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Original Research Article

DETERMINATION OF SEX FROM ADULT HUMAN FEMUR FROM SOUTH GUJARAT REGION

Deepak S. Howale [1], Mehul R. Tandel *[2], Manish R. Ramawat [3], Dnyanesh P. Pandit [4], Mahesh B. Madole [5].

[1] Professor and Head, Department of Anatomy, GMERS Medical College, Valsad, India.

*[2] Assistant Professor, Department of Anatomy, Pramukhswami, Medical College, Karamsad, Anand, Gujarat, India.

[3] Professor and Head, Department of Physiology, GMERS Medical College, Dharpur-Patan, India.

[4] Professor and Head, Department of Physiology, GMERS Medical College, Valsad, India.

[5] Associate Professor, Department of Biochemistry, GMERS Medical College, Valsad, India.

ABSTRACT

Introduction: Assessment of human sex from skeletal parts is important in anthropology, archaeology, paleoanthropology, comparative anatomy and forensic medicine where it provides accurate information to medico-legal information. Hence this study was taken to determine the sex from femur. Determination of sex from skeletal remains is an important component in the identification but sometimes becomes difficult to the forensic expert especially when the pelvis is absent. The sex identification by the fingerprint systems and DNA tests are the best methods. Sex determination carried out from the male and female femur bones is accurate in ninety percent of cases than in cases of adult pelvis or skull. Various studies demonstrated the metric assessment of sex to differentiate in races and regions in the populations.

Aim: This study was conducted for metric standards of sex determination by femur measurements.

Materials and Methods: Osteometric data were obtained from the 100 adults femurs (50 males and 50 females).

Results: Values of female femur are slightly higher than males.

Conclusion: We have used either univariate or multivariate analysis for sexual dimorphism of femur, this is a statistical technique which has proven to have a high utility in studies of sex determination [1]. With the help of seven standard parameters using the maximum length, maximum diameter of head, midshaft circumference, maximum antero-posterior diameter of medial and lateral epicondyle and bicondylar width showed significant differences in male and female femur with accuracy of 90.2%. This result clearly indicated the importance of these variables in identification of sex from femur [2].

KEY WORDS: Femur, Sex determination, Osteometric data, Midshaft circumference, Head circumference.

Address for Correspondence: Dr Mehul R Tandel, Assistant Professor, Department of Anatomy, Pramukhswami Medical College, Karamsad, Anand, Gujarat – 388325, India.
Contact No: (+91) 9558568679 **E-Mail:** mehulrtandel@gmail.com

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INTRODUCTION

The Skulls and pelvis are most reliable bones for sex determination [3]. In medicolegal cases the sex determination can be done at crime site from isolated bones or their fragments. In the present study femur was studied for sex deter-

mination in the South Gujarat region. The aim of this study was to provide accurate distinguishing features between males and females. This study may help to forensic experts to analyse long bones either individual or in combination on the basis of statistical or morphological standards. However certain fundamental deficiencies have been noted in traditional anthropological methods, where the measurements on the bone were done without any reference. it has been observed by various authors [4-7]. If the entire skeleton is available for examination, determination of sex become easy. There are number of different populations in India but only few studies of femur are available. In the present study, femur was studied for sex determination in the population of south Gujarat region of India.

MATERIALS AND METHODS

This study was done in the Dept of anatomy at GMERS Medical College, Valsad (Gujarat) on 100 dry adult femora (50 males and 50 females). All bones were from south Gujarat region. A total of seven parameters were analysed. During measurements bone was held in anatomical position

OBSERVATIONS

Table 1: Shows Mean values of measurements of femur in males and females.

	Male		Female		P - Value
Variables	Mean (mm)	S.D.	Mean (mm)	S.D.	
Maximum length	439.57	30.14	410.6	21.9	<0.0001
Max. diameter of head	44.45	2.83	39.89	2.37	<0.0001
Max. midshaft A.P.Diameter	27.82	3.09	25.25	2.1	<0.0001
Midshaft circumference	79.62	6.19	73.47	4.08	<0.0001
Distal epiphyseal breadth	76.27	4.21	69.26	5.5	<0.0001
Head circumference	136.63	8.08	122.82	7.19	<0.0001
Weight (g)	344.83	67.92	262.68	44.12	<0.0001

Table 3: Comparison of discriminate analysis of Femur.

	Chinese [10]	Thai [11]	South African Whites[12]	American [13] Blacks	American [13] Whites	Germans [14]	Indians [4]	Present Study
Maximum diameter of Head	83.1	91.3	85.9	90	90.9	89.6	88.4	78.7
Epiphyseal Breadth	94.9	93.3	90.5	86.6	89.2	81.4	86	
Midshaft circumference	81.7	85.6		73.1	84		76.7	

1) Maximun length- from the head to the medial condyle, measured with an osteometric board.

2) Maximum head diameter- measured with a vernier caliper

3) Midshaft circumference -midpoint was marked at a level on the Maximum vertical length of femur and midshaft circumference was measured around this point using a thread on a measuring tape.

4) Maximum midshaft anteroposterior diameter- measured approximately at the midpoint of diaphysis at the highest elevation of linea aspera, using vernier calliper [6,8].

5) Antero posterior diameter of epicondyles -The medial and lateral epicondyles was identified and anteroposterior diameter was measured using divider and measuring scale.

