A Study of Sex Determination from Human Mandible Using Various Morphometrical Parameters

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ABSTRACT

Introduction: *Examination of bones is important for identification of deceased and determination of sex. The mandible is the largest and hardest facial bone, that commonly resist post mortem damage and forms an important source of information about sexual dimorphism.*

Aim: *The purpose of the study is to analyze sexual dimorphism in the mandibles of South Indian population.*

Materials and Methods: *A random collection of 50 adult, dry, complete, undamaged human mandibles of South Indian population were subjected to metrical parameters like Gonial angle, Bigonial width, Height of ramus, Bicondylar breadth, Mandibular length, Length of lower jaw, Mandibular index, Body thickness, Coronoid height, Bimental breadth, Symphyseal height and Body height using Mandibulometer and Digital Vernier caliper.*

Statistical Analysis used: *The data's were expressed as Mean ± SD and then analyzed by unpaired t-test by using IBM SPSS Statistics 21. Discriminating point and limiting points were also calculated.*

Results: *After obtaining all the measurements, unpaired 't-test' was performed. The Gonial angle, Bigonial width, Height of ramus, Bicondylar breadth, Mandibular length, Length of lower jaw, Body thickness, Coronoid height, Bimental breadth, Symphyseal height and Body height showed statistically significant gender difference.*

Conclusion: *The present study highlighted that the gender of the mandible can be determined using different metrical parameters as an additional tool to establish the identity of a person.*

Key words: *Mandible, Metrical parameters, Sexual dimorphism, South Indian population.*

INTRODUCTION

Identification of human skeletal remains is very important and integral part of medico legal and anthropological work. The determination of sex of an individual is important and necessary both in the living and the dead for medico legal purpose. According to Krogman, the degree of accuracy in sexing adult skeletal remains is entire skeleton 100%, Pelvis alone 95%, Skull alone 90%, Pelvis and skull 98% and long bones alone 80%.[1] In case of mass disasters like explosions, earthquake, warfare, aircraft crashes, floods, only when the fragmented bones are found, sex determination with 100% accuracy is not possible and it depends largely on the available parts of skeleton. Skull is the most dimorphic and easily sexed portion of skeleton after pelvis. But in cases where intact skull is not found, mandible may play a vital role in sex determination, as it is the most dimorphic bone of skull.

The mandible is a Latin word which means lower jaw. Mandere means to chew. Thus the word mandible is derived. The mandible is the largest, strongest and lowest bone in the face. Mandible retains its shape better than other bones, so it plays an important role Forensic osteology and Anthropological works.

Present study wants to highlight the status of statistical correlation among the 12 different metrical parameters in a known sample of 50 adult dry Mandible in South Indian population.

MATERIAL AND METHODS

Study design and collection of Data

The study was carried out on 50 adult, dry, complete human mandible, collected from Department of Forensic Medicine and Toxicology, J J M Medical College, Davangere. The different parameters of each mandible were studied with the help of Digital Vernier caliper and Mandibulometer.

Gonial angle: Angle formed by the inferior border of the corpus and the posterior border of the ramus. Instrument: Mandibulometer.(fig. 1)
Bigonial width: it measures the straight distance between two gonia. Instrument: Vernier Caliper.(fig.2)
Height of ramus: direct distance from the highest point on the mandibular condyle to gonion. Instrument: Vernier caliper.(fig. 5)
Bicondylar breadth: it measures the straight distance between two condylia lateralia. Instrument: Vernier Caliper.(fig. 4)
Mandibular length: distance of the anterior margin of the chin from a centre point on the protected straight line placed along the posterior border of the two mandibular angles. Instrument: Mandibulometer. (fig.2)
Length of lower jaw: it measures the straight distance from the posterior margin of the chin to the tangent drawn at the two gonia. Instrument: Vernier Caliper and Mandibulometer.(fig. 2)
Mandibular index (Thomson criteria): Length of lower jaw/Bicondylar Breadth X 100. Range variation (According to Lindegard and Sonesson) - Dolichostenomandibular ≤ 97.9, Mesomandibular 98.0 – 104.9, Brachyeurymandibular ≥ 105.0.
Body thickness: it measures the maximum thickness in the plane of foramen mentale perpendicular to the longitudinal axis of the body. Instrument: Vernier Caliper. (fig. 7)
Coronoid height: it measures the projective distance between coronion and lower wall of the bone. Instrument: Vernier caliper. (fig. 6)
Bimental breadth: it measures the straight distance between the inner margins of two mental foramina. Instrument: Vernier Caliper.(fig. 3)
Symphyseal height: it measures the straight distance between infradentale and gnathion. Instrument: Vernier Caliper.
Body height: it measures the distance from alveolar margin to the lower margin of the mandible in the level of mental foramen perpendicular to the base. Instrument: Vernier Caliper.[2] (fig. 6)
In case of height of ramus, body thickness, coronoid height and body height, the average value of right and left side of the mandible was taken into consideration in this study.

