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Sex Determination of Femur Using Discriminant Function Analysis

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ABSTRACT

Background: The kinematical chain of the femur can be designated as a crank mechanism, thus reciprocating the foot motion into rotary motion through the hip. Hence, the present study was planned to assess femur using discriminant function analysis.

Materials & Methods: A total of 50 dry adult femora retrieved from the Department of Anatomy, Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh (India) were included in the present study. Following parameters were assessed sing sliding vernier calipers: Maximum Length (L1), Proximal Breath (L2), Vertical diameter of neck (L3), and Antero-posterior diameter of lateral condyle (L4). All the results were recorded in Microsoft excel sheet.

Results: Significant results were obtained while comparing the L2 in between males and females. Average accuracy (%) of discriminant function analysis among males and females was found to be -63.1 and -63.9 respectively.

Conclusion: Femur could be used for assessing the gender, in which breath is significantly responsible for large variation in comparison to length.

Keywords: Discriminant, Femur, Function.

INTRODUCTION

The kinematical chain of the low extremity can be designated as a crank mechanism, thus reciprocating the foot motion into rotary motion through the hip that in turn is being transformed into the ascending variable directive torsion movements of the flexed sloping spiral of the spine.[1-3]

While the human femur is an element of the non-linear system of the locomotor's apparatus (as the super system for the femur), functionally dependent upon the other elements of the super system, being some time a subsystem, the elements of which are epiphysis and diaphysis, the investigation of its system and anatomical organization has not only theoretical, but also, perhaps, direct practical and clinical significance.[4,5]

Hence; under the light of above mentioned data, the present study was planned to assess femur using discriminant function analysis.

MATERIALS & METHODS

The present study was planned in the Department of Anatomy, Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh (India) and it included assessment of femur using discriminant function analysis in known population. A total of 50 dry adult femora retrieved from the department of Human Anatomy were included in the present study. All these femora aged between 30 to 60 years at the time of death.

Inclusion Criteria

- Femur in good conditions,
- Femur with gender and age details available,
- Femur with absence of any kind of damage or deformity

Following parameters were assessed using sliding vernier calipers:

- Distance between the highest landmark of the head and the lower most landmark on the lateral medial condyle: Maximum Length (L1)
- Distance between medial most placed anatomical landmark and lateral most landmarks on greater trochanter: Proximal Breath (L2)
- Minimum diameter of femoral neck in a plane perpendicular to the head–neck midline: Vertical diameter of neck (L3)
- Projected distance between the most posterior point on the lateral condyle and the lateral lip of the patellar surface taken perpendicular to the axis of the shaft: Antero-posterior diameter of lateral condyle (L4)

All the results were recorded in Microsoft excel sheet and were analyzed by SPSS software.

Table 1: Demographic data of the femur bone

Parameter	Number
Total	50
Males	25
Females	25
Mean age (years)	45.6

Table 2: Femur characteristics

Femur variable	Males	Females	p- value
L1	425.2	430.4	0.09
L2	73.5	78.1	0.00*
L3	29.5	30.1	0.71
L4	56.8	57.3	0.82

Table 3: Discriminant function analysis

Variable	Unstandardized coefficients	Standardized coefficients	Average accuracy (%)	
			Males	Females
L1	-0.007	-0.281	-63.1	-63.9
L2	-0.017	-0.089		
L3	0.111	0.356		
L4	0.230	0.912		

RESULTS

In the present study, a total of 50 femur bones were analyzed. Among these 50 femur bones, 25 were of males while the remaining 25 were of females. Value of L1, L2, L3 and L4 variables among males was 425.2, 73.5, 29.5 and 56.8 respectively. Value of L1, L2, L3 and L4 variables among females was 430.4, 78.1, 30.1 and 57.3 respectively. Significant results were obtained while comparing the L2 in between males and females. Average accuracy (%) of discriminant function analysis among males and females was found to be -63.1 and -63.9 respectively.

DISCUSSION

Determination of sex from unidentified human skeletal remains is a challenge for anthropologists and forensic investigators. Skull and pelvis are widely used for sex identification. In addition, mastoid, craniofacial region, mandible and other bones of the human skeleton are used for sexing. Femur is the largest and heaviest bone of the human skeleton.[6, 7]

In the present study, a total of 50 femur bones were analyzed. Among these 50 femur bones, 25 were of males while the remaining 25 were of females. Value of L1, L2, L3 and L4 variables among males was 425.2, 73.5, 29.5 and 56.8 respectively. Value of L1, L2, L3 and L4 variables among females was 430.4, 78.1, 30.1 and 57.3 respectively. Trancho GJ et al presented a sample of 132 femora (72 females and 60 males) belonging to a Spanish population of adult individuals of known filiation deposited in the Complutense University of Madrid. The ten mathematical functions which yield a higher sexual discrimination in each part of the femur, were selected. The resulting percentages of correspondence varied between 84 and 97% when each variable was considered independently, and a 99% is obtained with two variables of the epiphyses combined.[8]

In the present study, significant results were obtained while comparing the L2 in between males and females. Alunni-Perret V et al studied a sample of 88 female and male femurs taken from recently deceased elderly French people. The bones were collected from subjects who had donated their bodies to the Medical School of Nice. The mean value of the male bicondylar breadth was found to be greater than that of females (84.3mm versus 74.8mm), confirming the sexual dimorphism of this parameter. Furthermore, the results showed a 95.4% accuracy rate for sexing individuals. To date, in the French population, as in some other samples, epicondylar breadth is the single most accurate measurement of sex determination, ahead even of head diameter. A discriminant function is presented to allow sex determination from remains of the distal femur. With regard to the data available in the literature, sexual dimorphism is probably the result of both genetic and environmental factors. The comparison of their results with those of other populations shows that there are inter-population variations of the bicondylar breadth, and also intra-population variations that account for the differences in the accuracy rate of this variable for the purposes of sex determination.[9]

In the present study, average accuracy (%) of discriminant function analysis among males and females was found to be -63.1 and -63.9 respectively. Purkait R et al made an attempt to examine the sexual dimorphism in femur of Indian origin using 124 femora from central India. Eleven standard dimensions were measured on the bones. The data were analysed using discriminant function procedures and the results of different measurements are reported independently and in various combinations. Maximum head diameter alone could correctly assign sex to 92.5% of males and 95.5% of females. Evaluation of the discriminating ability of the variables selected in stepwise analysis was then conducted using cross validation procedure. To understand the population variation, the discriminant formula derived from Thai, Chinese, South African white, American black and white were

applied on the present sample. The comparison indicated that Indians had very different dimension from South African whites and American whites.[10]

CONCLUSION

Under the light of above obtained data, it can be concluded that femur could be used for assessing the gender, in which breath is significantly responsible for large variation in comparison to length. However; further studies are recommended.

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