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Sexual Dimorphism in the Mandibles of Bengali Population: A Geometric Morphometric Approach

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Abstract : *The identification of skeletal remains is of paramount importance in medico-legal investigations. Much of our understanding of modern human skeletal variation is derived from anthropological techniques based on the traditional linear metrical system (1). As evident from the earlier studies, skull is the most dimorphic and easily sexed portion of skeleton after pelvis, providing accuracy up to 92% (2). But in cases where intact skull is not found, mandible may play a vital role in sex determination as it is the most dimorphic, largest, and strongest bone of skull. The present study was conducted with the aim to measure, compare and evaluate the various measurements of mandible. The present study is a cross-sectional descriptive study. The sample comprised of 50 (25 male and 25 female) adult dry mandible bones. In our study, statistically significant (p=0.000) differences were seen in the linear distances of anatomical angles between the males and females. Same differences, also statistically significant (p=0.004), were seen in the linear distances of medico-legal angles. Also the mean distances between the two mental foramens in females and males were 74.74 mm and 83.46 mm respectively, hence making the difference to be statistically significant (p=0.001).*

Keywords: *Bengali, Mandible, Medico-Legal, Sexual Dimorphism, Skull)*

I. Introduction

The identification of skeletal remains is of paramount importance in medico-legal investigations. Much of our understanding of modern human skeletal variation is derived from anthropological techniques based on the traditional linear metrical system (1). With specific reference to either the whole skull or its functional components, there is a long history of such research. Recent research works have also focused on using various skeletal elements to quantify variation related to sexual dimorphism, primarily because the determination of sex in unknown skeletal remains is one of the key biological characteristics used to facilitate forensic identification. The need for research of this nature is driven by the increasing incidence of violent activities resulting in large number of unidentified bodies being referred to the forensic investigator. As evident from the earlier studies, skull is the most dimorphic and easily sexed portion of skeleton after pelvis, providing accuracy up to 92% (2). But in cases where intact skull is not found, mandible may play a vital role in sex determination as it is the most dimorphic, largest, and strongest bone of skull. Presence of a dense layer of compact bone makes it very durable, and hence remains well preserved than many other bones. Dimorphism in mandible is reflected in its shape and size. As the mandible is the last skull bone to cease growth, it is sensitive to the adolescent growth spurt (3). The stages of mandibular development, growth rates and its duration are distinctly different in both sexes and so this bone is particularly useful in differentiating between sexes. In addition, masticatory forces exerted are different for males and females, which influence the shape of the mandible.
The present study is conducted with the aim to measure, compare and evaluate the various measurements of mandible and to assess the usefulness of this morphometry as an aid in sex determination.

II. Materials & Methods

The present study was a cross-sectional descriptive study. The investigation was conducted in the Department of Forensic & State Medicine of Bankura Sammilani Medical College, Bankura. The sample comprised of 50 (25 male and 25 female) adult dry mandible bones. No pathological, fractured, deformed or edentulous mandible was included in the study. The investigations were carried out from the months of October 2014 to December 2016.

All measurements were taken three times with a sliding caliper (0.05 mm precision), protractor and mean value was used for analysis. The following measurements were taken:

- Mandibular Body Height [MBHt]: direct distance from the alveolar process to the inferior border of the mandible perpendicular to the base at the level of the symphysis menti (4).
- Length of Condylar process [ConLt]: The distance between the most lateral and the most medial point of the mandibular condylar process (5).
  Length of Coronoid process [CorLt]: The distance between the most lateral and the most medial point of the mandibular coronoid process (5).

- Anatomical angle [AA]: Measuring the angle with a protractor formed by the lines tangent to the posterior ramus and the inferior border of the mandible (6).
- Medico-legal angle [MLA]: Measuring the angle with a protractor formed by the lines tangent to the anterior ramus and the superior border (alveolar border) of the mandible (6).
- Linear distance between Anatomical angles [LDAA]: Measuring the linear distance between the two points formed by the intersections of lines tangent to the posterior rami and the inferior borders of mandible on both sides (7).
- Linear distance between Medico-legal angles [LDMLA]: Measuring the linear distance between the two points formed by the intersections of lines tangent to the anterior rami and the superior borders of mandible on both sides (7).
- Linear distance between Mental Foramens [LDMF]: Linear distance between the mental foramens of both sides.

