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Research Article

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Determination of Gender by the Anthropometric Measurement of Human Mandible Using Ramus Breadth and Mandibular Angle: A Cross Sectional Study from South India

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Abstract

Background: Determination of gender of an individual from human skeletal remains is the first and arguably the most important step encountered by both forensic experts and archaeologists. Assessment by metrical methods over simple morphological observations is quite difficult. The mandible is the strongest and hardest facial bone and retains its shape better than other bones. The main objective of the present study was to measure, compare, and evaluate the various measurements of ramus breadth and mandibular angle to assess the usefulness in gender determination.

Methods: The study was carried out on 220 dry, complete, undamaged human adult mandibles of unknown gender collected various medical colleges in and around Bangalore. Minimum ramus breadth, maximum ramus breadth and mandibular angle were measured using mandibulometer and sliding caliper.

Results: After obtaining all the measurements, t test was performed. It was found that if the value of minimum ramus breadth ≥ 3.79 cm it could be considered as male and if the value is ≤ 2.36 cm it is of female. For maximum ramus breadth ≥ 4.85 cm it could be considered as male and if the value is ≤ 3.21 cm it is of female.

Conclusion: Minimum ramus breadth and maximum ramus breadth are highly predictive for the gender of unknown mandible. The present study shows that the mandible is an important bone in the determination of gender with high accuracy.

Keywords: Mandible; gender determination; Ramus breadth; Mandibular angle

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Background

Recognition of human skeletal remains is an essential and crucial part for the forensic experts, which helps in further investigations [1]. Determination of gender depends on the intactness of the Skeletal remains and another factor responsible is degree of sexual dimorphism. This two factors plays key role in the reliability of the procedure [2]. Therefore the study of sexual dimorphism of bones in human population is a matter of interest not only for the anatomist but also for the anthropologist and forensic scientist [3]. The usual indicators of gender in bones are size, shape, weight, density, muscular markings etc. If the gender of human skeletal remains is assessed correctly then further investigations are likely to be more accurate as separate male and female standards may be then used for estimations of both age and stature. Comparing with other bones, mandible is the largest and hardest facial bone. This retains its shape comparatively better than other bones of our body [4]. Two exceptionally well qualified physical anthropologists, Stewart and Krogman found themselves erring in sexing crania of known identity by visual methods in 23% and 13% of cases respectively [5,6]. When dental records are

unavailable or non-existent, then gender determination of unknown mandibles by the usual methods of size, muscular markings or angulations become unreliable [7]. Research works in different part of the globe suggested that ramus measurement and mandibular angle could be a better option for gender determination [8-10]. Data from south India is deficient. Therefore the objective of this study is to determine whether the metrical parameters like maximum ramus breadth, minimum ramus breadth and mandibular angle show any gender differences in the study group of mandibles.

Material and Methods

Study design and collection of Data

The study was carried out on 220 adult dry, complete, undamaged human mandibles of unknown gender collected from Department of Anatomy, Bangalore Medical College and Research Institute and various other medical colleges in and around Bangalore. The different parameters of each mandible were studied with the help of sliding caliper and mandibulometer. Mandibular angle measured using Mandibulometer after properly placing mandible on the instrument. All readings were taken properly and carefully to avoid parallax error. Unbroken, intact, well formed, complete human adult mandibles were considered for experimental purpose. Current study was done in May 2008 to April 2009.

Minimum ramus breadth: the least breadth of the mandibular ramus measured perpendicular to the height of the ramus (Fig. 1).

Fig-1: Minimum ramus breadth measured using sliding caliper

Maximum ramus breadth: the distance between the most anterior point on the mandibular ramus and line connecting the most posterior point on the condyle and the angle of the jaw (Fig. 2).

Fig-2: Maximum ramus breadth measured using sliding caliper

Mandibular angle: the angle formed by inferior border of the body and the posterior border of the ramus measured with mandibulometer (Fig. 3).

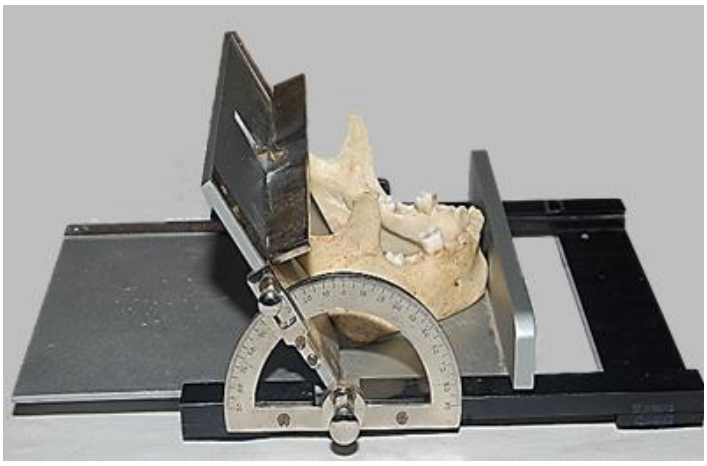

Fig-3: Mandibular angle measured using Mandibulometer

Inclusion criteria

All the intact, well formed adult Mandibles were included in this study.

Exclusion criteria

Damaged, mutilated and deformed mandibles, Pathological, fractured, developmental disturbances of the mandible, deformed and edentulous mandibles were excluded from the study.

Ethical committee approval

Ethical committee approval was taken from the respective authorities before the experiment.

Data management and statistical analysis

After all the measurements were done, observations were statistically analyzed in SPSS. Student 't' test was performed. In the first step of analysis, based on morphological features mandibles were categorized into male and female [11-13]. Then these male and female bones were compared.

