Research Article

Sex determination from femur using length of femur in Gujarat

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ABSTRACT

Background: Anatomy is a story of many, many migrations and relations of cells, tissues, and organs. It is an assembled of artifacts and facts. Physical anthropology is one of the oldest studies of man. Skeleton gives structural framework to the body. The study of bones serves important information like; they constitute the evidence for the study of fossil man. They are the basis of racial classification in prehistory. They are the means of biological comparison of prehistoric peoples with the present living descendants. They give evidence for the culture and worldwide of the people studied. Their identification often helps solve forensic cases and give information about stature, age, and sex of the individual. It also provides information on prehistoric customs and diseases. **Objectives:** The assessment of human sex from skeletal parts is of very much medicolegal and anthropological importance. The present study aims at obtaining results from the length of femur in Gujarat and to develop standards in the determination of sex and compare the present study with those of other population. **Materials and Methods:** The study was carried out using 150 dry, normal adult femora (97 male and 53 female) in NHL municipal medical college, Ahmedabad, Gujarat, India. **Results:** Mean maximum length of male femur is more than female femur in the Gujarati population of the present study. In Gujarat population, if the maximum length of male femur is >462 mm, then it is definitely male femur and if it is <366 mm than it is definitely female femur. **Conclusion:** The maximum length of femur of Gujarat population is less than the length of American white, California, Marathwada, North Central India and population of Maharashtra, while more than the length of Chinese population. The findings of the present study may be useful in medicolegal cases for the estimation of sex from available fragmentary femora. The study can also be useful for anatomist and physical anthropologist.

KEY WORDS: Femur, Sexual dimorphism, Maximum length

INTRODUCTION

Anatomy is a story of many, many migration and relations of cells, tissues, and organs. It is an assembled of artifacts and facts. Physical anthropology is one of the oldest studies of man. Skeleton gives structural framework to the body. The study of bones serves important information like; the skeleton constitutes the evidence for the study of fossil man and the basis of racial classification in prehistory. The bone provides tools for biological comparison of prehistoric peoples with the present living descendants. Their identification often helps solve forensic cases and give information about stature, age, and sex of the individual.

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Determination of sex from long bones of skeleton plays an important role in physical anthropology, osteology, and demographic assessment in medicolegal investigations.

If the entire skeleton is available for examination, the sex determination becomes easy. For determination of sex accurately, skull and pelvis are the highly reliable skeletal element. Standards of morphometric sex differences in the skeleton differ with the different population samples.[1] The long bones, either individually or in combination with other

bones, have been used for statistical and morphological analysis for determining sex.[2]

For the study of sexual dimorphism, long bones are better alternative compared to short bones due to their small size, measurement error, as small as half millimeter can amount to 5–6% of the total measurements.[3]

The present study has been carried out to find out sexual dimorphism of maximum femoral length in Gujarat populations and compare with the other populations. There is no other study done on Gujarat population and such study very useful for medicolegal purpose and anthropological purpose in Gujarat.

MATERIALS AND METHODS

Ethical permission was given by the ethical committee of the college. With the ethical clearance of the college, the study was carried out on the femur at NHL Medical College and BJ Medical College, Ahmedabad. A total of 150 human femora (97 male and 53 female) were used for the present study.

All the bones with complete growth as by the fusion of the proximal and distal femoral epiphysis included in the study. Any femora exhibit any pathologies, fractured and unknown sex were excluded from the study.

Maximum length of femur (mm) was measured by the osteomatric board in such a way that medial condyle touches the short vertical wall; the movable part touches the highest point of the head. Maximum vertical distance between the upper end of the head of the femur and the lowest point on femoral condyle was measured.[4]

For each measurement, the following values were calculated:

- Mean
- Standard deviation (SD)
- Minimum – maximum for identification point (IP)
- IP
- Demarcation point (DP).

RESULTS

As shown in Table 1, the average maximum length of the male femur was 440.29 mm and average maximum length of the female femur was 393.25 mm.

IP for maximum length of male femur was >462 mm and for female femur was <366 mm. IP method identified 25(37.6%) male femur correctly as male. IP method also identified 10 (19.2%) female femur correctly

Demarcating point for male femur was >487.66 and for female femur was <359.52.

DP identifies 3 (3.09%) male and 8 (15.09%) female femur correctly.

Mean maximum length of male femur was more than the mean maximum length of female femur and the data were statistically highly significant, as $P < 0.01$.

Thirty-nine male femurs out of 97 male were in the range of 426–450 mm while 23 female femurs out of 53 were in the range of 401–425 mm [Table 2].

DISCUSSION

The average maximum length of the male femur was 440.29 mm and average maximum length of the female femur was 393.25 mm.

IP for the maximum length of male femur was >462 mm and for female femur was <366 mm. IP method identified 25 (37.6%) male femur correctly as male. IP method also identified 10 (19.2%) female femur correctly.

Demarcating point for male femur was >487.66 and for female femur was <359.52.

DP identifies 3 (3.09%) male and 8 (15.09%) female femur correctly.

The comparison of our study with the other studies is given in Table 3.

