study Out of 107 mandibles, bigonial breadth correctly identified 27.87% of males and 80.43% of females, indicating moderate reliability for female classification but limited accuracy for males. Bicondylar breadth showed improved performance, correctly identifying 49.18% of males and 95.65% of females, suggesting it is a more robust parameter, especially for female sex determination. In similar study by Sikka et al. (2012)[5] reported that bigonial and bicondylar breadths were significantly higher in males, with discriminant function analysis correctly classifying 81% of mandibles based on combined parameters. Gindha et al. (2018)[6] found that the average bicondylar breadth was 2.22 mm greater in males, supporting its utility in sex estimation. Their study also emphasized the importance of population-specific thresholds for accurate classification. Kanwar et al. (2021)[11] observed statistically significant differences in both bigonial and bicondylar breadths across sexes in a central Indian population, reinforcing the role of these metrics in forensic identification. Sikka et al. (IJCMR, 2012)[5] reported mean bigonial breadths of 9.64 ± 0.64 cm in males and 8.93 ± 0.58 cm in females, closely aligning with the dimensional trends observed in your dataset. Vinay et al. (2013)[11] reported that bigonial breadth correctly classified 75.92% of males and 71.16% of females, while bicondylar breadth achieved 71.39% male and 63.54% female accuracy. These values are notably higher than those observed in your study, especially for male classification, suggesting population-specific variability and possibly

broader sample representation. Aparna et al. (2024)[12] found that both bigonial and bicondylar breadths were significantly higher in males, with a p-value < 0.05 across 100 mandibles. Their conclusion emphasized that no single parameter is sufficient for sex determination, advocating for multivariate approaches—an insight that aligns with your observation of limited male sensitivity in bigonial breadth.

Limiting points for bicondylar breadth were reported around 107 mm, with demarking points ranging from 91.58 mm to 124.12 mm for males and 97.68 mm to 122.55 mm for females, suggesting a measurable overlap but clear central tendency differences. Study's findings are consistent with existing literature in demonstrating that bicondylar breadth is a more reliable metric than bigonial breadth for sex determination. The higher sensitivity for females across both parameters aligns with trends observed in Indian and international populations. However, the relatively lower sensitivity for male classification suggests that additional morphometric or multivariate approaches may be needed to improve diagnostic accuracy.

CONCLUSION

The present study demonstrates that while both bigonial and bicondylar breadths exhibit sexual dimorphism, bicondylar breadth is markedly more reliable for sex determination, particularly in female classification (95.65% sensitivity). In contrast, bigonial breadth showed limited male sensitivity (27.87%), underscoring its reduced diagnostic utility in isolation. These findings align with prior research by Vinay et al. and Sikka et al., which also emphasized the superior discriminative power of bicondylar breadth across diverse populations. However, the variability in male classification accuracy across studies highlights the need for population-specific thresholds and supports the integration of multivariate morphometric models to enhance forensic precision.

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