Inclusion criteria: All the intact, well-formed adult Mandibles were included in this study.
Exclusion criteria: Damaged, mutilated and deformed mandibles, pathological diseased, fractured, developmental disturbances of the mandible, deformed and edentulous mandibles were excluded from the study.

DATA MANAGEMENT AND STATISTICAL ANALYSIS

In the first step of analysis, based on morphological features mandibles were categorized into male and female. Then these male and female bones were compared by 12 different metrical parameters. After all the measurements were done, observations were statistically analysed by IBM SPSS Statistics 21. Unpaired T-Test was performed.

Mean and Standard Deviation were calculated for the ranges of each parameter of both the genders. Using these values 'calculated range' was arrived at by the formula 'mean ± 3 standard deviation'. For a given male calculated range is 'a to b' and for female 'c to d', values of 'a' (minimum in male range) and 'd' (maximum in female range) were chosen as 'demarking points'. Limiting point is an absolute value found within both ranges. 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. So as compared to demarking point, the percentage of mandibles could be identified was far larger with limiting point.

RESULTS

Gonial angle: Gonial angle of male mandible varies from 115° – 140° with an average of 126.6° ± 6° and that of female mandible varies from 123° – 150° with an average of 135.72° ± 8°. The demarking point of mandibular angle for male was less than 159.72 and for female was more than 108.6. Limiting point for mandibular angle was 131.16°, by which 84% of male and 64% of female were correctly sexed. The gender differences in mean values of Mandibular angle of male and female is statistically highly significant (p=0.0001) for mandible. [Table 1].

Table 1: Gonial angle

Details of measurement	Male	Female
No of bones	25	25
Ranges (degrees)	115 - 140	123 – 150
Mean ± SD	126.6 ± 6	135.72 ± 8
Calculated Range	108.6 – 144.6	111.72 – 159.72
p value	0.0001	
t value	-4.522	

Bigonial width:
Bigonial width of male mandible varies from 85.57 – 104.61 mm with an average of 95.70 ± 5.19 and that of female mandible varies from 78.13 – 103.03 mm with an average of 88.75 ± 6.78. The demarking point of Bigonial width for male was more than 109.09 and for female was less than 80.13. Limiting point for Bigonial width was 92.22, by which 72% of male and 80% of female were correctly sexed. The gender differences in mean values of Bigonial width of male

and female is statistically highly significant (p=0.0001) for mandible. [Table 2]

Table 2: Bigonial width

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	85.57 – 104.61	78.13 – 103.03
Mean ± SD	95.70 ± 5.19	88.75 ± 6.78
Calculated Range	80.13 – 111.27	68.41 – 109.09
p value	0.0001	
t value	4.073	

Height of Ramus:

Height of Ramus of male mandible varies from 63.74 – 77.86 mm with an average of 67.98 ± 4.40 and that of female mandible varies from 41.72 – 64.64 mm with an average of 55.72 ± 5.33. The demarking point of Height of Ramus for male was more than 71.09 and for female was less than 54.78. Limiting point for Height of Ramus was 61.54, by which 96% of male and 84% of female were correctly sexed. The gender differences in mean values of Height of Ramus of male and female is statistically highly significant (p=0.0001) for mandible. [Table 3].

Table 3: Height of ramus

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	63.74 – 77.86	41.72 – 64.64
Mean ± SD	67.98 ± 4.40	55.72 ± 5.33
Calculated Range	54.78 – 81.18	39.11 – 71.09
p value	0.0001	
t value	9.311	

Bicondylar breadth:

Bicondylar breadth of male mandible varies from 102.66 – 121.97 mm with an average of 112.72 ± 5.57 and that of female mandible varies from 86.48 – 116.51 mm with an average of 107.48 ± 7.68. The demarking point of Bicondylar breadth for male was more than 130.52 and for female was less than 96.01. Limiting point for Bicondylar breadth was 110.1, by which 72% of male and 68% of female were correctly sexed. The gender differences in mean values of Bicondylar breadth of male and female is statistically highly significant (p=0.008) for mandible. [Table 4].