  SPSS version 19 for windows was used for analysis of results. Descriptive statistics and ANOVA test were used to examine the variables. "p" values of less than 0.05 and 0.01 were considered to be significant and highly significant respectively

III. Results And Tables

The present descriptive cross-sectional study was conducted with 50 adult dry mandible bones (25 male and 25 female). Taking linear distance between anatomical angles into consideration, the mean values in cases of male and female mandibles were 95.62 mm and 78.47 mm respectively, and the difference of linear distances between males and females was statistically highly significant (p=0.000). Again, the mean values of linear distance between the two medico-legal angles in males and females were 71.55 mm and 63.76 mm respectively and the difference of the linear distances of medico-legal angles between males and females was also statistically significant (p=0.004). The mean heights of the left coronoid process in males and females were 60.19 mm and 52.2 mm respectively, but the difference was statistically significant (p=0.017). Again the mean heights of the right coronoid process in males and females were 59.53 mm and 51.13 mm respectively and the difference was also significant statistically (p=0.008). The mean heights of the left and right condylar processes in males were 55.63 mm and 55.05 mm respectively, whereas the same values in females were 43.34 mm and 43.35 mm respectively.

The difference of heights of left condylar processes was statistically significant (p=0.000) and that of right condylar processes was also statistically significant (p=0.001). The mean mandibular body heights for males and females were 28.90 mm and 28.51 mm respectively and the difference of heights were not statistically significant (p=0.829). The mean values of right medico-legal angles in males and females were 94.58 degrees and 99.10 degrees respectively and the difference was not statistically significant (p=0.281). Again the mean values of left medico-legal angles in males and females were 93.83 degrees and 99.30 degrees respectively and the results here too didn't have any statistical significance (p=0.227). The mean values of right anatomical angles in males and females were 121.25 degrees and 127.20 degrees respectively, making the difference statistically significant (p=0.035). Again the mean values of left anatomical angles in females and males were 125.60 degrees and 118.17 degrees respectively, and the difference was again significant statistically (p=0.017). The mean distances between the two mental foramens in females and males were 74.74 mm and 83.46 mm respectively, hence making the difference to be statistically significant (p=0.001).

Table 1

SEX		AA	MLA	LCR	RCR	LCL	RCL	SMenti	RMLA	LMLA	RAA	LAA	MFDISTANCE
Female	Mean	78.47	63.76	52.20	51.13	43.34	43.35	28.51	99.10	99.30	127.20	125.60	74.74
	SD	8.92	6.73	9.49	8.57	7.88	8.34	3.72	9.91	10.73	7.02	6.44	6.03
	Min	63.00	53.40	36.70	37.60	31.40	31.00	22.40	91.00	87.00	112	113	64.70
	Max	90.30	72.60	66.40	61.00	56.80	54.90	33.60	121.00	122	136	134	83.40
	SE	2.82	2.12	3.00	2.71	2.49	2.63	1.17	3.13	3.39	2.22	2.03	1.90
Male	Mean	95.61	71.55	60.19	59.53	55.63	55.05	28.90	94.58	93.83	121.25	118.16	83.45
	SD	6.10	4.40	4.42	4.61	4.50	5.63	4.49	9.19	9.81	5.31	6.78	3.89
	Min	88.80	64.10	53.00	50.50	45.90	44.50	20.30	82	82	110	107	78.70
	Max	111.20	78.10	65.90	67.20	63.20	64.30	37.50	115.00	114.00	128.00	129.00	91.10
	SE	1.76	1.27	1.27	1.33	1.30	1.62	1.29	2.65	2.83	1.53	1.95	1.12

