Original Research Article

Morphometric evaluation of human femur

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Abstract

Background: The femoral morphology, throughout ontogeny, seems to be influenced by its functions. The parameters might be useful in providing important data to orthopaedicians, archeologists, forensic legal experts and anatomists. **Aim:** To evaluate the morphological features of femur i.e. length, various angles, circumferences and diameters at specified points and to compare these findings with earlier studies. **Material and Methods:** A total of 353 dried, intact human femora were selected for the study. All the femora were classified into Right side and Left side. The femora were not sexed for measurements in the present study. Nine parameters pertaining to proximal end, shaft, distal end and various angles of the femora were measured. **Results:** On bilateral comparison of the femora, the circumference of the neck, neck- shaft angle and bicondylar angle were found to be significantly different on both the sides. Whereas, the length of femur, circumference of shaft, vertical diameter of the head and neck, transverse diameter of the shaft and the bicondylar width did not show significant difference on comparison of both the sides. **Conclusion:** The measurements and indices obtained from this study will allow safe instrumentation and fixation. In addition, the distances and curvatures determined by this study will help in the proper alignment of bone fragments.
Key Words: Femur, Femoral Length, Neck circumference, Neck-Shaft angle.

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INTRODUCTION

Femur, the longest and the strongest bone of the human body, has evolved to perfectly serve the purpose of walking, while maintaining erect posture of the body. It has acquired an efficiently ergonomic design for weight bearing and locomotion, through the evolutionary process. During evolution the femoral morphology has changed to a great extent as the need for erect posture and bipedalism became a necessity for survival of human race. These changes, especially at the upper and lower end, have made weight bearing and locomotion possible with extreme efficiency.[1,2] All the parameters selected in the present study have a very significant clinical, forensic, and anthropological significance. As is well known, the function of an organ decides its structure; or alternatively the structure sub serves the function. Thus femoral morphology, throughout ontogeny, seems to be influenced by its functions. This is reflected by the changes in the neck-shaft angle and the bicondylar angle in an infant as it starts weight bearing and locomotion.[3] The present study was undertaken to evaluate the morphological features of femur i.e. length, various angles, circumferences and diameters at specified points and to compare these findings with earlier studies. The findings of this study, variations in size, shape and relationships of proximal and distal ends of femur might be useful in providing important data to orthopaedicians, archeologists, forensic legal experts and anatomists.

MATERIAL AND METHODS

The present study involved the preparation of morphometric database of Human Femur in Indian population. A total of 353 dried, intact human femora were selected for the study. All the femora were classified

into Right side and Left side. The femora were not sexed for measurements in the present study. Nine parameters pertaining to proximal end, shaft, distal end and various angles of the femora were measured. The following measurements were recorded.

- The femoral length: With the help of osteometric board
- The femoral anterior neck length: With the help of sliding caliper
- The femoral neck shaft angle: With the help of goniometer.

The findings were tabulated, statistically analyzed and discussed, comparing them with similar studies done earlier. Quantitative femoral morphometric record was prepared that may be of interest to the anatomists, anthropologists, and clinicians.

RESULTS

After completing the measurements of all 353 femora, data was divided into two groups: Right side (n=175) and Left side (n=178). The study was carried out on right and left femora. In total 353 cases are studied and observation on the morphometric data of the various aspects of femur like length, shaft circumference and diameter, neck circumference and diameter, bicondylar width, bicondylar angle, neck-shaft angle etc. were recorded.

Table 1: Descriptive Statistics (Right Side)

Parameters (Rt. side)	N	Minimum	Maximum	Mean	SD
Length	175	32.3	44.63	44.79771	30.6503641
Circumference Neck	175	7.6	11.8	9.507429	.7809526
Circumference Shaft	175	6.8	9.8	8.125143	.5900973
Vertical Diameter Head	175	3.1	4.9	3.988571	.3478765
Vertical Diameter Neck	175	2.1	12.9	2.946286	.8199211
Transverse Diameter Shaft	175	1.3	3.0	2.394857	.2259764
Bicondylar width	175	5.7	8.7	7.303429	.5848565
Neck-shaft Angle	175	114.4	154.7	134.4977	7.7099425
Bicondylar Angle	175	1.4	13.3	6.566857	2.5297628

The mean value of the length of femur on the right side was 44.79±30.65andon the left side was 44.67±30.80. There was no significant difference between mean length of right side and left side. The mean values of circumference of the neck of femur on the right side was 9.50±0.78 and on the left side was 9.33±0.78. There was significant difference between mean circumference of neck of right side and left side. The mean value of circumference of shaft on the right side was 8.12±0.59 and on the left side was 8.06±0.60.There was no significant difference between mean circumference shaft of Right side and left side. In the present study, mean value of the vertical diameter of the head of femur on the right side was 3.98±0.34 and on the left side was 3.92±0.33. There was no significant difference between mean diameter head of Right side and left side. The mean value of the vertical diameter of the neck of femur on the right side was 2.94±0.81 cm and on the left side was 2.83±0.31. There was no significant difference between mean diameter head of Right side and left side. The mean values of transverse diameter of shaft of femur on the right side was 2.39±0.22 and on the left side was 2.42±0.24. There was no significant difference between mean diameter of shaft of right side and left side. Mean values of bicondylar width of femur on the right side was 7.34±0.58 and on the left side was 7.25±0.57. There was no significant difference between bicondylar width of right side and left side. In the present study mean values of neck-shaft angle of femur on the right side was 134.49±7.70 and on the left side was 132.63±8.71. There was significant difference between neck shaft angle of right side and left side. Mean values of bicondylar angle of femur on the right side was 6.56±2.52 and on the left side was 7.70±6.18. There was significant difference between bicondylar angle of right side and left side.