Table 4: Bicondylar breadth

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	102.66 – 121.97	86.48 – 116.51
Mean ± SD	112.72 ± 5.57	107.48 ± 7.68
Calculated Range	96.01 – 129.43	84.44 – 130.52
p value	0.008	
t value	2.763	

Mandibular length:

Mandibular length of male mandible varies from 65 - 82 mm with an average of 76.6 ± 4.39 and that of female mandible varies from 60 - 80 mm with an average of 70.64 ± 4.77. The demarking point of Mandibular length for male was more than 84.95 and for female was less than 63.43. Limiting point for Mandibular length was 73.62, by which 80% of male and 72% of female were correctly sexed. The gender differences in mean values of Mandibular length of male and female is statistically highly significant (p=0.0001) for mandible. [Table 5].

Table 5: Mandibular length

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	65 - 82	60 - 80
Mean ± SD	76.6 ± 4.39	70.64 ± 4.77
Calculated Range	63.43 – 89.77	56.33 – 84.95
p value	0.0001	
t value	4.599	

Length of lower jaw:

Length of lower jaw of male mandible varies from 51.79 – 66.75 mm with an average of 61.45 ± 4.29 and that of female mandible varies from 45.68 – 66.96 mm with an average of 58.12 ± 4.86. The demarking point of length of lower jaw for male was more than 73.26 and for female was less than 48.58. Limiting point for length of lower jaw was 59.78, by which 72% of male and 68% of female were correctly sexed. The gender differences in mean values of length of lower jaw of male and female is statistically significant (p=0.013) for mandible. [Table 6].

Table 6: Length of lower jaw

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	51.79 – 66.75	45.68 – 66.96
Mean ± SD	61.45 ± 4.29	58.12 ± 4.86
Calculated Range	48.58 – 74.32	43.54 – 73.26
p value	0.013	
t value	2.565	

Mandibular Index:

Mandibular index of male mandible varies from 44.67 – 59.86 with an average of 54.40 ± 4.00 and that of female mandible varies from 39.39 – 62.53 with an average of 54.29 ± 5.22. The demarking point of Mandibular index for male was more than 69.95 and for female was less than 42.4. Limiting point for Mandibular index was 54.34, by which 52% of male and 44% of female were correctly sexed. The gender differences in mean values of Mandibular index of male and female is statistically not significant (p=0.929) for mandible. [Table 7].

Table 7: Mandibular Index

Details of measurement	Male	Female
No of bones	25	25
Ranges	44.67 – 59.86	39.39 – 62.53
Mean ± SD	54.40 ± 4.00	54.29 ± 5.22
Calculated Range	42.4 – 66.4	38.63 – 69.95
p value	0.929	
t value	0.089	

Body thickness:

Body thickness of male mandible varies from 13.87 – 20.03 mm with an average of 16.59 ± 1.55 and that of female mandible varies from 11.2 – 17.71 mm with an average of 14.43 ± 1.63. The demarking point of Body thickness for male was more than 19.32 and for female was less than 11.94. Limiting point for Body thickness was 15.51, by which 76% of male and 72% of female were correctly sexed. The gender differences in mean values of Body thickness of male and female is statistically highly significant (p=0.0001) for mandible. [Table 8].

Table 8: Body thickness

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	13.87 – 20.03	11.2 – 17.71
Mean ± SD	16.59 ± 1.55	14.43 ± 1.63
Calculated Range	11.94 – 21.24	9.54 – 19.32
p value	0.0001	
t value	4.802	

Coronoid height:

Coronoid height of male mandible varies from 53.56 – 73.73 mm with an average of 60.90 ± 4.64 and that of female mandible varies from 43.60 – 62.62 mm with an average of 52.54 ± 4.89. The demarking point of Coronoid height for male was more than 67.21 and for female was less than 46.98. Limiting point for Coronoid height was 56.72, by which 84% of male and 84% of female were correctly sexed. The gender differences in mean values of Coronoid height of male and female is statistically highly significant (p=0.0001) for mandible. [Table 9].

