



## Morphometric Analysis Of Neck-Shaft Angle And Head Circumference Of Adult Dry Femur Bone In South Indian Population

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

### Abstract

**Introduction:** Femur, the thigh bone, is the strongest and longest bone in the human skeletal system. The head of the femur fits in the acetabulum cavity to allow smooth mobility. It is necessary to perform a morphometric analysis of the femur before constructing the implants and prosthesis for the hip joint in total hip replacement surgeries.

**Aim of the study:** The measure of a neck-shaft angle and the femur head circumference in the South Indian population as a sample.

**Methods:** An observation study was performed on 100 dry femur adult bones of the South Indian population available at the Department of Anatomy, Government medical college & ESI hospital, Coimbatore, Tamilnadu. Fifty bones were from the left limb, and 50 bones were from the right limb. Bones with fracture, deformation, or any pathology were excluded. The angle between the neck and shaft (neck-shaft angle), for both the femur (left and right), was measured with a handheld 360° goniometer, and femur head circumference was measured with a flexible tape.

**Results:** The mean angle of the femur of the right leg was 127.44°, while that of the left femur was 127.10°. The mean head circumference of the right femur and left femur were 133.41 mm and 130.73 mm, respectively.

**Conclusion:** The data obtained with this study can be used in designing and constructing the implants and prostheses for hip surgery. The data may also be a base for future studies related to the morphometric analysis of the femur.

**Keywords:** Femur, Head circumference, Hip joint Implant, Neck shaft angle

### Introduction

The femur is the strongest, heaviest, and longest bone of the human body. The shape of the neck is in the form of a pyramid. The neck attaches to the head at the distal end while it attaches to the shaft at the proximal end. The neck is attached to the shaft by creating an angle. In a normal, healthy adult, the inclination angle is approximately 128°. However, with age, a reduction in inclination angle is reported.[1,2] The femur's primary function is to

provide stability and bear the weight of the body. The capsular ligament helps in holding the femur head in the pelvic acetabulum. It allows the external rotation and limits the internal rotation. [3,4] orthopedic surgeons manage the femoral head fracture and hip joint dislocation quite often during clinical practice. It is, thus, essential to have comprehensive knowledge about various femur measurements.[5] It helps in the accurate construction of the hip prosthesis and orthopedic implants. Suppose the

implants and prosthesis are not properly selected during orthopedic surgery, particularly during hip replacement surgery, In that case, it may result in post-surgical complications and may also affect the movement and stability. Abnormal stress on the patella and tension on the soft tissue may occur if femoral implants are not of accurate size.[6] Irrespective of whether the person is left-handed or right-handed, the lower left limb is used for bearing excess weight.[7] Lifestyle factors, ethnicity, and gender also affect the parameters of the femur bone. Angle formed where the axis of the femoral head and femoral shaft intersect, known as the neck-shaft angle. The other terms for neck-shaft angle are diaphysis-femoral neck angle, collodiaphyseal angle (CDA), angle of femur neck, cervical-diaphyseal angle, and angle of inclination, and collum diaphyseal angle.[8] The neck-shaft angle plays an essential role in providing movement to the hip joint. The neck-shaft angle enables, during mobility, to clear the limbs from the pelvis.[9] The angle with a value greater than 135.00° is known as Coxavalga, while the value of an angle lower than 120.00° is known as Coxavara. The angle is also associated with age. As the age increases, the neck-shaft angle decreases. Infants have a neck-shaft angle of 150.00° that reduced to 140.00° in childhood. It further reduces to 125.00° in adults. In the elderly, the neck-shaft angle reaches about 120.00°.[10]

**Materials and Methods**

The present research is an observational study done on 100 adult dry human femur bones. Fifty femur bones were of the left limb, while 50 bones were of the right limb. The bones were from the Department of Anatomy, Government medical college & ESI hospital, Coimbatore, in South India. The age and gender of the people to which the bones belong were not known. The bones underwent the inclusion and exclusion criteria. The inclusion criteria were the cadaveric dried adult femoral bones of the South India population. We excluded bones with any pathology, deformation, or fracture. We studied the neck-shaft angle and the head circumference in the sample femur bones. The neck-shaft angle is created at the interception of the axis of the femoral head and femoral shaft. We used the handheld 360° goniometer for measuring the angle. We also measured the femoral head circumference of both the right and left femurs. We used flexible tape for measuring the head circumference. The measurement was done by wrapping the tape around the articular surface of the femur at its maximum diameter.

**Results**

The present research measures various parameters on 100 femoral bones (50 left femur bones and 50 right femur bones). The parameters we measured include the neck-shaft angle and the head circumference.