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 'p to q' and for female 'r to s', values of 'p' (minimum in male range) and 's' (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. Hence as compared to demarking point, the percentage of mandibles could be identified was far larger with limiting point.

Results

Table–1: Minimum ramus breadth

Details of measurements	Male	Female
No of bones	154	66
Range(cm)	2.51–3.94	2.31–3.63
Mean±SD	3.16±0.27	2.93±0.29
p value	<0.0001†	
t value	5.68	

†P<0.001, statistically significant

Minimum ramus breadth:

Minimum ramus breadth of male mandible varies from 2.51 – 3.94 cm with an average of 3.16 ± 0.27 cm and that of female mandible varies from 2.31 – 3.63 cm with an average of 2.93 ± 0.29 cm. The demarking point of minimum ramus breadth for male was 3.79 and for female was 2.36. Limiting point for minimum ramus breadth was 3.05, by which 68.18% of male and 62.12% of female was correctly sexed.

The gender differences in mean values of minimum ramus breadth of male and female is statistically significant (p<0.001) for mandible bone.

Maximum ramus breadth:

Maximum ramus breadth of male mandible varies from 3.34 – 4.88 cm with an average of 4.17 ± 0.32 cm and that of female mandible varies from 3.17 – 4.71 cm with an average of 3.89 ± 0.32 cm. The demarking point of maximum ramus breadth for male was 4.85 and for female was 3.21. Limiting point for maximum ramus breadth was 3.95, by which 72.08% of male and 63.64% of female was correctly sexed.

The gender differences in mean values of maximum ramus breadth of male and female is statistically significant (p<0.001) for mandible bone.

Table–2: Maximum ramus breadth

Details of measurements	Male	Female
No of bones	154	66
Range(cm)	3.34–4.88	3.17–4.71
Mean±SD	4.17±0.32	3.89±0.32
p value	<0.0001†	
t value	5.86	

†P<0.001, statistically significant

Table–3: Mandibular angle

Details of measurements	Male	Female
No of bones	154	66
Range(degrees)	111–136	97–137
Mean±SD	122±6	122±7
p value	0.99×	
t value	-0.01	

×p>0.05, statistically not significant

Mandibular Angle

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 was correctly sexed. The gender differences in mean values of Mandibular angle of male and female is not statistically significant (p=0.99) for mandible.

Discussion

While commenting over the sexual dimorphism in human skeleton, it has long been customary among anatomists, anthropologists and forensic experts to judge the gender of skeletal material by metrical observation. Later on sexual divergence has been based upon the actual measurements in many different bones. The osteometric data of the mandible of our work is compared and discussed with other similar studies. However all the parameters used in the present study are not studied by all workers.

Minimum ramus breadth:

The mean value of the Minimum ramus breadth of mandible was found to be 3.16 cm in males and 2.93 cm in females. Standard deviation for minimum ramus breadth in males was

0.27 and in females was 0.29. Ranganath et al. showed that mean for minimum ramus breadth in males was 3.17 cm and for females was 3.11 cm. Standard deviation for male was 0.48 and for females was 0.38. Ongkana studied data on 102 mandibles which showed that the mean value of minimum ramus breadth for male mandible was 3.28 cm and for female was 3.14 cm. Standard deviation for male was 0.34 and for females was 0.31. We got statistically significant difference between male and female mandible value. The mean value of male and female mandibles in the present study were almost similar to previous studies; whereas mean values of females were found to be smaller than males [14, 15].

Maximum ramus breadth

In the present study the mean value of the maximum ramus breadth of mandible was found to be 4.17 cm in males and 3.89 cm in females. Standard deviation for maximum ramus breadth in males was 0.32 and in females was 0.32. Ranganath et al. showed that the mean value of Maximum ramus breadth in males was 3.88 cm and for females mean is 4.07 cm. Standard deviation for male was 0.52 and for females was 0.54 [14].

The present study showed statistically significant difference between male and female mandibles.

Mandibular angle

In the present study the mean value of the mandibular angle was found to be 121º in males and 122º in females. Standard deviation for mandibular angle in males was 6º and in females was 7º. Jayakaran et al in their series of 207 mandible found that the mean of mandibular angle for male mandible was 121.43º and for female 124.19º. Standard deviation was 6.99 in males and 6.90 in females. Ranganath et al. found that the mean for mandibular angle in males was 110.68º and for females mean was 114.53º. Standard deviation for male was 15.50 and for female 6.95. In present study there was no statistical significant difference between male and female mandible [14, 16].

Study Limitations & Future scope of the study

This is a cross sectional study, where we have included a relatively less adult dry mandibles from Bangalore city and nearby medical colleges. Further broad spectrum study can be done including different states medical colleges of South India.

Conclusion

Identification of gender from the skeletal remains has immense anthropological and medico legal importance. A traditional non-metrical method for determination of gender of various parts of the skeleton depends on expert's ability and experience. Maximum ramus breadth, minimum ramus breath were statistically significant when compared between male and female mandibles. Maximum ramus breadth and minimum ramus breadth parameters were found highly predictive for the determination of gender of mandible except the mandibular angle. Thus the present study shows that the mandible is an important bone in gender determination with high accuracy. Further broad spectrum investigation of the correlation between gender and either metric parameters or morphology should be conducted to obtain a specific standard for the south Indian population.

Competing interests

Authors do not have any competing interests.

Authors' contribution

Vinay G and Mangala Gowri S.R designed the study, performed the experiment, interpreted the data, drafted the manuscript, and revised it. Vinay G took part in data analysis, interpreted the data, and revised the manuscript. Final manuscript was approved by all authors.

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