Table 9: Coronoid height

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	53.56 – 73.73	43.60 – 62.62
Mean ± SD	60.90 ± 4.64	52.54 ± 4.89
Calculated Range	46.98 – 74.82	37.87 – 67.21
p value	0.0001	
t value	6.204	

Bimental breadth:

Bimental breadth of male mandible varies from 40.61 – 47.84 mm with an average of 44.38 ± 2.27 and that of female mandible varies from 34.73 – 44.86 mm with an average of 42.38 ± 4.23. The demarking point of Bimental breadth for male was more than 55.07 and for female was less than 37.57. Limiting point for Bimental breadth was 43.38, by which 64% of male and 68% of female were correctly sexed. The gender differences in mean values of Bimental breadth of male and female is statistically significant (p=0.042) for mandible. [Table 10].

Table 10: Bimental breadth

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	40.61 – 47.84	34.73 – 44.86
Mean ± SD	44.38 ± 2.27	42.38 ± 4.23
Calculated Range	37.57 – 51.19	29.69 – 55.07
p value	0.042	
t value	2.087	

Symphyseal height:

Symphyseal height of male mandible varies from 23.06 – 36.82 mm with an average of 28.84 ± 3.23 and that of female mandible varies from 16.68 – 27.89 mm with an average of 22.75 ± 3.75. The demarking point of Symphyseal height for male was more than 34 and for female was less than 19.15. Limiting point for Symphyseal height was 25.79, by which 88% of male and 72% of female were correctly sexed. The gender differences in mean values of Symphyseal height of male and female is statistically highly significant (p=0.0001) for mandible. [Table 11].

Table 11: Symphyseal height

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	23.06 – 36.82	16.68 – 27.89
Mean ± SD	28.84 ± 3.23	22.75 ± 3.75
Calculated Range	19.15 – 38.53	11.5 - 34
p value	0.0001	
t value	6.162	

Body height:

Body height of male mandible varies from 25.03 – 34.51 mm with an average of 28.65 ± 2.58 and that of female mandible varies from 14.81 – 29.23 mm with an average of 22.83 ± 3.73. The demarking point of Body height for male was more than 34.02 and for female was less than 20.91. Limiting point for Body height was 25.74, by which 88% of male and 76% of female were correctly sexed. The gender differences in mean values of Body height of male and female is statistically highly significant (p=0.0001) for mandible. [Table 12].

Table 12: Body height

Details of measurement	Male	Female
No of bones	25	25
Ranges (mm)	25.03 – 34.51	14.81 – 29.23
Mean ± SD	28.65 ± 2.58	22.83 ± 3.73
Calculated Range	20.91 – 36.39	11.64 – 34.02
p value	0.0001	
t value	6.415	

Fig 1: Measurement of the angle of the mandible (Gonial angle).

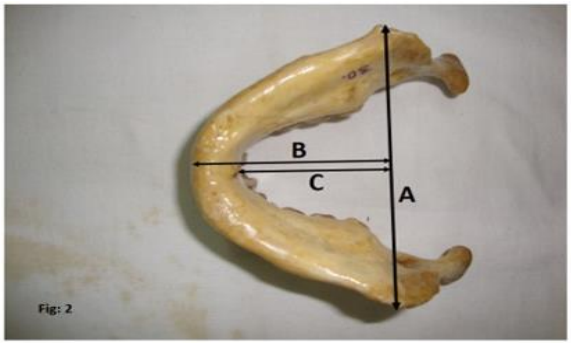

Fig 2: Bigonial width (A). Mandibular length (B). Length of lower jaw (C).

Fig 3: Measurement of Bimental breadth.

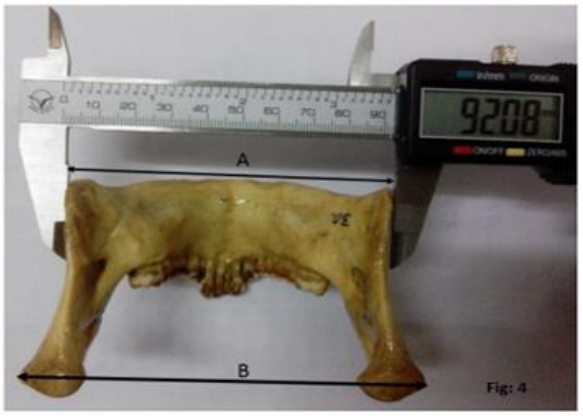

Fig 4: Bigonial width (A). Bicondylar breadth (C).

Fig 5: Measurement of Height of the ramus.

