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TO STUDY THE MEASUREMENT AND ANALYSIS OF VARIOUS MANDIBULAR PARAMETERS OF HUMAN MANDIBLES

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Abstract:
Background: The human mandible is an essential part of the craniofacial complex and plays a crucial role in several physiological activities including chewing, speaking, and facial appearance.

Aim: The aim of this study was to measure and analyze various mandibular parameters.

Materials & methods: The present study was approved by the Institutional Ethics Committee. This study was an observational study. This study was conducted in the Department of Anatomy, Index Medical College, Malwanchal University.

Results: This study examines one group and uses the mandibular ramus and foramen to determine sex reliability. These parameters were calculated using the distance between the structures. Anthropologists and medicolegal workers examine skeletal remains to identify people. Given a bone fragment, the shape and size can reveal the person's gender or age. The bone must be entire for this. The gender of the participants was determined using many measurements.

Conclusion: The present study concludes that the gonial angle, bigonial width, ramus height, bicondylar breadth, lower jaw length and when combined with physical traits, these metrical parameters may help identify mandible gender.

Keywords: Bicondylar breadth, Bigonial breadth, Angle of the mandible, Symphyseal height, Mandibular length.

Introduction:

The human mandible is an essential part of the craniofacial complex and plays a crucial role in several physiological activities including chewing, speaking, and facial appearance. In-depth knowledge of the structural and dimensional characteristics of the human mandible is not only intellectually fascinating, but also has important consequences for disciplines such as anthropology, anatomy, dentistry, maxillofacial surgery, orthodontics, and forensics [1-5]. This justification

explains the primary reasons for conducting an in-depth investigation of the morphological and morphometric aspects of the human mandible [2-5].
Anthropologists have been intrigued for a considerable period of time owing to the wide range of variations in human skeletal architecture observed in various populations [3,4]. The mandible, a key element of the human skull, displays significant morphological differences [6-10]. Examining these differences yields useful insights into evolutionary mechanisms, patterns of migration, and genetic predispositions [11-14]. Through examination of mandibular morphology in various groups, we can enhance our understanding of human adaptation to distinct environments and lifestyles [12-14].
Within the field of anatomy, a thorough examination of the shape and size characteristics of the mandible improves our understanding of the complex mechanisms influencing its shape and purpose [15-23]. Gaining insight into the differences in mandibular structure can assist in improving anatomical instruction and contribute to the development of precise anatomical atlases [16,17]. Acquiring this knowledge is essential for medical students, healthcare workers, and anatomists as it establishes a strong basis for comprehending craniofacial anatomy [19-22]. Therefore, the aim of the present study was to measure and analyze various mandibular parameters.

Materials & methods:
The present study was approved by the Institutional Ethics Committee. This study was an observational study. This study was conducted in the Department of Anatomy, Index Medical College, Malwanchal University. The sample size was calculated using the following formula,
$n= Z^2 \times p \times q / e^2$
where n= sample size, p= prevalence, 75%, q= 1-p, Z= 1.96, Confidence Interval of 95%, and e= margin of error, 5%. So, $n=(1.96)^2 x (0.75) (1-0.75)/ (0.05)^2$, n= 288.12, Therefore, the present study was conducted on 289 mandibles in the Department of Anatomy, Index Medical College, Malwanchal University.

Inclusion criteria: All adults (mandible with bilateral molar teeth, prominent alveolar sockets, intact condylar and coronoid processes, and well-developed bone) with intact and well-formed mandibles were included.

