Shivashankarappa A
Assistant Professors,
Department of Orthopaedic
surgery, JJM Medical College,
Karnataka, India

Prasad NC
Assistant Professors,
Department of Orthopaedic
surgery, JJM Medical College,
Karnataka, India

Pavan P Havaldar
Associate Professor, Department
of Anatomy, Gadag Institute of
Medical Sciences, Gadag,
Karnataka, India

A study on femur neck shaft angle and its clinical importance

Shivashankarappa A, Prasad NC and Pavan P Havaldar

Abstract
Introduction: Prevalence of hip osteoarthritis, fracture neck femur and other hip joint ailments are increasing day by day. Arthroplasty is the definite treatment for these patients. The femur forms the skeleton of the thigh, carries body weight, supports the movements of leg and provides attachment to the muscles. Morphology of bones is very much affected by race, sex, environmental factors and life style.
Materials and Methods: 457 femurs were used in present study, femur measurements were collected from different colleges in Karnataka. The measurements of Neck shaft angle, Femoral Length and Neck Length of femur were measured and recorded.
Results: The results of present study are the length of femur was 426.6 ± 32.76mm, right femur was 434.3 ± 28.54mm and left femur was 418.7 ± 36.14mm. The neck length femur was 38.8 ± 7.2mm, right femur was 40.6 ± 5.3mm and left femur was 36.3 ± 7.1mm. The neck shaft angle of femur was 138.3 ± 5.67^0, right femur was 136.2 ± 4.54^0 and left femur was 140.1 ± 5.43^0.
Conclusion: The present study observed no significance difference between right and left femur measurements. The present study measurements are may be helpful for orthopaedic surgeons, radiology and anthropological practice.

Keywords: Femur, femoral neck, femoral neck length and femoral neck shaft angle

Introduction
The transition from quadrupedal to bipedal gait was a considerable biomechanical milestone in the evolution of Homo sapiens. The neck of the femur inclines to form an angle with the shaft. This is wide in infancy when the child learns to walk and gradually decreases during growth. The neck-shaft angle also shows gender difference, smaller in females due to wide pelvis. There is a racial difference owing to the morphology of head, neck and shaft of femur. Normal range of neck-shaft angle varies from 120^0-145^0 with an average value of 135^0 [1, 2]. The femur is the largest and strongest bone in the body and the structure of its proximal portion allows the leg to move in three dimensions relative to the torso, thus serving as a linchpin of human mobility. Moreover, age related and pediatric disorders at this skeletal site are common and confer strong risk factors for current and future disability. In Orthopedic practice, operations on femur are the most common. Variations in hip morphology are also of critical interest to surgical planning where the ability to take hip morphology into account on a patient specific basis is crucial for success in choosing designs of implants and other structures used for hip replacements and augmentations of hip stability [3, 4].

Anatomical study of femur bone serves helpful data to understand different aspect of clinical disease conditions, including common site of fracture, changes in osteoporosis, associated congenital anomalies as well as medicolegal cases. The femur is the longest & strongest bone in the body. Its length is associated with a striding gait, its strength with the weight and muscular forces which it must withstand. Its shaft is almost cylindrical. It has a proximal rounded articular head projecting medially from its short neck. he femoral neck length is approximately 5cm long and connects the head to shaft at an average angle of 135°. This angle facilitates movements at the hip joint, enabling the limb to swing clear of the pelvis [5].

Osteoporosis is generally considered to be a condition affecting women, but up to 30% of fragility fractures occur in men. The lifetime risk of fracture at the age of 50 years has been estimated to be 20% for men. Bone mineral density has long been recognised as an important skeleton determinant of fracture risk, but it is becoming apparent that skeletal geometry also

Correspondence
Prasad NC
Assistant Professors,
Department of Orthopaedic
surgery, JJM Medical College,
Karnataka, India

influences the risk. This has been most extensively studied in women at the hip, in terms of hip axis length, femoral neck axis length, neck shaft angle and femoral neck width. The role of all of these factors as independent predictors of hip fracture risk is controversial in both sexes, with studies giving conflicting results. This uncertainty may have arisen partly because of differences in study design, numbers of patients studied, and also because of wide variations in geometric parameters in different countries and races. Given this variation, it may be necessary to generate data specific to the population under consideration [5, 6]. The knowledge of the angle of inclination is a valuable aid in the diagnosis and treatment of the fractures of upper end of femur. The length of the femur and stature are of forensic & anthropological significance. Bony markers such as the head & neck of femur can be used in determining the femoral length when only a fragment of proximal femur is available & the required size of length of the neck can be determined to design prosthesis for restoration of normal neck shaft angle. The present study aim is that to find out femoral length, Neck length and Neck shaft angle.

Materials and Methods
In present study have used 457 femurs (243 right and 214 left) from different colleges in Karnataka. Institutional ethical clearance obtained. The following measurements were measured Neck shaft angle, Femoral Length and Neck Length of femur. Instruments Used for this study are Sliding Calliper, Osteometric Board and measurements measured according to standard anthropometrical method [7, 8].

Results
The results of present study are the length of femur was 426.6±32.76mm, right femur was 434.3±28.54mm and left femur was 418.7±36.14mm. The neck length femur was 38.8±7.2mm, right femur was 40.6±5.3mm and left femur was 36.3±7.1mm. The neck shaft angle of femur was 138.3±5.67^0, right femur was 136.2±4.54^0 and left femur was 140.1±5.43^0 (Table 1, 2, 3).

Table 1: Showing the results of femoral length.

Parameter		Number	Mean±SD(mm)
Femoral Length	Total	457	426.6±32.76
	Right	243	434.3±28.54
	Left	214	418.7±36.14

Table 2: Showing the results of Neck Length.