**Table 1: Neck Shaft Angle: Right Femur**

	Minimum	Maximum	Mean	Std. Deviation	Coefficient variation (%)
<b>RIGHTNECK-SHAFT ANGLE</b>	120.00°	132.00°	127.44°	2.72°	2.10%

Table 1 provides information about the measurements of the right neck-shaft angle. The angle has a mean value of 127.44°. The minimum angle of the right femur was 120.00°, while the maximum was 132.00°. The standard deviation was 2.72

**Table 2: Neck Shaft Angle: Left Femur**

	Minimum	Maximum	Mean	Std. Deviation	Coefficient variation (%)
<b>LEFT NECK-SHAFT ANGLE</b>	125.00°	133.00°	127.10°	1.90°	1.50%

Table 2 mentions the measurements of the neck-shaft angle of the left femur. The minimum angle of the left femur was 125.00°, while the maximum angle measured was 133.00°. The mean angle was 127.10° with a standard deviation of 1.90°.

**Table 3: Head Circumference: Right Femur**

	Minimum (in mm)	Maximum (in mm)	Mean (in mm)	Std. Deviation (in mm)	Coefficient variation (%)
<b>RIGHT HEAD CIRCUMFERENCE</b>	120.00	150.00	133.41	8.75	6.60%

Table 3 comprises the measurement of the head circumference of the right femur. As measured through the flexible tape, the minimum right head circumference was found to be 120.00 mm. The maximum value of the right head circumference was 150.00 mm, with a mean of 133.41 mm. The standard deviation calculated was 8.75 mm.

**Table 4: Head Circumference: Left Femur**

	Minimum (in mm)	Maximum (in mm)	Mean (in mm)	Std. Deviation (in mm)	Coefficient variation (%)
<b>LEFT HEAD CIRCUMFERENCE</b>	116.00	152.00	130.73	6.88	5.30%

Table 4 shows the measurement of the head circumference of the left femur. The minimum head circumference was 116.00 mm, while the maximum was 152.00 mm. The mean head circumference measured was 130.73 mm. The standard deviation was 6.88 mm. The results from table 1 and table 2 indicate that the mean angle of the left femur was smaller than that of the right femur. Similarly, on comparing table 3 and table 4, it can be interpreted that the mean head circumference of the left femur was smaller than that of the right femur.

### Discussion

A total of 100 dry femur bones were evaluated. The angle and the femur head circumference were measured for both the left and the right femur. The sample size of our study was similar to Choudhary et al.[11] However, in contrast to our study, the sample of the femur was higher (250) in Khan et al.[13] The fewer number of samples, as compared to our study, was analyzed in Silva et al. [15] and Osorio et al.[16] The angle between the neck and shaft of the right femur has a mean value of 127.44° and a minimum of 120.00° and a maximum of 132.00°. Our results are approximately close to the results obtained in Choudhary et al. that recorded a mean right femur neck-shaft angle of 126.78°.[11] However, our result is in contrast with Gurjar et al., which had reported the angle between the neck and shaft on the higher side (136.00°).[12] Our results are also in contrast with Khan et al., in which the measurement of angle in the right femur was 137.30°.[13] The angle between the neck and shaft of the left femur has a mean value of 127.10°. The minimum and maximum left femur angle was 125.00° and 133.00°,

respectively. Our result is close to the result obtained in Choudhary et al. The mean neck-shaft angle of the left femur was 127.64°. However, our results contrast with Gurjar et al. in which the mean neck-shaft angle of the left femur was 136.6°.[12] Our results are also in contrast with Khan et al., in which the measurement of left femur neck-shaft angle was 136.90°.[13] In this study, the head circumference of the right femur has a mean value of 133.41 mm. The maximum and minimum circumference was 150.00 mm and 120.00 mm, respectively. The results of our study are slightly lower than the results of Rashid et al., which reported the mean right femur head circumference to be 138.6 mm.[14] Our results align with Silva et al., in which the mean right femur head circumference was 133.96.<sup>15</sup> A slightly higher mean right femur head circumference was obtained in Osorio et al. that reported the circumference of 144.90 mm.[16] Our study reported a mean head circumference of the left femur of 130.73 mm with a maximum and minimum circumference of 152.00 mm and 116.00 mm, respectively. Our results are lower than Rashid et al., which reported the mean left

femur head circumference to be 137.1 mm.[14] The result of our study contrasts with Silva et al., which had a mean left femur head circumference of 136.80 mm.[15] In contrast to our study, the values obtained in Osorio et al. for mean left femur head circumference were higher(141.70 mm).

### Conclusion

The study provides the measurement of the neck-shaft angle and head circumference of the femur bone in the population of Southern India. The study concludes that there is a variation in femoral neck-shaft angle and head circumference in adults. Thus, clinicians must accurately measure various femur parameters to construct the most suitable implant and prosthesis during orthopedic surgery. This will improve mobility, reduces post-operative complications, and lowers the chance of revision surgery.

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