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Original Research

DETERMINATION OF THE SEX OF FEMUR - A MORPHOMETRIC STUDY

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Abstract

Background: Skeletal elements are important tool to establish biological profile. of an individual. Femur is the longest and strongest bone of the body. The aim is to evaluate the gender difference for femur in north Indian population of Bihar region.

Materials and Methods: The study was conducted using 48 human adult femoral bones of known gender (25 males and 23 females). A digital vernier calliper was used for all measurements. Seven parameters were measured.

Result: The metric values for males and females were highly significant for all the parameters. Female bones were found to have lower values compared to males.

Conclusion: The sexual dimorphism of femoral bobe was confirmed again in this study.

INTRODUCTION

The longest and hardest bone in our body is femur. The length of femur is linked with gait, its strength with weight.[1] It is the most commonly studied bone to determine the stature and gender of an individual, owing to its significant variation between individuals.[2] The exceptional strength and toughness of femur (skeletal remain), adds to its potential to resist ageing and environment. 3

Bones remained the most significant tool to ascertain the biological profile in humans. Determination of sex holds the first step in defining the profile and establishing identity of an individual, further the technique for determination of stature and age is dependent on gender.[3]

Amongst the human skeletal remains, skull and pelvis are most studied and reliable for gender dimorphism, but gender can also be determined in absence of these bones.[4]

The variation in pelvis morphology owing to higher pelvic breadth in females as an adaptation to reproduction1, variation influenced by body size and as well as the musculature.[5,6]

Long bones are recovered intact in majority of times. Femur is believed to be highly sexually dimorphic after skull and pelvis.

Female femoral bones are smaller and displays superior obliquity. It is also established that typically male bones are large in dimension, longer in length, have more roughness and are massive compared to long bones of female. The impact of body weight is borne by femur.[7]

The ever increasing cases of road traffic accidents, violence and disasters encompassing humans calls for a more reliable gender determination technique using long bones. Femur is established to play an important role in gender determination. The gender differentiation is also dependent on genetic and epigenetic factors. Diets and lifestyle adds to gender differentiation.

A generalized norms regarding gender may cause bias. Therefore, the time calls for population and geographical area based anthropometric data and norms. In view of the above, the current study was designed to evaluate the gender difference for femur in north Indian population of Bihar region.

MATERIALS AND METHODS

Study Setting

The study was conducted in the department of Anatomy, at ESIC Medical College and Hospital, Bihta.The study was conducted over a period of 05 months from January 2022 to May 2022.

Study Sample

The study sample consisted of 48 human adult femoral bone. The study sample bones, of known gender (25 males and 23 females) were collected from anatomy department of our institute and also were taken on loan from the nearby institutes.

Inclusion Criteria: Intact, well formed, adult femoral bone.

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Exclusion Criteria: Damaged bones, pathology and bones with anomalous feature.

Measurements

A digital vernier calliper was used for all measurements. The following parameters were measured.

1. Maximum Length of Femur (MLF): A straight distance between the highest point on the head and the lowest point on the medial condyle.
2. Maximum Mid Shaft Antero Posterior Diameter: The antero-posterior distance measured at the midpoint of the maximum length.
3. Proximal Breadth (PB): The distance between the most medial point on the head to the most lateral point on the greater trochanter.
4. Vertical Diameter of Neck: The minimum diameter of femoral neck in a plane perpendicular to the head–neck midline.
5. Vertical Diameter of Head (VDH): The straight distance between the highest and the lowest point on the head.
6. Transverse Diameter of Head (TDH): The straight distance between the most laterally projected points on the head perpendicular to the VDH.
7. Epicondylar Breadth (ECB): The maximum distance between the two most projecting points on the lateral and medial epicondyles.

Statistical Analysis

The data was tabulated in a Microsoft excel spread sheet and was subjected to statistical analysis using SPSS software version 16.0. The descriptive statistics were calculated and the test of significance was done for difference in mean values. P <0.001values was considered statistically significant.

RESULTS

The present study evaluated 48 femoral bones (male =25, Female=23) of known sex for gender dimorphism. The observed metric parameters are shown in [Table 1].

Table 1: Descriptive statistics of measurement parameters amongst gender.

Parameter	Male (n=25)		Female (n=23)		p
	Mean (cm)	S.D.	Mean (cm)	S.D.	
Maximal Length	37.63	2.26	34.17	2.97	<0.001
Proximal Breadth	7.26	0.51	6.45	0.48	<0.001
Vertical Diameter of Head	3.50	0.24	3.06	0.26	<0.001
Transverse Diameter of Head	3.52	0.23	3.07	0.27	<0.001
Epicondylar Breadth	6.20	0.437	5.512	0.38	<0.001
Vertical Diameter of Neck	2.50	0.19	2.11	0.26	<0.001
Mid Shaft Diameter	2.28	0.23	1.95	0.23	<0.001

The mean values for all the parameters studied were higher for males compared to females. This difference in mean values for the gender was found to be statistically significant.
The demarcating and limiting values are shown in [Table 2].

Table 2: Demarcating Points and Limiting Values for Metric Parameters

Parameter	Males (n=25) Demarcating Point 'y' (cm)	Females (n=23) Demarcating Point 'a' (cm)	Limiting Value (cm)
Maximal Length	46.89	35.91	41.4
Proximal Breadth	7.74	6.75	7.2
Vertical Diameter of Head	4.23	3.24	3.69
Transverse Diameter of Head	4.23	3.33	3.78
Epicondylar Breadth	7.29	5.76	6.48
Vertical Diameter of Neck	4.05	2.25	3.15
Mid Shaft Diameter	3.33	1.89	2.61

It is evident from table 2 that female bones could be identified more correctly using limiting values.
These observations show that, when all parameters are taken together it exhibits sexual dimorphism.

DISCUSSION

The current study was done on multiple parameters to determine the gender of femur. Previous several studies have tried to conclude the gender of femur with reliability. Krogman and Iscan reported the variation in morphological and morphometric characterictic norms to be variable with specific population. This standardization may be applicable to the specific population on which it is based and derived.[9,10] Kate also reported regional variation in the morphometric parameters of femur.[11,12]
Reliability of sexual dimorphism is dependent on the extent of dimorphic character displayed in a specific population. The parameters studied in the present study is applicable to anatomist, orthopedic surgery as well as in medico-legal issues. The femoral length is established to exhibit sexual dimorphism with reliability.[13]
The current study found, the length of femur to be higher in males compared to females, this finding

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was similar to many previous studies in this series.[3,7,10,13,14,15] A population variation was found in Japanese and Thai subjects where the mean value was found to be lower.[16] This difference may be attributed to the short stature due to genetic and epigenetic factors including diet exercise and physical activities etc.[10]

In the present study, mean proximal breadth again was higher in males and females respectively. The difference was highly significant. A similar result was found with south Indian population with lesser statistical significance.[2]

The mean vertical and transverse diameter of head also was found to be higher in males compared to females. This observation was comparable to previous studies on north Indian population but was higher than South Indian population.[2,3,15] The maximum head diameter is a single best variable for determination of sex. The knowledge of population specific morphometric characteristics regarding various dimensions of head amongst gender is of great use in anatomy, orthopedic surgery and in forensic science.[12] The mean epicondylar breadth and the mid shaft diameter was also found to be higher in males compared to females. This was in consonance with the previous studies.[15,16]

CONCLUSION

The accuracy of gender determination increases by incorporating higher number of parameters in the study. The morphometric characteristics observed in this study may be useful in setting the base line data for the population. The sexual dimorphism of femoral bobe was confirmed again in this study.

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