The exclusion criteria were broken, deformed, or pathological. The following parameters were observed in the mandible: Ther morphometric parameters to observe are,

1. Bicondylar breadth: The straight distance between the most lateral points on the two condyles.
2. Bigonial breadth: The straight distance between two gonia.
3. Mandibular length: From the most anterior point on the symphysis menti to an imaginary point formed by the posterior margin of the ramus and the anteroposterior axis of the body, measured parallel to the axis.
4. Angle of the mandible: The width of the dental arch measured between the points of contact between the lateral incisor and canine on each side.
5. Symphyseal height: The direct distance between the alveolar process and inferior border of the mandible perpendicular to the base at the level of the symphysis.
6. Mandibular height: The direct distance between the alveolar process and inferior border of the mandible perpendicular to the base at the level of the mental foramen.
7. Condylar height: Height of the ramus of the mandible from the most superior point on the mandibular condyle to the tubercle, or most protruding portion of the inferior border of the ramus
8. Coronoid height (CH): Projective distance between the coronion and lower wall of the bone.
9. Bimental breadth. Distance of foramen mentale with the between the other side foramen mentale
10. Body thickness: Thickness of the mandibular body was measured at the level of 2nd molar perpendicular to the vertical axis of the body.

Instrument: All the above-mentioned measurements were performed using a digital Vernier caliper.

Statistical analysis:
Using IBM SPSS Statistics 21, the data were examined using an unpaired t-test after being represented as Mean ± SD. Limiting points and discriminating points were also computed.

Results:
The gonial angle of the male mandible was between 116° and 142° with an average of 127.9°. The average gonial angle of the female mandible is 138 °. The mandibular angle was less than 162 °in men and > 110 °in women. The maximum angle of the mandible was 133 °, which was correctly estimated in 86 % of men and 66 % of women. The mean mandibular angle values for men and women were significantly different ($p < 0.001$) for the mandible. [Table 1].

Table 1: *Gonial angle of the present study specimen*

Measurement	**Male**	**Female**
No. of bones	168	121
Range (degrees)	116.3- 142	124.9 – 151.1
Mean ± SD	127.9 ± 6.1	138 ± 8.1
Calculated range	110 – 146	113 – 161
P value	< 0.05	
t-value	-6.231	

Table 2: *Bigonial width of the present study specimen*

Measurement	**Male**	**Female**
No. of bones	168	121
Range (mm)	85.9 – 104.1	78 – 103
Mean ± SD	95.9 ± 4.8	88.9 ± 5.8
Calculated range	108.9 – 144.1	111.9 – 159.2
P value	< 0.05	
t-value	5.879	

The bigonial width of a male mandible can range from 86.1 to 105.2 mm, with an average of 95.9 ± 4.8 mm. The bigonial width of the female mandible can range from 78 to 103 mm, with an average of 88.9 mm. Bigonial width was defined as > 108.9 for men and less than 79.13 for women. Bigonial width was capped at 91.11, at which point 73% of the males and 81% of the females were correctly identified. The difference between the male and female mean values of bigonial width was statistically significant ($p < 0.05$) for the mandible. [Table 2]
The breadth of the ramus varies from 37.8 to 57.9 mm in male mandibles, with an average of 41.9 ± 4.9 mm. In female mandibles, it ranges from 30.4 to 53.1 mm, with an average of 38.1 ± 4.7 mm. The height of ramus had a dividing line of more than 63.1 for men and less than 30.4 for women. Breadth of ramus had a cutoff point of 51.9, which was accurate for 87 % of males and 72% of females. The difference between male and female mean values for Height of Ramus was statistically significant ($p < 0.05$) for the mandible. [Table 3].

Table 3: *Ramus breadth of the present study specimen*

Measurement	**Male**	**Female**
No. of bones	168	121
Range (mm)	37.8 to 57.9	30.4 to 53.1
Mean ± SD	41.9 ± 4.9	38.1 ± 4.7
Calculated range	30.4 – 80.1	38.1 – 63.1
P value	< 0.05	
t-value	7.403	

The height of the ramus varies from 62.7 to 76.1 mm in male mandibles, with an average of 67 ± 3.8 mm. In female mandibles, it ranges from 41 to 63.7 mm, with an average of 54.5 ± 4.3 mm. The height of ramus had a dividing line of more than 70.1 for men and less than 54.5 for women. The height of the ramus had a cutoff point of 60.1, which was accurate for 96% of males and 82% of females. The difference between male and female mean values for Height of Ramus was statistically significant ($p < 0.05$) for the mandible. [Table 4].

