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Forensic Evaluation of Various Osteometric Parameters of Human Mandible in both Sexes

Priyamvada Kurveti[1] , Gyanendra Kumar[2], Dheeraj Singh Verma[3], JayanthiYadav[4], B. P. Dubey[5]

[1]Assistant Professor, [2]Ex Resident, Dept. of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal, Presently Assistant Professor, Late Baliram Kashyap Govt. Medical College, Jagdalpur, Chattisgarh, [3]Demonstrator, Dept. of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal, [4]Ex Professor and Head, Dept. of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal, Presently Additional Professor, Dept. of Forensic Medicine and Toxicology, AIIMS, Bhopal, [5]Ex Professor and Head, Dept. of Forensic Medicine and Toxicology and Ex Dean, Gandhi Medical College, Bhopal , Presently Dean, L. N. Medical College, Bhopal

Abstract

Identification of sex could be made on differences in the size and shape of the morphological markers i.e. shapes of chin, size of condyles etc. Morphological traits are more subjective and sex determination depends on experience of the investigator. So, visual methods of sexing mandible are likely to be inaccurate when performed by an inexperienced worker and sometimes produce misleading results. Hence, metric analyses are found to of superior value owing to their objectivity, accuracy, reproducibility and lower incidence of inter and intra observer errors as compared to that of descriptive traits.

The focus on present study is to use morpho-metric analytical method to evaluate the ability of selected parameters to determine sex in forensic sample.

Aims and Objectives: To study the various osteometric parameters of human mandible and evaluate their utility in sex determination

Material and Method: Some measurements of the 200 mandibles were taken using sliding calliper and mandibulometer and statistically analysed.

Findings: On statistical analysis, it is found that height of the symphysis menti, bigonial width, shows a higher index of sexual dimorphism. Hence, these can be used for determination of sex. Other parameters such as bicondylar width, mandibular angle are found to be statistically insignificant in this study.

Conclusion : When the findings of present study were compared with those of past investigators, marked variations in the various osteometric parameters of mandible was noticed, which differed all over the world as well as in different regions of India. Hence, it is suggested, not to apply the findings of study of one region over the samples of other region, to avoid fallacies.

Keywords*: symphysis menti, bigonial width, bicondylar width, mandibular angle*

Corresponding Author:
Dr. Priyamvada Kurveti,
Assistant Professor, Department of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal, Madhya Pradesh, INDIA, Ph.- 07879793466, 08839367975, Email- rayan.priya@gmail.com

Introduction

100 % accuracy in determining sex could be achieved if entire skeleton is available (Krogman1946)[7]. But problems arise, when either incomplete or fragmentary remains of skeleton are brought for examination. Then it depends largely on the available parts of the skeleton. A number of literatures have shown sexual dimorphism in

almost every bone of human skeleton. As evident from the past studies, skull is the most dimorphic and easily sexed portion of skeleton after pelvis, providing accuracy up to 92%. 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 the skull

Identification of sex could be made on differences in the size and shape of the morphological markers i.e. Shape of chin, size of condyles etc. Morphological traits are more subjective and sex determination depends on experience of the investigator, so visual methods of sexing mandible are likely to be inaccurate when performed by an inexperienced worker and sometimes produce misleading results. Hence, metric analyses are found to of superior value owing to their objectivity, accuracy, reproducibility and lower incidence of inter and intra observer errors as compared to that of descriptive traits.

The focus on present study is to use morpho-metric analytical method to investigate the sexual dimorphism and to evaluate the ability of selected parameters to determine sex in forensic context.

Material & Method

The present study was undertaken in the Department of Forensic Medicine and Toxicology, Gandhi Medical College Bhopal. 200 mandibles were measured, of which 130 were male and 70 were female. All the pathological, deformed and fractured mandibles were excluded from the study. The numbers of female samples were limited, because all sample were forensic cases and the female skeleton brought for examination are limited.

For sex determination, following point was taken into consideration –

1. Size – larger / thicker heavier in male, smaller, thinner lighter in female.

2. Surface – smooth relatively in female and rugged in female.

3. Shape of chin – square shaped in males and pointed or rounded (U shaped) in females.

4. Condyles – bigger and larger in male and smaller in females.

Allotment of mandibles to different sexes was carried out by experts in the department, namely, forensic medicine experts and forensic anthropologists.