Table 1: The mean, SD, IP, DP, and *P*-value of maximum length of femur in male and female

Variables	Male (*n*=97)	Female (*n*=53)
Mean	440.29	393.25
SD	26.92	31.47
IP	>462	<366
DP	>487.66	<359.52
% of DP (N)	3.09 (3)	15.09 (8)
P VALUE	<0.01 highly significant	

Table 2: Range of male and female femur length

Range	Male (*n*=97)	Female (*n*=53)
300–325	0	1
326–350	0	3
351–375	1	11
376–400	6	9
401–425	14	23
426–450	39	4
451–475	28	1
476–500	8	1
501–525	1	0

Table 3: Comparison of our study with the other studies

Author	Population	Sex	No.	Mean (mm)	SD (mm)	DP (mm)	% identified Bones	*P*-value	Re-mark
Dibennardo and Taylor (1979)[5]	American white	M	50	450	20.4	-	80	-	-
		F	35	423	22.1	-	71	-	-
Dittrick and Myers (1986)[6]	California	M	148	450	20.1	-	79.5	-	-
		F	145	420.6	17.2	-			
Wu (1989)[7]	Chinese	M	74	431.3	25.8	-	79.4	<0.001	HS
		F	67	394.1	17.5	-			
Purkait and Chandra (2002)[2]	Central India	M	200	451.47	23.38	-	84.50	0.05	NS
		F	80	436.9	19.79	-	91.30		
Pandya *et al*. (2011)[8]	Gujarat	M(R)	67	451.81	23.94	>476.70	13.40	<0.001	HS
		F(R)	23	417.48	19.74	<379.99	4.35		
		M(L)	69	453.35	22.54	>484.49	7.25	<0.001	HS
		F(L)	25	420.44	21.35	<385.73	8.00		
Maske *et al*. (2012)[9]	M arath-wada	M	189	443.6	22.6	478.45	31.28	<0.0001	HS
		F	179	398.6	26.6	375.85	26.63		
Srivastava *et al*. (2012)[10]	North Indian	M	94	435.5	26.26	>465.6	14.89	<0.000	HS
		F	28	404.1	20.55	<356.7	0		
Bhosale and Zambare (2013)[11]	Maha- rashtra	M(R)	67	450.82	23.84	>476.8	13.33	<0.01	HS
		F (R)	23	416.49	19.83	<379.9	4.37		
		M(L)	69	452.37	22.63	>484.4	7.24		
		F(L)	25	420.43	21.38	<385.83	8		
Jacob *et al*. (2013)[12]	Manglore	M	41	441.4	22.0	-	-	<0.0001	HS
		F	25	396.0	21.0	-	-		
Gaikwad and Nikam (2014)[13]	Western maha-rastra	M	100	441.36	24.04	>466.3	18	<0.0001	HS
		F	100	394.60	23.89	<369.23	2		
Present study	Gujarat	M	97	440.29	26.92	>487.66	3.09	<0.01	HS
		F	53	393.25	31.47	<359.52	15.09		

As we can see in the present study found that the mean maximum length of male femur was higher than the female femur and it was statistically highly significant which is similar with findings of Wu,[7] Maske *et al*.,[9] Srivastava *et al*.,[10] Bhosale and Zambare,[11] Jacob *et al*.,[12] and Gaikwad and Nikam,[13] In the present study, demarcating point for male femur was >462 and for female femur was <366. DP method identifies 3(3.09%) male and 8 (15.09%) female femur correctly. Maske *et al*.[9] correctly identified 31.28 % of male femur and 26.63 of female femur using the maximum length of femur. Srivastava *et al*.[10] found that average 14.89 % of male femur was correctly identified as male femur. Pandya *et al*.[8] found average 7.25% of the left male femur, 13.40% of the right male femur, 4.35% of the right female bones, and 8.00% of the left female bones identified. Bhosale and Zambare[11] found that average 13.33% of the right and 7.24% of the left male femur were correctly identified as male femur, while 4.37% of the right and 8% of the left female femur was correctly identified as female femur. Gaikwad and Nikam[13] correctly identified 18% of male femur and 2% of female femur using the maximum length of femur. There was difference in the maximum length of femur between the present study and Maske *et al*.[9] Srivastava *et al*.,[10] and Bhosale and Zambare[11] may be due to variation in population.

As we can see in the study that the maximum length of femur of Gujarat population is less length of American white, California, Marathwada, North India and population of Maharashtra, while more than the of Chinese population.

There was more marked difference in the maximum length of femur between the present study and Dibennardo and Taylor,[5] Dittrick and Myers,[6] Wu,[7] and Purkait and Chandra.[2] This can be explained by the use of different statistical method applied. While the different studies referred above were based on the discriminate analysis, the present study had used the demarcating point analysis.

The numbers of the dry femur are comparable with other studies, but the dry femur of all the regions of Gujarat will have more impact on the sample size and can consolidate our findings.

CONCLUSION

Mean maximum length of male femur is more as compared with female femur in the Gujarati population of the present study. In Gujarat population, if the maximum length of male femur is >462 mm than it is definitely male femur and if it is <366 mm then it is the definitely female femur. The maximum length of femur of Gujarat population is less than the length of American white, California, Marathwada, North Central India, and population of Maharashtra, while more than the length of Chinese population. The findings of the present study can be applicable in medicolegal cases for the estimation of sex from femur. The study can also be useful for anatomist and physical anthropologist.

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