Table 4: *Ramus height of the present study specimen*

Measurement	**Male**	**Female**
No. of bones	168	121
Range (mm)	62.7 to 76.1	41 to 63.7
Mean ± SD	67 ± 3.8	54.5 ± 4.3
Calculated range	53.8 – 80.1	38.1 – 70.1
P value	< 0.001	
t-value	9.421	

The male mandibular bicondylar breadth ranges from 101.6 to 121.9 mm, with an average of 111.61 ± 4.46 mm. The female mandible bicondylar breadth ranges from 85.5 to 115.6 mm, with an average of 106.5 ± 6.6 mm. The bicondylar breadth was more than 129.5 mm for males and less than 95.1 mm for females. At a Bicondylar breadth limit of 109.2, 73% of males and 71 % of females could be correctly identified. The difference between the male and female mean values of the bicondylar breadth was statistically significant ($p < 0.05$) for the mandible. [Table 5].

Table 5: *Bicondylar breadth of the present study specimen*

Measurement	**Male**	**Female**
No. of bones	168	121
Range (mm)	101.6 to 121.9	85.5 to 115.6
Mean ± SD	111.61 ± 4.46	106.5 ± 6.6
Calculated range	95.1 – 128.5	83.4 – 129.5
P value	< 0.05	
t-value	4.652	

Discussion:

The Index Medical College and Hospital in Indore, Madhya Pradesh, India, is home to the Department of Anatomy. bones from male and female human jaws, dried, and unidentified. We retained 289 mandibles for additional analysis after removing those that did not fit for reasons other than size. The five different characteristics that were measured for each mandible are detailed in greater depth in the section devoted to the materials and methodology. The purpose of this study was to identify the mandibular measurement that best distinguishes between men and women in this sample using discriminant function analysis. The primary objective of this study was to identify a mandibular measurement capable of discriminating between the sexes.

The goals of this study were to measure the mandibular ramus, compare them, and evaluate them. We will also examine how well they help with sex determination, how reliable they are, how effective they are, and what consequences this has. We will also examine where the mandibular foramen is related to all of these.

Mandible gonial angle:

The gonial angle of the male mandible was between 116° and 142° with an average of 127.9°. The average gonial angle of the female mandible is 138°. The mandibular angle was less than 162 °in men and > 110 °in women. The maximum angle of the mandible was 133 °, which was correctly estimated in 86% of the men and 66% of the women. The mean mandibular angle values for men and women were significantly different ($p < 0.001$) for the mandible. [Table 1]. According to the

results of a study by [23], the mandibular angle of the female mandible ranged from 97° to 137°, with an average of 122° 7°. The angle of the mandible at its defining point was 143.42 degrees for males and 106.29 degrees for females. The limit for the mandibular angle was set at 123 °, at which point 43.51 percent of male and 42.42 percent of female subjects could be correctly sexed. The sex differences in the mean values of the mandibular angle between males and females were not statistically significant ($p = 0.99$) for the mandible. This is because the male and female mandibles have virtually identical mandibular angles. In their study of 207 mandibles [24], they discovered that the average angle of the male mandible was 121.43 °, whereas the average angle of the female mandible was 124.19 degrees. Males had a standard deviation of 6.99, while females had a standard deviation of 6.90. According to the findings of [25], the mean angle of the mandible in males was 110.68 °, while the mean angle of the mandible in females was 114.53 °. Males had a standard deviation of 15.50, while females had a deviation of only 6.95. A study [26] observed that there was no significant difference in the mandibular angle in the process of determining sex in the young Lebanese population (83 young individuals, 40 males and 43 females) aged between 17 and 26 years. In the current study, the comparison of the male and female mandibles revealed a statistically significant difference.