Instruments used for taking measurements – were sliding caliper and mandibulometer

Of the various measurements of mandible mentioned in different standard anthropological studies, 4 anthropometric parameters were selected (Table-II). To ensure familiarities of reference and forensic anthropologist alike, landmarks were selected to correspond closely to those common in both traditional and geometric morphometric studies.(Table- I) To minimize the intra observer error , all the measurements are taken with sliding caliper (0.1 mm precision) 3 times and the average value were utilized for the analysis.

TABLE - I (Landmarks on Mandible)

No.	Landmarks	Definition	Unilateral/ Bilateral
1	Condylion superior	The most superior point of the mandibular angle	Bilateral
2	Condylion laterale	The most lateral point of the mandibular angle	Bilateral
3	Gonion	The most lateral and external point at the junction of the horizontal end on – rami of the lower jaw.	Bilateral
4	Infradentate(id)	The mid- point of a line tangent to the outer margin of the cavities of the two mandibular central incisor	Unilateral
5	Gnathion	The middle point of the lower border of the mandible in the saggital plane	Unilateral

TABLE – II (Anthropometric Parameters for measurement)

Height of symphysis mentii	Direct distance from infradentate to gnathion	Sliding calliper
Bigonial width	Measured between right and left gonion	Sliding calliper
Bicondylar width	Measured between the right and left condylion laterale	Sliding calliper
Mandibular angle	It is the angle formed by the inferior border of the corpus and the posterior border of the ramus	Mandibulometer

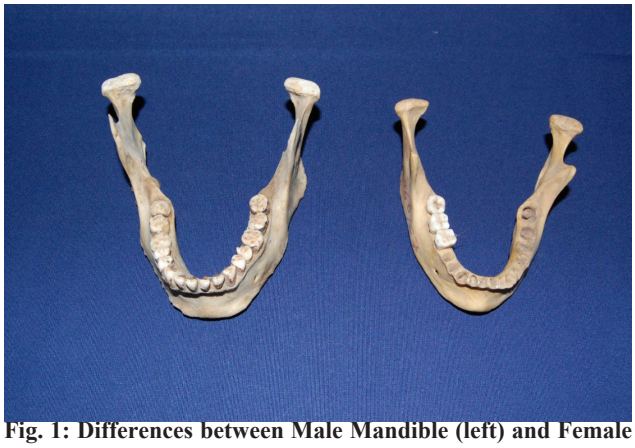


Fig. 1: Differences between Male Mandible (left) and Female Mandible (right);

Fig. 2: Procedure of measuring bi-gonial width i.e. distance between right and left gonion using sliding calliper

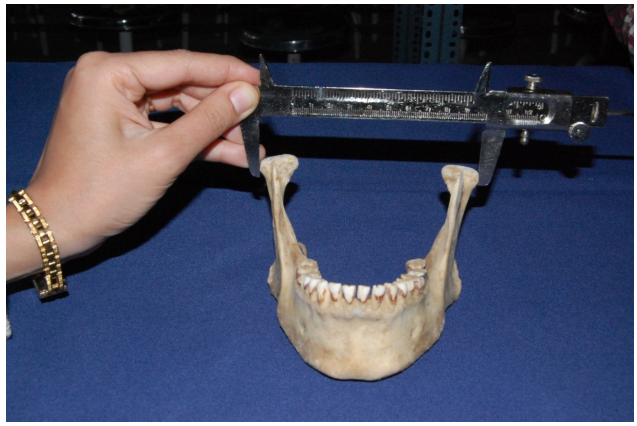


Fig. 3: Technique of measuring bi - condylar width with the help of sliding calliper.

Fig. 4: Mandibulometer, a specific apparatus, being used for measuring mandibular angle

Statistical methods used for analysis were as follows:

Index of Sexual dimorphism (1SD)

ISD =Mean value of Male / Mean value of female X 100.

It indicates the level of difference between sexes; values close to hundred indicate low level of sexual difference and on the other hand the level of sexual difference increases with the increase of the distance from hundred.