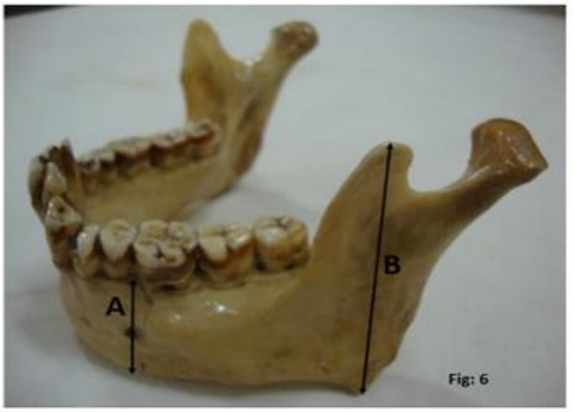

Fig 6: Body height (A). Coronoid height (B).

Fig 7: Measurement of body thickness.

DISCUSSION

Dry human mandibles of unknown sex were collected from Department of Forensic Medicine, J J M Medical College, Davangere, Karnataka State, India. By eliminating pathologically misfit mandibles, 50 fit mandibles were selected. Each mandible was carefully measured for 12 different parameters as

described in materials and methods. In the present study an attempt is made to utilize the discriminant function analysis to establish mandibular measurement that gives the most reliable information to differentiate males and females in South Indian population.

Study conducted by Pillai TJ et al in Tirupati, India concluded that six the dominating characters that possibly explain sex of mandible are height of ramus-right, body thickness, anthropometric arch width, inter incisor width, mandibular index and mandibular angle. The study reveals that mandibles of unknown gender can be sexed to the extent of 75 percent accuracy by carefully studying 22 parameters mentioned in the study.[3] Another study conducted by Kumar MP et al in Tirupati, India concluded the same.[4]

Gonial angle: In the present study the mean value of gonial angle was found to be 126.6˚ in male and 135.72˚ in females. The standard deviation in male was 6 ˚ and female was 8 ˚. The values of female mandibles were higher than that of males. Study conducted by Vinay G et al found that mandibular angle of male mandible varies from 111° – 136° with an average of 121° ± 6° and that of female mandible varies from 97° – 137° with an average of 122° ± 7°. The demarking point of mandibular angle for male was 143.42 and for female was 106.29. Limiting point for mandibular angle was 123°, by which 43.51% of male and 42.42% of female were correctly sexed. The gender differences in mean values of Mandibular angle of male and female is not statistically significant (p=0.99) for mandible.[5] Jayakaran F et al in their series of 207 mandible found that the mean of mandibular angle for male mandible was 121.43 ˚and for female 124.19 ˚. Standard deviation was 6.99 in males and 6.90 in females.[6] Ranganath V et al found that the mean for mandibular angle in males was 110.68 ˚and for females mean was 114.53 ˚. Standard deviation for male was 15.50 and for female 6.95.[7] Ayoub F et al observed no significant difference in mandibular angle in sex determination in the young Lebanese population (83 young individuals - 40 males and 43 females) aged between 17 and 26 years.[8] In present study there was a statistical significant difference between male and female mandible.

Bigonial width: In the present study the mean value of the bigonial breadth of mandible was found to be 95.70 mm in males and 88.75 mm in females. The standard deviation for bigonial breadth in male was 5.19 and in female was 6.78. The values in the female mandible was lesser compared to that obtained in males. Jayakaran F et al in their series of 207 mandibles found that the mean of bigonial breadth for male mandible was 9.38 cm and of females was 8.71 cm. Standard deviation was 0.54 in males and 0.48 in females.[6] Ranganath V et al in their study on 111 mandibles (65 males, 46 females) showed that the mean for bigonial breadth for male was 8.68 cm and for females was 8.62 cm. Standard deviation was 1.37 in males and 0.72 in females.[7] Ongkana N, Sudwan P in their study on 102 Thai mandibles showed that the mean value of bigonial breadth for male mandible was 9.68 cm and for female was 8.97 cm. Standard deviation for male was 0.77 and for females was 0.59. The gender differences in the mean values of Bigonial width between male and female mandibles were statistically significant (p= 0.001) for mandibles.[9] The present study showed statistically significant difference between male and female mandible values. The mean value of male mandibles in the present study was almost similar to previous studies.