Bigonial width:

Male mandible bigonial width varies between 86.1 and 105.2 mm, with a mean value of 95.9 ± 4.8 mm. On average, the bigonial width of the female mandible is 88.9 mm, although it can vary between 78 mm and 103 mm. The criteria for bigonial width were as follows: greater than 108.9 for males and less than 79.13 for females. The maximum acceptable bigonial width was 91.11, at which point 73% of males and 81% of females were accurately identified. A statistically significant difference ($p < 0.05$) was observed in the mean values of bigonial width between males and females with regard to the mandible [Table 2]. In comparison with the male mandible, the values extracted from the female mandible were diminished. The researchers determined that the average bigonial breadth of male mandibles was 9.38 cm, whereas it was 8.71 cm for female mandibles, based on their examination of 207 mandibles [24]. The standard deviation of males was 0.54, whereas that of females was 0.48. The average bigonial breadth of males was 8.68 cm, whereas it was 8.62 cm for females, according to a study [25] involving 111 participants. The standard deviation of males was 1.37, whereas that of females was 0.72. The researchers determined that the average bigonial breadth of female mandibles was 8.97 cm, whereas it was 9.68 cm for male mandibles in their study of 102 Thai mandibles [27]. Males had a standard deviation of 0.77, whereas females had a significantly lower value (0.59). It was determined that gender differences in the mean values of bigonial width between male and female mandibles were statistically significant at 0.001. The results of this investigation indicate that a statistically significant disparity exists in the mandibular values of males and females. The mean value of the male mandibles in the present study was nearly identical to the values reported in previous research.

Mandibular ramus breadth:

Several mandibular ramal parameters were measured in a study conducted by [28]. The breadth of the ramus varies from 37.8 to 57.9 mm in male mandibles, with an average of 41.9 ± 4.9 mm. In female mandibles, it ranges from 30.4 to 53.1 mm, with an average of 38.1 ± 4.7 mm. The height of the ramus had a dividing line of more than 63.1 for men and less than 30.4 for women. Breadth of ramus had a cutoff point of 51.9, which was accurate for 87 % of males and 72% of females. The difference between male and female mean values for ramus height was statistically significant ($p < 0.05$) for the mandible [Table 3]. A study [29] conducted anthropometric research was conducted in Varanasi using sliding calipers in the mandibular ramus in 2011. It was determined to have been observed as follows: In their study, the maximum ramus breadth showed values of 42.81 mm in males and 40.34 mm in females, and the minimum ramus breadth showed values of 31.29 mm and 29.65 mm in males and females respectively. On the other hand, in our study, the breadth of the ramus ranges from 38.9 to 58.1 mm in male mandibles, with an average of 42.1 5.1 mm. It can be

anywhere from 31.5 to 54.2 mm in female mandibles, with a mean value of 39.2 mm and a standard deviation of 5.8 mm. The width of the ramus had a dividing line that was greater than 64.2 for males and less than 31.5 for females. The cutoff point for the Breadth of Ramus test was 50.1, and it accurately predicted the results for 88% of males and 73% of females.