Table 2

	Sum of Squares	Df	Mean Square	F	Sig.
AA*SEX	1603.681	1	1603.681	28.462	.000
MLA*SEX	331.004	1	331.004	10.661	.004
LCR*SEX	348.364	1	348.364	6.781	.017
RCR*SEX	385.178	1	385.178	8.601	.008
LCL*SEX	824.324	1	824.324	21.048	.000
RCL*SEX	747.737	1	747.737	15.329	.001
Man Ht*SEX	.830	1	.830	.048	.829
RMLA*SEX	111.274	1	111.274	1.226	.281
LMLA*SEX	163.006	1	163.006	1.554	.227
RAA*SEX	193.105	1	193.105	5.123	.035
LAA*SEX	301.388	1	301.388	6.849	.017
MF Dis*SEX	414.596	1	414.596	16.737	.001

IV. Discussion & Conclusion

The identification of sex from human remains is of fundamental importance in forensic medicine and anthropology, especially in criminal investigations as well as in the identification of missing persons and in attempts at reconstructing the lives of ancient populations (2). Identification of sex based on morphological marks is subjective and likely to be inaccurate, but methods based on measurements and morphometry are accurate and can be used in determination of sex from the skull. Mandibles were used for the analysis for two simple reasons: firstly, there appears to be a paucity of standards utilizing this element and secondly, this bone is often recovered largely intact. In our study, statistically significant (p=0.000) differences were seen in the linear distances of anatomical angles between the males and females. Same differences, also statistically significant (p=0.004), were seen in the linear distances of medico-legal angles. However, literature regarding these linear distances (Anatomical and Medico-legal angles) is lacking.

Taking into consideration, the lengths of the coronoid processes in males and females, coronoid process of males were seen to be longer as compared to the coronoid process of females on either sides, making the differences to be statistically significant (Left: p=0.017 and Right: p=0.008). Bejdova and Krajicek also noticed the higher coronoid process in male mandibles than females (8), which is consistent to our findings. The same features were also reflected in condylar lengths, where the males were seen having higher condylar process lengths as compared to that of females. The differences were also statistically significant (Left: p=0.000 and Right: p=0.001). Fabian and Mpembeni also found the similar results, though the difference was not statistically significant (9).

Considering the mandibular heights at the level of symphysis menti, the mean mandibular body heights for males and females were 28.90 mm and 28.51 mm respectively and the difference of heights was not statistically significant (p=0.829). Saqlam AA in his panoramic radiograph study of dentate and edentulous subjects at Isparta, Turkey, found that the height of the mandible was significantly greater in men than woman (10), which is consistent to our findings. The same results were also reflected in the study by Jayam R. and Annigen R., where they found the males having higher mandibular basal bone heights as compared to females (11).

Correlation of sex with medicolegal angles was not significant in the present study, though males presented with lower values as compared to females. Males had significantly smaller antegonial angle than females (162.2° ± 7.39 and 167.52° ± 6.27, respectively) in the study conducted by Chole and Patil at Bhubaneswar, India, quite consistent to our results, except the level of significance (12). Statistically significant gender differences were observed on both sides when the anatomical angles were taken into consideration. Xie and Ainamo also found difference in size of the gonial angle between dentate men and women ($p < 0.05$ in the young and $p<0.001$ in the older dentate group) but not between elderly edentulous men and women (13).

In the present study, the mean distances between the two mental foramens in females and males were 74.74 mm and 83.46 mm respectively, hence making the difference to be statistically significant (p=0.001). However, no such comparisons or literature was found even after thorough and intense search. Simple instruments like slide calipers and protractors are efficient for making the proposed measurements and can be considered as an additional method to determine the gender from skeletal remains. There is a significant difference in the distances between the anatomical angles, medicolegal angles and mental foramens in males and females. The same statistically significant difference is observed in the sizes of the anatomical angles, length of the coronoid and condylar processes in both the genders; the technique is particularly important in mass disasters in which the jaws are available in fragments.

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