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Morphometric Study On Adult Human Mandibles Of South Indian Population

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Abstract

Introduction: Human skeletal remains are an evidence in estimating the age and sex of the individual after their demise. Since Mandible is a single bone that is resistant to decomposition and bears importance in sex determination, an attempt is made to determine the mandibular parameters that are significant in determining the sex of an individual and the percentage reliability of the significant parameters.

Aim: To measure and analyze the various parameters of the mandible and to assess the reliability of the parameters in terms of percentage accuracy in sex determination.

Material and Methods: A total of 106 whole adult human mandibles belonging to South Indian population of unknown sex, between the age group of 18–60 years, were collected and studied at the Department of Anatomy and Forensic Medicine Guntur Medical College, Guntur. The following parameters were studied: Condylar height or height of Ramus (right and left), bicondylar breadth, length of lower jaw, mandibular index, ramus breadth (right and left), and mandibular body breadth.

Results: Of the eight parameters studied, highly significant (statistically) difference in sex was observed in right ramus height (68.8% accuracy), left ramus height (67% accuracy), bicondylar diameter (67.5% accuracy) and mandibular index (70.5% accuracy).

Conclusion: As 100% accuracy cannot be obtained with any single parameter, a combination of parameters with a high accuracy level may be considered while estimating the sex of the individual.

Keywords: Human Mandible, Morphometry, Sexual Dimorphism, South Indian Population

Introduction

The earliest contributions to study the intricate structure of the human body started ever since the time of Vesalius, and were not just aimed at analyzing population and gender differences of human mandibles but to use the mandibular measurements for the development and exploration of new statistical techniques and methods.

In 1940, Hrdlicka opined the mandible as “the neglected stepchild of anthropometry” and considered the samples studied till that time and age as too less. He evaluated sexual differences of the gonial angle and several other mandibular dimensions and found that there were consistent differences between the male and female mandible in a diverse range of human groups. Sexual differences were not significant in the breadth and length of the mandibular body, but differences were significant in symphyseal height and there was significant difference in the height of the ramus. With regards to

the gonial angle, he concluded that it is of limited significance for sex determination and that "all that can be said is that, a gonial angle of less than 118 degrees represents a male, and above 128 degrees represents a female, nevertheless there were numerous exceptions". Hrdlicka was able to obtain 80% of accuracy in determining the sex with only adult cranium and 90% with cranium and mandible.[1,2]

Sexual Dimorphism in human mandible is well reflected in its shape and size (Table 1).[3] Generally speaking, more of the childhood characteristics are retained in the skull of the adult female.[4]

The condyles of mandible are relatively smaller in females. Sex determination of skull by radiological method is possible to the extent of 88 percent.[5] According to Du Brul and Sicher, the male lower jaw as a whole, shows on an average, a greater size, weight and thickness, a higher body throughout, a higher symphysis, especially, a broader ascending branch, a less obtuse angle, stouter and rougher gonion regions and stronger condyles than in the female jaws. Markedly everted angles are as a rule masculine. A lower jaw of moderate size and strength with a rounded or pointed and smooth chin, low symphysis and body, delicate or moderately strong condyles, only moderately broad ascending ramus, smooth gonion regions and angle of more than 125^0, may be diagnosed as feminine. No great weight, however, should be placed in the sexing of a lower jaw either on the angle or the breadth of the ramus, for there is a considerable overlapping in these features in the two sexes.[6]

Materials And Methods

Since Mandible is a single bone that is resistant to decomposition and bears importance in sex determination, an attempt is made to determine the mandibular parameters that are significant in determining the sex of an individual and the percentage reliability of the significant parameters. The aim of the present work is

To study and measure the various anthropological parameters of the mandible

To analyse the reliability of the measured parameters in terms of percentage accuracy in determination of sex of the mandible.

The present study was conducted in the Department of Anatomy and Department of Forensic Medicine, Guntur Govt Medical College and Hospital, Guntur, of South India. Institutional ethical committee clearance was obtained for the study and 106 whole adult Human Mandibles of unknown sex, belonging to South Indian population were selected by convenience sampling. The mandibles of the age group between 18 to 60 years were collected from the above institutions in the same region and studied and statistically analyzed using SPSS software.

Inclusion criteria: Whole adult Human mandibles between the age of 18 to 60 years.