Parameter		Number	Mean±SD(mm)
Femoral Length	Total	457	38.8±7.2
	Right	243	40.6±5.3
	Left	214	36.3±7.1

Table 3: Showing the results of Neck Shaft angle.

Parameter		Number	Mean±SD
Femoral Length	Total	457	138.3±5.67^0
	Right	243	136.2±4.54^0
	Left	214	140.1±5.43^0

Discussion
The neck of femur lies at an angle with the shaft- the neck-shaft angle. The angle in the new born is nearly equal to the adult. The average being 126.5° and range being 106°-151°. There is a racial and gender difference, smaller in females when compared to males. The difference in mean femoral

length in between populations may possibly be a result of factors affecting bone morphology such as genetic constitution, diet, nutrition status, environment, and physical activity [9].
In present study the length of femur was 426.6±32.76mm, right femur length was 434.3±28.54mm and left femur length was 418.7±36.14mm. Study of Pandya A M et al study [6] results in agreement with our results, this study mean value of maximum length was higher in male as compared to female. In Pandya A M et al study for right male bone calculated range was 379.99-523.63mm and for right female bone it was 358.26-476.70mm, according to Pandya A study right femur with maximum length more than >476.70 mm can be correctly classified as a male and right femur with maximum length less than <379.99 mm can be correctly classified as a female. According to Pandya if the length is between 379.99 mm and 476.70 mm, sexing was not possible [10]. The present study femur length is correlated with study of Rajeshwari S B. According to Rajeshwari S B, the calculated range for right male was 379.88-523.33 mm and that for right female it was 358.16-476.80 mm [11]. In study Shakil et al the length of femur was 446.2±26.39 mm, right femur was 446.6±26.66 mm and left femur was 445.8±26.12 mm [12].
The mean femur neck length of study was 38.8±7.2 mm, the right femur neck length was 40.6±5.3mm and the left femur neck length was 36.3±7.1mm. The study of Ravichandran et al results found, the mean femur neck length was 31.88mm [13]. Our results also in correlation with Siwach RC [14] study in his study the mean femur neck length was 37.2 mm and minimum effective neck length was 22.6 mm. The mean femur neck length of Shakil et al study was 36.3±4.2 mm, the right femur neck length was 36.1±4.1 mm and the left femur neck length was 36.4±4.3 mm [12].
The mean Neck shaft angle of present study 138.3±5.67^0, the right femur neck shaft angle 138.3±5.67^0 and the left was 138.3±5.67^0. Our results are in agreement with Ravichandran et al study, in their study the neck shaft angle was 126.55^0 [13]. Our results also in agreement with study of Subhash Gujar, in their study the average neck shaft angle was 136.2^0 [15]. In Siwach RC study it was 123.5^0 [14]. The mean Neck shaft angle of Shakil et al study 137.1^0, the right femur neck shaft angle 137.3^0 and the left was 136.9^0 [12]. The morphometric measurements of femurs are helpful in practice of orthopaedic surgery practice during treatment in fractures of femur.

References
1. Gray's Anatomy, Susan Standring 40th ed., Churchill Livingstone, 1360-1390.
2. Neelima P, Ravi Sunder R, Himabindu A. Study of Neck-Shaft Angle in Adult Dried Femora Int Jour Heal Scie & Res. 2013; 6(11):100-102.
3. Lang TF. Proximal femoral anthropometry by computer tomography. In: Preedy VR, editor. Handbook of Antrhropometry: Physical Measures of Human Form in Health and Disease. New York: Springer Science, Business Media, LLC. 2012; 1:756.
4. Dhivya S, Nandhini V. A Study of Certain Femoral Metrics in South Indian Population and its Clinical Importance. International Journal of Scientific Study. 2015; 3(7):132-135.
5. Subhash Gujar, Sanjay Vikani, Jigna Parmar, Bondre KV. A correlation between femoral neck shaft angle to femoral neck length. IJBAR. 2013; 04(05).
6. Khan SM, Saheb SH. Study on neck shaft angle and femoral length of South Indian femur. Int J Anat Res.

2014; 2:633-5.

7. Singh IP, Bhasin MK. A manual of Biological Anthropology. 1st edi, Kamla Raj Enterprices. 1970.

8. Singh IP, Ekandem GJ, Ani EO. Identification of sex from the head of the femur- demarking points for Calabar, Cross-River State Nigeria. West Afr J Anat. 1986; 1:16-23.

9. Christ Lavelle. An analysis of human femur-Amer Jour of Anat. 1974; 141(3):415-426.

10. Pandya AM, Singel TC, akbari VJ, Dangar KP, Tank KC, Patel MP. Sexual dimorphism of maximum femoral Length. National journal of medical research. 2011; 1(2).

11. Rajeshwari S Bhosale, Dr. Zambare BR. Sex determination from femur using length of femur in Maharashtra. Journal of Dental and Medical Sciences. 2013; 3(4):01-03.

12. Shakil Mohamad Khan, Shaik Hussain Saheb. Study on Neck Shaft Angle and Femoral Length of South Indian Femurs. Int J Anat Res. 2014; 2(4):633635.

13. Ravichandran D. Proximal femoral geometry in Indians and its clinical applications. J Anat. Sco. India. 2011; 60(1):6-12.

14. Siwach RC, Dahiya S. Anthropometric study of proximal femur geometry and its clinical apllication. Indian journal of Orthopaedics. 2003; 37(4):247-51.

15. Subhash Gujar, Sanjay Vikani, Jigna Parmar, Bondre KV. A correlation between femoral neck shaft angle to femoral neck length. IJBAR. 2013; 04(05).