Height of ramus: In the present study the mean value of the height of ramus of mandible was found to be 67.98 in males and 55.10 in females. The standard deviation for height of ramus in male was 4.40 and in female was 5.33. The values in the female mandibles was lesser compared to that obtained in males. Study conducted by Rai R et al showed mean mandibular ramus height was greater in males (53.9 cm) than in females (51.8 mm) and there was a statistically significant correlation in the height of ramus between the male and female mandibles (p=0.059).[10] Study conducted by Al-Shamout R et al concluded that males have higher values of the height of ramus compared to female counterparts and statistically significant gender differences were recorded in the height of ramus.[11] In present study there was a statistical significant difference between male and female mandible similar to previous studies.

Bicondylar breadth: In the present study, the mean value of the bicondylar breadth of mandible was found to be 112.72 mm in males and 107.48 mm in females. Standard deviation for bicondylar breadth in male was 5.57 and in female was 7.68. Jayakaran F et al in their series of 207 mandibles found that the mean of bicondylar breadth for male mandible was 11.26 cm and for females was 10.77 cm. Standard deviation was 0.53 in males and 0.53 in females.[6] Franklin D et al., based on measurements of 225 mandibles suggested that the mean of bicondylar breadth in males was 11.36 cm and for females was 10.86 cm. Standard deviation was 0.60 in males and 0.58 in females.[12] Ranganath V et al in their study on 111 mandibles showed that the mean for bicondylar breadth in males was 10.98 cm and for females was 11.51 cm. Standard deviation for male was 1.48 and for females was 0.93.[7] Ongkana N et al studied data on 102 mandibles which showed that the mean value of bicondylar breadth for male mandible was 12.38 cm and for female was 11.61 cm. Standard deviation for male was 0.63 and for females was 0.59.[9] Another study conducted by Vinay G et al concluded the the mean value of the bicondylar

breadth of mandible was 11.34 cm in males and 10.82 cm in females. Standard deviation for bicondylar breadth in male was 0.55 and in female was 0.70. The demarking point of bicondylar breadth for male was 12.9 and for female were 9.69. Limiting point for bicondylar breadth was 11.15, by which 71.39% of male and 63.54% of female were correctly sexed. The t-value of bicondylar breadth was 5.29. The sex differences in mean values of bicondylar breadth of male and female was statistically significant ($p<0.0001$) for mandible bone.[13] All of the studies showed statistically significant difference between male and female mandible values. Present study also shows similar findings.

Mandibular length: In the present study the mean value of the mandibular length was found to be 76.6 mm in males and 70.64 mm in females. Standard deviation for mandibular angle in male was 4.39 and in female was 4.77. Jayakaran F et al in their series of 207 mandible found that the mean of mandibular length for male mandible was 7.44 cm and for female was 7.06 cm. Standard deviation was 0.41 in males and 0.47 in females.[6] Ranganath V et al in their study on 111 mandibles showed that the mean of mandibular angle in males was 6.78 cm and for females 6.63 cm. Standard deviation for male was 0.94 and for female was 0.76.[7] Ongkana N et al data on 102 mandibles showed that the mean value of mandibular length for male mandible was 8.94 cm and for female was 8.53 cm. Standard deviation for male was 0.60 and for females was 0.55.[9] Vinay G et al in their study found the mean value of the mandibular length 7.54 cm in males and 7.25 cm in females. Standard deviation for mandibular angle in male was 0.43 and in female was 0.51. The demarking point of mandibular length for male was 8.81 and for female was 6.22. Limiting point for mandibular length was 7.36, by which 66.02% of male and 53.01% of female were correctly sexed. The t-value of mandibular length was 4.83. The sex differences in mean values of Mandibular length of male and female was statistically significant ($p<0.0001$) for mandible bone.[13] The present study showed statistically significant difference between male and female mandible and mean values of male and female mandibles shows almost similar findings like previous studies.

Length of lower jaw: In the present study the mean value of the length of lower jaw was found to be 61.45 mm in males and 58.12 mm in females. Standard deviation for length of lower jaw in male was 4.29 and in female was 4.86. Study conducted by Jayachandra TP et al stated that length of lower jaw in their study totally differ from the values of the mandibles of known sex. Therefore, length of lower jaw was not applied to identify the sex of the mandible.[3] But in the present study there was a statistically significant correlation between the male and female mandible values.