Exclusion criteria: Mandibles with either absorbed alveolar margins or with any pathological lesions were excluded from the study.

Morphologically, the mandibles were grouped as female(22) and male(84). The morphological features considered for grouping were everted mandibular angles and prominent bony markings were considered as male and less prominent and smooth bony markings with inverted or straight mandibular angle were considered as female mandibles.[7]

Parameters were measured with the below instruments as seen in fig.1:

1. Measuring scale
2. Sliding calipers

All measurements were noted carefully to avoid parallax error. The following Parameters were recorded:

1. Condylar height or height of Ramus: It measures the straight distance between gonion and highest point on the mandibular capitulum (Fig.2). Instrument used – sliding calliper.[4,8]
2. Ramus breadth: Measured between the anterior and posterior border of the ramus of the mandible (Fig.3). Instrument used – sliding calliper.[4,8]
3. Bicondylar breadth: The straight distance between two condylia laterale are measured (Fig 4). Instrument used – sliding calliper.[4,8]
4. Length of lower jaw: the straight distance from the posterior margin of the chin to the tangent drawn at the two gonia is measured. Instrument used – scale and sliding calliper.[4,8]
5. Mandibular index (By Thomson criteria): (The length of lower jaw / bicondylar breadth) * 100 [4,8]

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Range of variation (According to Lindegard and Sonesson) can be classified into Dolichostenomandibular, Mesomandibular and Brachyeurymandibular.[9]

6. Mandibular body thickness: The maximum breadth measured at the level of the mental foramen perpendicular to the long axis of the mandibular body (Fig.5). Instrument used – sliding calliper.[9]

Results

The range, mean and standard deviation for each of the eight parameters for male and female mandibles was calculated (Table 2)

Data Management And Statistical Analysis:

All the 8 parameters were measured accurately and tabulated, and the 106 mandibles were classified as males (84) and females (22) based on morphological features as mentioned above. The range, mean and standard deviation of each of the parameters both for the male and the female mandibles were calculated as in Table 2. Statistical analysis was done, Independent sample T test was applied and the P value of significance was noted as in Table 3. For those parameters that showed significance, using mean and standard deviation, a "calculated range" was arrived at by the formula 'Mean±3SD'. A calculated range was obtained for male mandibles (p and q) and for female mandibles (r and s). From these values, the minimum in male range and the maximum in female range were taken as 'demarking points', and the limiting point was determined as shown in Table 4 by known statistical standards. According to standard methods followed by previous workers, the Limiting point is an absolute value found within the range of the demarking points. Limiting point was so chosen that vast number of male mandibles showed values greater than it and bulk of female mandibles showed values lesser than the chosen limiting point. Based on the limiting point for each, the percentage accuracy of the sex was calculated as in Table 5, by taking the mandibles whose values were more than the limiting factor as males and those values less than the limiting factor as females.

Discussion

The results obtained in the present study were compared with the results of earlier workers.

Ramus Height:

In the present study, the mean male ramus height on the right and left side was 64.9mm and 64.7mm respectively. In females, the mean ramus height on the right and left side was 62mm and 61mm respectively.

Vodanovic in 2006, on Croatians studied the measurements to be 67.42mm in males and 61.46mm in females.[10] N Ongkana on Thais in 2009 noted that the mean male value was 68.1mm and mean female value was 62.6mm.[11] In 2005, M Bajiorgu on Zimbabweans studied that mean ramus height in males was 59.8mm and in females was 61.3mm.[12] Sivapakash S in 2012, studied that mean values in males was 59.21mm and in females was 55.5mm. The ramus was more vertical in males than in females.[13] Bhagya shree et al in 2023, studied the significance of metric mandibular parameters in sex determination on 80 dry adult human mandibles and found a significant difference in height and breadth of mandible.[14]

In our study, the mean male values on the right and left sides were higher compared to females and the difference was highly significant. Our results were similar to the earlier studies done.

Bicondylar Diameter:

In the present study, the bicondylar diameter was 112.34 mm in males and 105 mm in females with P value of 0.000, which was very highly significant. The male values were markedly higher than the female values.