Table 2: Descriptive Statistics (Left Side)

Parameters (Lt. side)	N	Minimum	Maximum	Mean	SD
Length	178	35.5	452.0	44.67303	30.8096187
Circumference Neck	178	7.3	11.9	9.335393	.7839745
Circumference Shaft	178	6.8	9.6	8.064045	.6016451
Vertical Diameter Head	178	3.1	4.9	3.927528	.3340820
Vertical Diameter Neck	178	2.1	3.7	2.836517	.3140103
Transverse Diameter Shaft	178	1.9	3.9	2.428090	.2490610
Bicondylar width	178	5.8	8.6	7.252247	.5746239
Neck-shaft Angle	178	110.3	177.9	132.6365	8.7174844
Bicondylar Angle	178	1.7	82.0	7.700562	6.1852978

DISCUSSION

Femur presents a large number of parameters for morphometric study and has been widely studied for anthropometric, forensic and clinical perusal. A large number of studies have been done using the sexually dimorphic nature of the femur. Similarly, the morphometric variations have been exploited by a large number of researchers to their advantage for discriminating races, populations and also to define evolutional changes. In the present study there was no significant difference between mean length of right side and left side. StreckerW *et al*,[4] in their study found that there is no significant difference in the mean lengths of the femora of both the sides. On comparison of both the studies, there is no significant difference in right side values, (p = 0.52) as well as left side values (p = 0.47).

Table 3: Comparison between mean values of length of femur of present study with different studies

Present Study* (cm)	GargiS *et al*[5] (cm)		Leelavathy N *et al*[6] (cm)		Gupta P *et al*[7] (cm)		Duthie RA *et al*[8] (cm)	
	M	F	M	F	M	F	M	F
44.73	43.95	41.06	44.33	40.42	43.75	39.81	46.49	42.84

*Sex not specified M-Male, F-Female.

In the present study there was significant difference between mean circumference of neck of right side and left side. Valter José da Silva *et al*[8] did not find statistically significant difference in circumference of the femur neck, when the right and left femurs were compared. There was no significant difference between mean circumference shaft of right side and left side.Züylan T *et al*,[10] did not find statistically significant difference circumference of the shaft, when the right and left femora were compared. In the present study, there was no significant difference between mean diameter head of right side and left side.Züylan T *et al*,[10]found that the vertical diameter of the head of the right femur was significantly greater than the corresponding left femur (p<0.05). Chauhan R *et al*[11] noticed that in both sexes the vertical diameter was more on the left side than the right side though the difference was statistically non significant (male p=0.71; female p=0.28). Asala SA *et al*[12] noted that the mean diameter of the head of the Nigerian male femur was significantly greater than that of the female (p <0.001). Asala SA *et al*[12]found that the mean head diameter of the male femur was significantly greater than the mean head diameter of the female femur in both the south African white and black population groups (significant at *P*<0.001). Afroze A *et al*[13]observed that the mean vertical and transverse diameters of the head of the male femur were significantly greater than that of female (p<0.001). Chauhan R *et al*[11] noticed that the vertical diameter of femoral head was greater in males than in females, both on right and left sides, but was statistically insignificant (right p=0.42, left p=0.42). It was also noticed that in both the sexes the vertical diameter was more on the left side than the right side, though the difference was statistically non significant (male p=0.71, female p=0.28). Mishra *et al*[14]found that the mean vertical diameter of head was 4.29 cm. There was no significant difference between mean diameter head of Right side and left side.Mishra *et al*[14]have found femoral neck diameter (superoinferior) to be 3.05cm.Züylan T *et al*,[10] did not notice any statistically significant difference in the two sides. In the present study, there was no significant difference between mean diameter of shaft of right side and mean diameter of shaft of left side. Züylan T *et al*,[10] in their study found that there is no significant difference in the transverse diameters of shaft of the femora of both the sides. There was no significant difference between bicondylar width of right side and left side. Züylan T *et al*,[10]in their study found that there is no significant difference in the biconydlar width of the femora of both the sides. There was significant difference between neck shaft angle of right side and left side. Otsianyi WK *et al*[15] have found no statistical difference between right and left sided femora, as well as between male and female sexes. Liaquat Ali[16] has found higher values in right side as compared to left side. KC Saikia *et al*[17] have found significantly higher values in left side as compared to right side. There was significant difference between bicondylar angle of right side and left side. Pandya AM *et al*[18]found that the bicondylar angle was higher in females on both the sides, and on comparison of the same sides between the sexes, the difference was statistically highly significant on the left side (p<0.001) and significant on the right side (p< 0.05).

CONCLUSION

The fixation of fractured fragments requires an appropriate knowledge of the dimensions of the femur. The measurements and indices obtained from this study will allow safe instrumentation and fixation. In addition, the distances and curvatures determined by this study will help in the proper alignment of bone fragments. The study will also help in formulating parameters for manufacturing implants using data derived from a studied population.

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