6) Distal epiphyseal breadth -distance between the two most projecting points on the epicondyles, using vernier calliper [9]

7) Weight- measured using single pan balance sensitive to 0.1g.

The materials used for measuring these parameters were a Vernier caliper, thread, scale, Measuring tape, divider and measuring scale.

Table 2: Canonical discriminate femur function coefficients.

	Variables	Raw Coefficients	Standard Coefficients	Structure Coefficients	Sectioning Point
1.	Maximum length	0.38	1	1	
	Constant	-16.134			
2.	Max.diameter of head	3.829	1	1	
	Constant	-16.107			
3.	Midshaft circumference	1.906	1	1	
	Constant	-14.59			
4.	Max. midshaft A.P diameter	3.775	1	1	
	Constant	-10.019			
5.	Epicondylar width	2.566	1	1	
	Constant	-18.676			
6.	Head circumference	1.307	1	1	
	Constant	-16.931			
7.	Weight (g)	0.017	1	1	
	Constant	-5.304			
8.	Max. diameter of head	3.368	0.88	0.943	0.963
	Max. midshaft diameter	1.281	0.339	0.503	
	Constant	-17.833			
9.	Head circumference	1.143	0.875	0.94	0.931
	Max. midshaft diameter	1.256	0.333	0.519	
	Constant	-18.145			
10.	Max. Length	0.26	0.686	0.863	
	Max. midshaft diameter	2.021	0.535	0.762	
	Constant	-16.434			
11.	Max. Length	0.201	0.53	0.827	
	Max. circumference	1.213	0.636	0.883	
	Constant	-17.833			
12.	Weight	0.013	0.733	0.925	
	Midshaft circumference	0.812	0.426	0.756	
	Constant	-10.102			

DISCUSSION

Axial skeleton weight is heavier in male than that of the female [15]. This weight is received by femur and takes part in transmission of body weight, therefore the stress and strain on the femur is different in a male than in a female. Table 1 shows all seven measurements which were higher in males than females. The best results were obtained by a combination of distal epiphyseal breadth and midshaft circumference in Chinese [10] (accuracy 94.7%), distal epiphyseal breadth and maximum diameter of head in Thais (accuracy 94.2%) [11], epiphyseal breadth and maximum diameter of head in South African whites (88.6%) [12], head circumference and midshaft diameter in Germans (91.7%) [13], maximum head diameter and epicondylar width in another Indian study from central India[4] (92.1%). In our study the combination of maximum diameter of head and maximum midshaft anteroposterior diameter result with 87.5% accuracy [5,16]. Table No2 shows the maximum diameter of head (0.880). the maximum diameter of head had the maximum structure coefficient (0.943) and therefore the highest contribution. Table 3 shows the percentage of sensitivity. The best parameters in both the sexes were maximum diameter of head followed by maximum midshaft anteroposterior diameter. The accuracy increased in both the sexes when these two parameters were combined. The sensitivity of all the parameters were more for female bones. Maximum diameter of head was 85% for male and 72.5% for female. With maximum midshaft anteroposterior diameter it was 80% for male and 67% for female, the combination of these two for male bones was 92.5% and for female it was 82.5. Singh,S and Singh S. stated that the right femur measures 44.5 cm in male and 37.7cm in female. For identification of left femur, bicondylar width is the best useful mearsurement, and the average is 7.12cm±0.4 [16].

Kate worked on femur from different regions of India and he found variation in values according to region. He concluded from his study of 50 femora in wet & dry conditions, that the articular cartilage adds 2.8mm on an average, with a range of 1 to 4mm [17].

In our study the length of the femur was 43.95 cm in males and 41.06 cm in females. In North Indian, it was 43 cm in males and 41cm in females. So there is no much difference seen between the south Indian and North Indian [18]. The antero posterior diameter of the shaft of femur was 2.78 cm in males and in females it was 2.52 cm. [19]. Mid shaft circumference was 7.96 cm in males and 7.34 cm in females, in which no difference in the males and females. Due to the wider pelvis in the females, the antero posterior diameter of the medial epicondyles in female was larger than the males on both the sides, so that there was medial inclination of lower end of the femur. During weight transmission this inclination helps the body weight to be kept closer to the centre of gravity. Weight was transmitted along a line passing through the medial epicondyle and medial condyle of the femur and due to such mode of weight transmission the medial epicondyle was wider in females although other measurements in females were comparably lesser than the measurements which were found in male [19]. Therefore, most of the long bones, either individually or in combination were subjected to statistical and morphological analysis of determining sex [20,21]. The bicondylar width in our study on the left side in the males was 7.5±18 cm and 6.8±.23cm in females, on the right side in the males, it was 7.3± .21cm and in females it was found to be 6.8±.19cm. which was statistically significant. Bicondylar width in north Indian population was found by Enock Prabhakar [18] was 7.8cm in males and 7.2cm in the females which was more in the north than in the south.

CONCLUSION

The medial epicondyle width was more in female. The average width of lateral epicondyle was more is males but was not statistically significant. This study of identification of sex of skeletal remains is useful in the field of forensic osteology and anthropometry. This study will also help in accurate diagnosis of sex from both complete and fragmentary femur from south Gujarat-India and thus constitute an important tool for forensic experts.

Conflicts of Interests: **None**

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