According to Tedeshi 1977, mandibular condyles are smaller in females thereby causing lesser Bicondylar diameter.[5] In a study done by T Jayachandra Pillai in 2002, the female mandibles showed lesser bicondylar diameter than males.[15] In 2000, Flossie J studied that mean male values were higher than females and the difference was statistically very highly significant.[16] In 2009, N Ongkana on Thais, studied that, in males the mean value was 123.8mm and in females was 116.1mm with a P value of 0.001 which was very highly significant.[11] In 2011, Sivaprakash S observed the male mean value to be 114.5mm and female mean value to be 109.5mm with a P value of 0.04 which was significant.[14]

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The findings of our study were similar to the earlier works done.

Mandibular Index:

In this present study, the average mandibular index in males was 54.77 and in females was 59.1 with a P value of 0.003 which was highly significant. The values were observed to be more in females compared to males.

According to Seshaiah 1992, the mean male value was 71.30 and mean female value was 72.72 and the P value was not found to be statistically significant.[18] According to Vinay G 2013, the mean male value was 66.52 and the mean female value was 66.41 and the values were not statistically significant.[19]

Similar to the study done by Seshaiah in 1992, our study showed a higher mean value in females than males, but, contrary to the previous two studies which showed insignificant P values, our study showed a significant statistical difference.

Percentage Accuracy:

In this study, the variable - mandibular index showed the highest percentage accuracy in the sex determination of Mandible.

Hanihara et al who worked on Japanese mandibles was able to classify the sex of 85.6% mandibles by using four mandibular parameters[20]. In a study done on American mandibles by Giles, they were able to classify the sex of mandibles in 83.2% of the cases by using three variables and 84.1% of the cases by using five variables[20]. In a study done by Sivaprakash S in south Indian mandibles, he was able to determine sex in 83% of cases by using ten variables and 85.5% of the cases by using three variables.[13]

Anupam Dattta et al in 2015, studied sex differentiation of human in 50 adult human mandibles, using various morphometrical parameters and concluded that, similar to our study, the height of ramus, bicondylar breadth and body thickness were all statistically highly significant.[21] In contrast to the present study, length of lower jaw was statistically significant while mandibular index showed no significance.

A similar study was conducted in Oman by Anil Kumar et al in 2022 where multiple metric and non metric parameters were used to analyze the significance of each in determination of sex of the mandible.[22]

In the present study no single parameter could be used to accurately sex the mandible. The percentage accuracy for determining the sex of the individual for right ramus height is 68.8%, left ramus height is 67%, bicondylar diameter is 67.5% and mandibular index is 70.5% The mandibles could be sexed upto 68.5% by using all the four significant variables and upto 70.5% using mandibular index.

Limitations Of The Study:

Studies with a larger sample size and across the Indian population may help to arrive at a more evidence based estimation of sex and age of human mandibles.

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Tables

Table 1: Showing differences between male and female mandibles

S.No	Trait	Male	Female
1	Chin	Square shaped	Rounded
2	Body height	At symphysis, greater	At symphysis, smaller
3	General size	Larger and thicker	Smaller and thinner
4	Ascending ramus	Greater breadth	Smaller breadth
5	Condyles	Larger	Smaller
6	Angle of body and ramus	Less obtuse(under 125^{o}), prominent and everted	More obtuse, not prominent and inverted
7	Mental tubercle	Large and prominent	Insignificant

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Table 2: Comparative statistics of male and female mandibles

S.No	PARAMETERS	SEX	RANGE	MEAN	STANDARD DEVIATION
1	right ramus breadth	male	23 - 28	30.63	3.107
		female	37 - 21	30	3.778
2	left ramus breadth	male	40 - 24	30.9	3.179
		female	39 - 23	30	3.732
3	right ramus height	male	77 - 52	64.9	5.561
		female	70 - 53	62	4.066
4	left ramus height	male	79 - 51	64.72	5.362
		female	68 - 50	61	4.086
5	body thickness	male	21 - 11	15.25	1.692
		female	19 - 13	15	1.659
6	bicondylar diameter	male	125 - 96	112.34	6.393
		female	117 - 87	105	7.94
7	length of lower jaw	male	75 - 47	61.48	6.376
		female	70 - 48	61	7.7
8	mandibular index	male	68 - 43	54.77	5.504
		female	70.9 - 44.4	59.1	6.903

Table 3: Independent sample test for various mandibular parameters to find P value and its significance