1. Mean

Arithmetic mean was calculated by dividing the total number of individual observations by number of cases

Mean $=\sum x/n$

Where $\sum x$ = summation of individual observation,

n= number of cases

2. Standard Deviation

It is the square root of the arithmetic average of the square of the difference between the observations and their mean. The formula is as follows:

$$S.D. = \sqrt[n]{\frac{\sum (x - \bar{x})^2}{\quad}}$$

Where $\sum (x-\bar{x})^2$ = Summation of each squared deviation

n = number of cases

3. Level of Significance ('t'test)

This test was used to find out any significant difference between the means of different groups. It was calculated by the formula, given below:

$$S.E.(d) = \sqrt{\frac{(S.D._1)^2}{n1} + \frac{(S.D._2)^2}{n2}}$$

Where S.E. (d) = Standard error of difference

$S.D._1$ & $S.D._2$ = Standard deviations of observations in two samples

n_1 & n_2 = No. of cases in the 2 samples

Probability(P value)

P<0.001 = extremely significant

P<0.01 = very significant

P < 0.05 = significant

P>0.05 = not significant

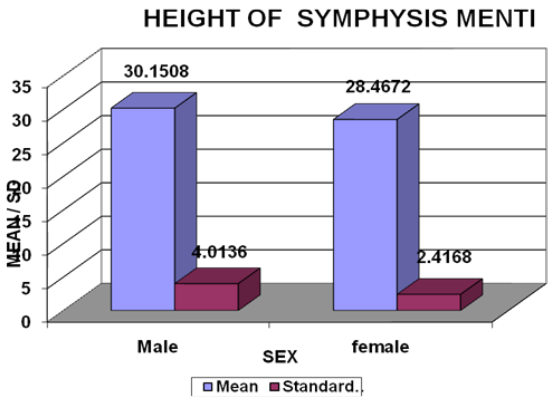
Findings

The data is represented in the master chart, the observation were statistically analysed and the results obtained were compared with the findings mentioned in pre-existing literature.

1. Height of Symphysis Menti

Mean of symphysis menti height for males is found to be 30.1508 with a standard deviation of 4.0136; and that of females is 28.4672 with a standard deviation of 2.4168. P value obtained for the parameter is<0.001 that means the difference between the two variables is extremely significant. Also the ISD is above 100, which shows the significant level of sexual differences between two means. In the study conducted by Fabien and Mpembeni[5]in the year 2002, on 25 male and 25 females; they found this parameter to be statistically significant and a reliable parameter for sex determination Ionescu et al (2007)[6] in his study on 50 male and 50 female mandibles have also found this parameter to be statistically significant..

Similar finding was observed by Corici et al[3] in 2009in his study conducted on 80 dry specimen of mandibles.



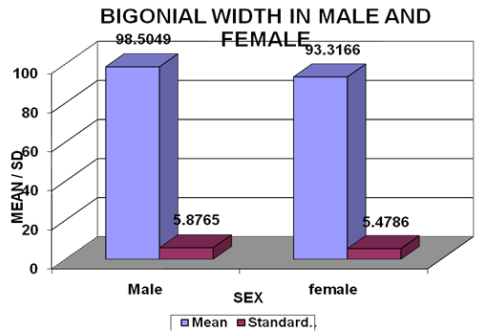
Graph A: depicts mean and standard deviation of height of symphysis menti in both sexes

2. Bigonial Width

The mean for this parameter is 98.5049 with a standard deviation of 5.8765; and for females mean found is 93.3166 with standard deviation of 5.4786. Probability level of P< 0.001 is obtained, showing an extremely significant statistical difference. Also, ISD is above 100, meaning the level of sexual difference for this parameter is significant.

Also, Ionescu et al[6] in 2007 while studying sexual dimorphism in mandible, using 25 male and 25 female samples, found this parameter to be statistically significant

Badiu et al[2] in his study on 80 preserved adult skull with matching mandibles in 2010 found that this parameter to be extremely significant statistically and having a higher ISD. He stated that "the bigonial width could be used for sex determination of an unidentified skull."