Mandibular index: In the present study, mean value of the mandibular index was found to be 54.40 in males and 54.29 in females. Standard deviation for mandibular index in male was 4.00 and in female was 5.22. The mean values of mandibular index in male and female mandibles were statistically not significant. The mean values of mandibular index in male and female mandibles were statistically not significant in the study conducted by Vinay G et al also and the mean value of the mandibular index was found to be 66.52 in males and 66.41 in females. Standard deviation for mandibular index in male was 4.42 and in female were 5.69 in their study.[13]

Body thickness and Body height: In the present study, mean value of the body thickness was found to be 16.59 mm in males and 14.43 mm in females. Standard deviation for body thickness in male was 1.55 and in female was 1.63. The mean value of body height was found to be 28.65 mm in males and 22.83 mm in females. Standard deviation for body height in male was 2.58 and in female was 3.73. Study conducted by Seshaiah E, stated that though body thickness, body height facilitate to sex the mandibles at higher percentage.[14] Present study also shows body thickness and body height facilitate to sex the mandibles at higher percentage and the mean values of body thickness and body height are statistically significant for both male and female mandibles.

Coronoid Height: In the present study, mean value of the coronoid height was found to be 60.90 mm in males and 52.54 mm in females. Standard deviation for coronoid height in male was 4.64 and in female was 4.89. Ongkana N et al studied data on 102 mandibles which showed that the mean value of coronoid height was 64.8 mm in males and 59 mm in females. Standard deviation for coronoid height in male was 0.50 and in female was 0.58. The mean values of coronoid height in male and female mandible was statistically significant ($p=0.001$).[9] In a study done by Saini V et al, Coronoid height was the single best parameter providing an accuracy of 74.1%.[15] The present study also shows almost similar findings and the mean values of coronoid height in males and females were statistically significant like the above mentioned studies.

Bimental breadth: In the present study, mean value of the bimental breadth was found to be 44.38 mm in males and 42.38 mm in females. Standard deviation for bimental breadth in male was 2.27 and in female was 4.23. Study conducted by Kranioti EF et al on Greek mandible observed the mean value of bimental breadth in male was 44.55 mm and in female was

43.82. Standard deviation in male was 2.66 and in female was 3.38 and the mean values of bimental breadth in male and female was statistically not significant.[16] In another study done by Pillai TJ et al observed that there was statistically significant correlation in the mean values of bimental breadth between the male and female mandibles.[3] The present study also shows statistically significant correlation between the male and female mandibles.

Symphyseal height: In the present study, mean value of the Symphyseal height was found to be 28.84 mm in males and 22.75 mm in females. Standard deviation for Symphyseal height in male was 3.23 and in female was 3.75. Higher mandibular symphyseal height in male has been reported earlier (Mallik 1969)[17] and also PillaiTJ et al in their studies.[3] This is in correlation with the present observation. The mean values of Symphyseal height in males and females were statistically significant in the present study.

The difference in the metric measurements and indices among the population depends upon the regional, geographic and environmental factors and so values may differ in different region of a country like India.

CONCLUSION

Human skeletal remains examination plays an important role in Anthropology and Medicolegal works to identify the individual, sometimes if a part of bone is also available, sex or age can be determined based upon different morphological and metrical parameters. The present study utilizes the 12 different metrical parameters like Gonial angle, Bigonial width, Height of ramus, Bicondylar breadth, Mandibular length, Length of lower jaw, Mandibular index, Body thickness, Coronoid height, Bimental breadth, Symphyseal height and Body height were taken for gender determination. The application of these metrical parameters along with morphological features could be an useful tool for sex determination of mandibles. This is the first time where 12 different metrical parameters has been taken for gender differentiation and out of those metrical parameters except mandibular index all the other parameters showed significant gender differentiation with an high accuracy. Studies with larger samples may help to correlate gender determination using metric parameters or morphology among South Indian population with more than higher accuracy.

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CONFLICTS OF INTEREST

There is no conflicts of interest since we have not gained any financial or any funds from any Agency/College/University.

Contributions of this Article:

Dr. Anupam Datta - Study selection, Study Design, Sample Size, Data Collection, Measurements, Statistical Calculations.

Dr. Santhosh Chandrappa Siddappa - Introduction, Review of Literature, Journal Selection.

Dr. Viswanathan Karibasappa Gowda - Providing Samples, Instruments, Measurements.

Dr. Siddesh Revapla Channabasappa – Measurements, Statistical Calculations.

Dr. Satish Babu Banagere Shivalingappa – Review of Literature, Collection of References.

Dr. Srijith – Statistical Calculations.

Dr. Debaleena Dey – Statistical Calculations.

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