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# Morphological variation of measurements of proximal end of femur in south Bihar population

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**Abstract**
**Introduction:** At the proximal end of Femur the Neck-shaft angle and different other parameters of neck are clinically important. In this study we evaluated the normal range of length of anterior and posterior aspect of neck, diameter of head and neck of femur and cross sectional area of neck of adult femur and Neck-shaft angle in south Bihar population.
**Methodology:** Dry adult femur available in the Department of Anatomy, J.L.N.M.C. Bhagalpur, Bihar and also getting from the students of J.L.N.M.C.H. Bhagalpur were used as study sample. Vernier caliper and Goniometer were used to measure all the parameters. Results were analysed by using statistical software.
**Results:** In the present study measurements of different parameters at the proximal end of Femur after statistical analysis are:- Neck-shaft angle 125°, Neck length 29.6mm anteriorly & 31.8mm, posteriorly, diameter of neck 23.5 mm, diameter of head 43.5 mm and cross sectional area 435.25 mm.
**Conclusion:** The output of this study might be helpful for dimension and design of implants at proximal end of femur (Hip replacement therapy) of south Bihar population

**Keywords:** femur, goniometer, vernier caliper, bone implant.

## Introduction
Femur is the longest and strongest bone of our body. The proximal end of femur consists of Head, Neck, Greater trochanter, Lesser trochanter and adjacent structures. The neck of femur is approximately 5cm long which connects the head to the shaft usually at an angle of 125°. In human being neck of femur has an important modification. Neck – shaft angle facilitates movements at the hip joint and also acts as a lever for the muscles acting around the hip joint.
The diameter of head & neck, neck-shaft angle, anterior and posterior neck length and cross sectional area of the neck of the femur are clinically important for the diagnosis of pathological condition of the hip joint and also for the management of fractures around proximal end of femur.
Neck of femur is the most common fracture site around proximal end of femur. Femoral neck fractures are mostly intracapsular and they form a major subtype of fracture around proximal end of femur. The management of fracture neck of femur, may be non-operative or internal fixation or prosthetic replacement. Standard implants are mostly used for the treatment of fracture of neck and head of femur, if the size of implants are not appropriate, there may be pain and other complications. To minimize these complications, the knowledge of the normal anatomical measurements of proximal end of femur is required. The normal anatomical values at the proximal end of femur may vary in different age group and racial variations are also observed.
In the present study we evaluated the normal range of anterior and posterior neck length and cross sectional area of neck of adult femur in south Bihar population and it was compared with the other races like Negroes, Caucasian etc. This study might be helpful for orthopedic surgeon for internal fixation and hip replacement therapy.

## Methodology
Vernier calipers and Goniometer were used for the measurements of all the parameters. Results were analyzed by using statistical software. The present study was conducted in the Department of Anatomy, J.L.N.M.C. Bhagalpur, Bihar. Total 200 dry adult femur bone were selected for sample size that was available in the Department of Anatomy and also some of the bones getting from the students of J.L.N.M.C.H. Bhagalpur. Only intact adult femurs after determination of side were taken for the study.

## Exclusion Criteria
Young bones having immature epiphysis and diaphysis are not united, Deformed bone, Bone with marks of fracture, Any bones having marks of decay and Sex determination were excluded from the study. The diameter of head (DOH) was measured at the widest part of head and the diameter of neck (DON) was measured at the narrowest part of the neck by using vernier calipers. Neck – shaft angle was measured by using Goniometer. The anterior and posterior neck length were measured along the long axis of the neck using vernier calipers. The anterior neck length (ANL) was measured from a midpoint on intertrochanteric line to a point on base of the head of femur by using vernier calipers. Similarly the posterior neck length (PNL) was measured on posterior aspect of neck by using vernier calipers.

**Fig 1:** Measurements of anterior shaft Angle by Goniometer

**Fig 2:** Measurements of posterior neck Length by using vernier caliper

**Fig 3:** Measurements of DON By vernier caliper

**Fig 4:** Measurements of DOH by Vernier caliper by Vernier caliper

**Fig 5:** Measurements of neck- shaft angle by Goniometer

(DON - Diameter of Neck of femur, DOH – Diameter of head of femur)

## Results

The average value (mean) of anterior neck length 3.45 cm with 0.05 cm standard error, posterior neck length 3.85 cm with 0.04 cm standard error, diameter of neck 2.35 cm with 0.03 cm standard error and transverse diameter of head 4.40 cm with 0.03 cm standard error. The standard deviation of above mentioned data are 0.52, 0.56, 0.48 and 0.51 respectively. The average value (mean) of neck-shaft angle 124.50° with 0.35 standard error & 5.94 standard deviation (Table 1).