S.NO	MANDIBULAR PARAMETERS	T VALUE	P VALUE	SIGNIFICANCE
1	RIGHT RAMUS BREADTH	0.721	0.235	NOT SIGNIFICANT
2	LEFT RAMUS BREADTH	1.039	0.151	NOT SIGNIFICANT
3	RIGHT RAMUS HEIGHT	2.741	0.003	**HIGHLYSIGNIFICANT**
4	LEFT RAMUS HEIGHT	3.545	0.000	**VERY HIGHLY SIGNIFICANT**
5	BODY THICKNESS	0.626	0.267	NOT SIGNIFICANT
6	BICONDYLAR DIAMETER	4.009	0.000	**VERY HIGHLYSIGNIFICANT**
7	LENGTH OF LOWER JAW	0.291	0.385	NOT SIGNIFICANT

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8	MANDIBULAR INDEX	2.724	0.003	**HIGHLY SIGNIFICANT**

Table 4: Demarking and limiting factors for the significant parameters

S.NO	SIGNIFICANT PARAMETERS	DEMARKING POINTS, MEAN±3SD				LIMITING FACTOR
		MALE		FEMALE		
		MEAN-3SD (p)	MEAN+3SD (q)	MEAN -3SD(r)	MEAN +3SD(s)	
1.	RIGHT RAMUS HEIGHT	48.22	81.58	49.82	74.18	61
2.	LEFT RAMUS HEIGHT	48.64	80.8	48.76	73.24	61
3.	BICONDYLAR DIAMETER	102.17	131.51	81.8	128.82	113
4.	MANDIBULAR INDEX	38.27	70.5	38.4	79.8	59

Table 5: Accuracy of mandibular parameters

S.NO	PARAMATERS	PERCENTAGE ACCURACY	AVERAGE
1.	RIGHT RAMUS HEIGHT	MALE - 78.5%	68.80%
		FEMALE - 59.1%	
2.	LEFT RAMUS HEIGHT	MALE - 75%	67%
		FEMALE - 59.1%	
3.	BICONDYLAR DIAMETER	MALE - 48.8%	67.50%
		FEMALE - 86.3%	
4.	MANDIBULAR INDEX	MALE - 77.4%	70.50%
		FEMALE - 63.6%	

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Figures

Figure 1: Instruments Used For Taking Measurements

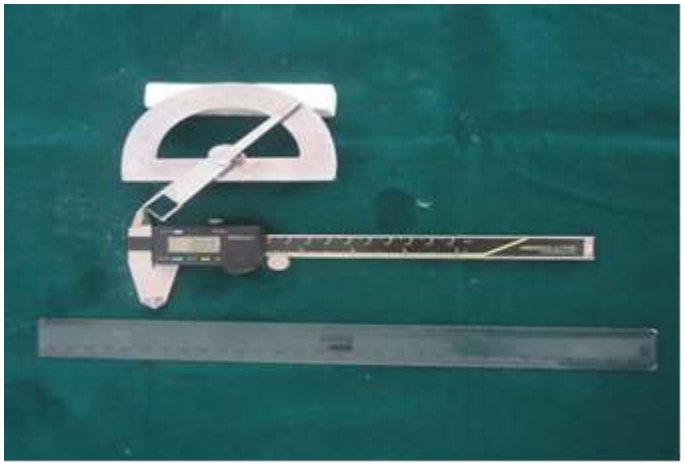

Figure 2: Measurement Of Ramus Height

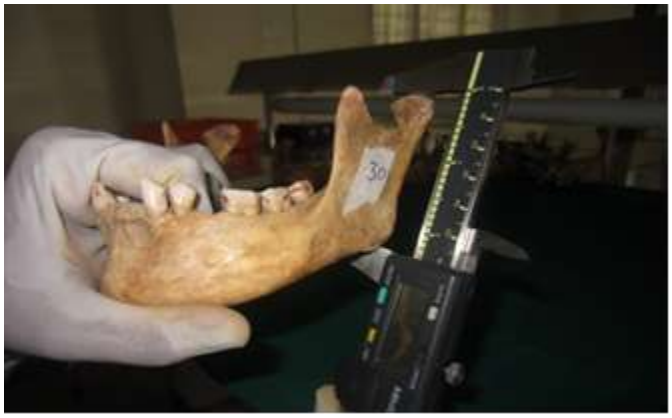

Figure 3: Measurement of Ramus Breadth

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Figure 4: Measurement of Bicondylar diameter

Figure 5: Measurement of Body Thickness

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