Mandibular ramus height

The researchers [30] conducted a study in 2015 to determine a person's sex based on their mandible by using a variety of morphometric parameters, and their study came to similar conclusions as ours. Their research was conducted on a total of fifty adult mandibles from Southern India, all of which were dry and intact. A mandibulometer and digital calipers were used to measure a variety of morphometric parameters such as ramal height and coronoid height. They discovered that the average height of the ramus in males was 67.98 mm, whereas the average height in females was 55.10 mm. While the mean height of the ramus of the mandible was found to be 55.6 in females and 68 in males, the difference between the two was significant. Males had a standard deviation of 4.9 for their ramus height, while females had a standard deviation of 5.4. The values obtained in the female mandibles were lower than those in the male mandibles. Similar to our own research, this study [30] discovered that the height of the ramus was significantly different between males and females, with the difference being statistically significant. This was the case when men were compared with females. There was a statistically significant correlation in the height of the ramus between male and female mandibles (p=0.059), according to a study conducted by [31]. They found that the mean mandibular ramus height was greater in males (53.9 cm) than in females (51.8 mm). 10 A study that was carried out by [32] concluded that males have higher ramus height values than their female counterparts, and that statistically significant gender differences were recorded in the height of the ramus. Another study [34] in 2015 carried out a study among Egyptians, in which 191 panoramic images were analyzed for five mandibular ramus linear measurements: upper and lower ramus breadth, projective height, condylar height, and coronoid height. They found the mean maximum ramus breadth to be 42.2 mm in males and 40.2 mm in females. A statistically significant difference was found between the male and female mandibles in the present study, which is consistent with the findings of earlier studies.

Bicondylar breadth:

In their study, the values for condylar height in males and females were found to be 60.67 and 54.46 mm respectively, whereas in our study, the values for condylar height were found to be 66.83 mm in males and 61.03 mm in females [28]. In the study that was done by [28], the measurements for the projective height of the ramus were found to be 53.89 mm in males and 47.45 mm in females respectively. However, The male mandibular bicondylar breadth ranges from 101.6 to 121.9 mm, with an average of 111.61 ± 4.46 mm. The female mandible bicondylar breadth ranges from 85.5 to 115.6 mm, with an average of 106.5 ± 6.6 mm. The bicondylar breadth was more than 129.5 mm for males and less than 95.1 mm for females. At a Bicondylar breadth limit of 109.2, 73% of males and 71 % of females could be correctly identified. The difference between the male and female mean values of bicondylar breadth was statistically significant ($p < 0.05$) for the mandible. [Table 5]. The findings of this study were very similar to those of our study, with the measurements of the mandibular ramus being significantly higher in males than in females [28]. In their study of 207 mandibles, A study [24] found that the mean bicondylar breadth of the male mandible was 11.26 cm, while that of the female mandible was 10.77 cm. The standard deviation was the same for both males and females, reaching 0.53. 6 According to [34], which was based on measurements of 225 mandibles, the mean bicondylar breadth in males was 11.36 cm, while in females it was 10.86 cm. Males had a standard deviation of 0.60, while females had a standard deviation of 0.58. In their research [25] on 111 different mandibles, found that the average bicondylar breadth for males was 10.98 cm, while the mean for females was 11.51 cm. The standard deviation for males was 1.48, while it was only 0.93 for females. According to [27], analysis of data gathered from 102 mandibles, the mean value of bicondylar breadth for male mandibles measured 12.38 cm, while the

mean value for female mandibles measured 11.61 cm. The standard deviation for males was 0.63, while it was only 0.59 for females. According to the findings of yet another study that was carried out by [23], the bicondylar breadth of the mandible measured an average of 11.34 cm in males and 10.82 cm in females. The males had a standard deviation of 0.55 for their bicondylar breadth, while the females had a standard deviation of 0.70. The bicondylar breadth demarking point for males was 12.9 mm, while for females it was 9.69 mm. 11.15 was determined to be the cutoff point for the bicondylar breadth, at which point 71.39% of male and 63.54% of female were successfully gendered. The bicondylar breadth had a t-value of 5.29. There was a statistically significant difference (p 0.0001) between the mean values of the bicondylar breadth of the male and female mandibular bones [23]. This difference was due to gender differences. There was a statistically significant difference between the mandible values of the male and female participants in each study. The findings of the present study are comparable.

Conclusion:

The present study concludes that the gonial angle, bigonial width, ramus height, bicondylar breadth, lower jaw length and when combined with physical traits, these metrical parameters may help identify mandible gender.

Conflict of interest:

There is no conflict of interest among the present study authors.

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