**Table 1:** Average value (Mean) of various parameters of proximal end of Human dry adult Femur.

| Parameters | Mean | Std. Deviation | Std. Error |
|---|---|---|---|
| Anterior neck length (cm) | 3.45 | 0.52 | 0.05 |
| Posterior necK length (cm) | 3.85 | 0.56 | 0.04 |
| Diameter of neck (cm) | 2.35 | 0.48 | 0.03 |
| Transverse dia. of head (cm) | 4.40 | 0.51 | 0.03 |
| Neck-shaft angle (deg) | 124.50 | 5.94 | 0.35 |

## Discussion

As surgery on proximal end of femur is one of commonest site in orthopaedic surgical practice, the proximal end of femur is the subject of much attention for orthopaedic surgeon and the main aim of this operation is to remove pathology and restore normal anatomy as far as possible. Properly selected and implanted total hip components of most designs can be expected to yield satisfactory results in

a high percentage of patients. No implant design of the system is appropriate for every patient, and a general knowledge of the variety of component designs and their strengths and weaknesses is an asset to the surgeon. Selection of implant also depends on dimensions of proximal end of femur along with the patient's needs, level of activity and bone quality.

The size of femoral head, the ratio of head and neck diameter and the shape of the neck of the femoral component have a substantial effect on the range of motion of the hip, the degree of impingement between the neck and rim of the socket and the stability of the articulation. The present study aims to evaluate the normal range of anterior and posterior neck length, diameter of femoral head and neck & the neck-shaft angle of femur in south Bihar population. The mean anterior neck length and posterior neck length in this study are 34.5 mm & 38.5 mm respectively that is very close to that obtained by RC Siwach & S. Dahiya, (average neck length – 37.2 mm), by Ravi G.O. *et al*. the average neck length is 36.3+5.4 mm (table 2). D. Ravichandran *et al*, found in their study that the average length of femoral neck was 31.88 mm that is very much similar to that obtained study by Tapati Roy *et al*. (mean anterior and posterior neck length are 29.5 mm & 31.6 mm respectively). The diameter of neck is 23.5 mm in present stdy which is similar to that Tapati Roy *et al* study (23.6 mm) but is smaller than previous studies of india and outside India.

**Table 2:** Comparison of present study with other studies in India

| Different studies of India | Neck length (average) mm | Neck width (average) mm | Diameter of head (mm) | Neck-shaft angle (degree) |
|---|---|---|---|---|
| RC Siwach,SDahiya | 37.2 | 24.9 | 43.45 | 114-136(average 123.5) |
| Ravi G.O. *et al* | 36.3+5.4 | - | - | 136.8(average) |
| Ravichandran *et al* | 31.88 | 30.99 | - | 125-155(average126.55) |
| Tapati Roy *et al* | Anterior-29.5 Posterior-31.6 | 23.6 | 43.1 | 110-140 (average 126) |
| Present study | Anterior-34.5 Posterior-38.5 | 23.5 | 44.0 | 108-140( average 124.5) |

The mobility of hip joints is also facilitated by the angle which allows the obliquity of the femur and which helps the knees to be adjacent and inferior to trunk as stated by Ravi G.O. *et al*. The neck-shaft angle generally ranges from 115° to 140° in adult. The diagnosis, treatment and follow-up of fractures of neck of femur, trochanteric fracture, slipped upper femoral epiphysis & developmental dysplasia are the clinical importance of neck-shaft angle of femur. According to K.L.Moore neck-shaft angle varies with with age, sex and development of femur. When this angle of inclination increased it is called coxavalga and when this angle decreased it is called coxavara. Chris Bailey reported that, a varus angulation greater than 5° relative to the anatomic neck-shaft angle have been associated with an increased risk of implant failure. Lower neck-shaft angle is a risk factor for greater trochanter pain in women as evaluated by A. M. Fearon *et al*. In the present study the average neck- shaft angle is 124.5° (ranges from 108 to 140°). Other studies on neck shaft angle reported by R.C. Siwach, D. Ravichandran, Saikia K.C.,Tapatiroy *et al* showed values of 123.5°, 126.55°, 139.5°, 126° respectively.

The transcervical region of neck is the narrowest portion of femoral neck and is of particular importance while fixing the fracture neck of femur with screw as large diameter screw can decancellate the neck and cause avascular necrosis of head resulting in non-union of fracture neck of femur as observed by Mishra A.K.*et al*. The availability of morphological data of proximal end of femur allows, assessment match between the shape of existing components and the proximal end of femuras stated by Reddy *et al*.

## Conclusion

The present study was concluded to evaluate the dimensions of proximal end of femur in south Bihar population. Uses of this data for the selection of appropriate prosthesis as well as pre-operative planning of hip replacement surgeries.This knowledge will help in designing patient specific implants thereby minimizing the complications as maximum functional end result only will be achieved,when the specific type of implants required are used.

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