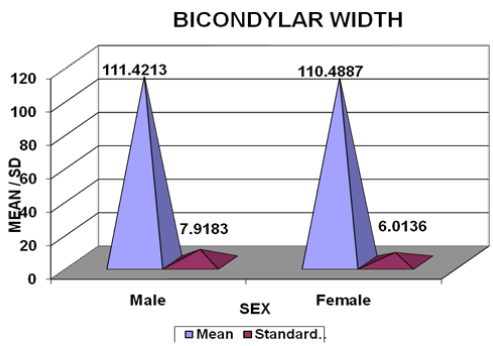
Graph B: depicts mean and standard deviation of bigonial width in both sexes

3. Bicondylar Width

The mean obtained for this parameter in males is 111.4213 with a standard deviation of 7.9183; and that for female is 110.4887 with standard deviation of 6.0136. in this case ,p = 0.39 , which is insignificant, also ISD obtained is just few decimal points above 100. Hence, it can be concluded by these observations that, this parameter is not that significant statistically.

Similarly, in 2002, Fabien and Mpembeni[5] in their study of sexual dimorphism in 25 male and 25 female mandibles of homogenous black population of Tanzania; found this parameter to be statistically insignificant.

But, the finding in the present study is in contradiction with a study carried out by Ionescu et al[6]in the year 2007 on 50 male and 50 female mandibles; that showed the bicondylar width to be a statistically significant parameter.



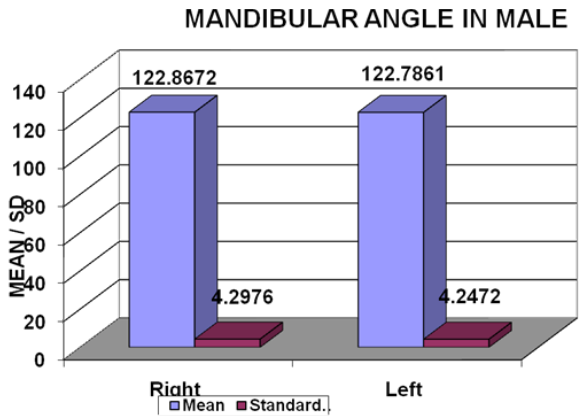
Graph C: depicts mean and standard deviation of bicondylar width in both sexes

4. Mandibular Angle

As observed in the present study, the mean +_ standard deviation for male on right side is 122.8672 +_4.2976; on left side, 122.7861+_ 4.2472. For females, on right side, the mean is 124.7661 with a standard deviation of4.0974; on left side, the mean and standard deviation are 124.6760 and 4.0471 respectively. Also, ISD is below 100, which gives an indication that the level of sexual difference is insignificant. But, on comparing means of male and female in adult and elderly age group separately, though the difference is statistically significant ($p< 0.001$) , but the ISD calculated is below 100, indicating that the level of sexual difference for this parameter is insignificant.

Similarly, Ionescu et al[6] in the year 2007 in his study on 25 male and 25 female mandibles found this parameter to be insignificant to study sexual dimorphism. This finding is also supported by the study of Oettle et al (2006)[10]who stated that "In the assessment of human remains, the mandibular angle is not very usable in determining sex." Loth and Henneberg (2000)[8] in their study have shown that the gonial form has a highly heritable component that appears to be associated with overall facial architecture and determining sex using this trait has an accuracy of only 45 %

On the contrary, Acsadi and Nemeskeri (1970)[1]and Novotny et al (1993)[9] stated the gonial eversion to be a sex marker for adults. Same is also considered a male characteristic by Ferembach et al (1980)[4]



Graph D: depicts mean and standard deviation of mandibular angle (right and left side)

Conclusion

On statistical analysis, it was found that height of the symphysis menti and bigonial width showed a higher index of sexual dimorphism. Hence, these can be used for determination of sex. Other parameters such as bicondylar width and mandibular angle were found to be statistically insignificant in this study.

When the findings of present study were compared with those of past investigators, marked variations in the various osteometric parameters of mandible was noticed, which differed all over the world as well as in different regions of India. Hence, it is suggested, not to apply the findings of study of one region over the samples of other region, to avoid fallacies. It is also recommended, to carry out more studies incorporating a larger sample; to make the data more precise and useful in terms of anthropological and medico- legal application.

Conflict of Interest – Nil

Source of Funding- self with assistance from institute

Ethical Clearance – The study protocol was approved by Institutional Ethics Committee of Gandhi Medical College, Bhopal

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