ORIGINAL ARTICLE

REGIONAL VARIATION OF MORPHOMETRIC MEASUREMENTS OF PROXIMAL END OF FEMUR IN COASTAL ANDHRA PRADESH AND ITS CLINICAL IMPLICATION TO IMPROVE SURGICAL OUTCOME

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ABSTRACT

Introduction: The neck of femur is an important modification in human being. The neck-shaft angle and different parameters of neck are clinically important to diagnose pathological conditions of the hip joint and also helpful in the treatment and follow-up of fractures around proximal end of femur. The present study is an attempt to evaluate the normal range of anterior and posterior neck length, diameter of head and neck of femur and cross sectional area of neck of adult femora and neck-shaft angle in South Indian Population.

Methodology: Adult femora available in the anatomy department of different Medical Colleges in coastal Andhra Pradesh were used as study sample to get exact idea of femoral morphometry. Goniometer and Vernier calliper were used to measure all the parameters. Values were analyzed by using statistical software (SPSS programmed, version-17)

Results: Analyzed value of present study regarding neck-shaft angle, neck length, diameter of neck, diameter of head and cross sectional area are 126⁰, 29.5mm & 31.6mm, 23.6mm, 43.1 mm and 437.21mm² respectively.

Conclusion: The results of present study might be helpful for bio mechanical engineer to design implant specific for South Indian population.

Keywords: Morphometric Measurement, Cross Sectional Area, Hip Replacement Therapy, Prosthesis

INTRODUCTION

The Femur or thighbone is the longest and strongest bone of human body. The proximal end of femur comprises of the head, neck, two trochanters and adjacent structures. The neck of femur is an important modification in human being. The femoral neck is approximately 5cm long and connects the head to the shaft at an average angle of 125 degree.[1] Not only the neck-shaft angle facilitates movement at the hip joint but the femoral neck also provides a lever for the muscles acting around the hip joint. The neck-shaft angle, diameter of head and neck, anterior and posterior neck length and cross sectional area of the neck of the femur are clinically important parameters to diagnose pathological conditions of the hip joint and also helpful in the treatment and follow-up of fractures around proximal end of femur. The neck is the weakest part of the femur and the fractures are mostly intra-capsular[2] in type and they form a major subtype of fractures around the proximal end of femur. The treatment may be non-operative management or internal fixation or prosthetic replacement. Standard implants are mostly used to treat fractures of neck and head of femur. If the sizes of implants are not appropriate there may be pain and other complications.[3] To minimize these complications the knowledge of the normal anatomical values of proximal end of femur is required. These normal values may vary in different age group. More over racial variations are also observed. The present study is an attempt to evaluate the normal range of anterior and posterior neck length and cross sectional area of neck of adult femora in South Indian Population and to compare it with the other races like Caucasian, Negroes etc as stated in different literatures that might be helpful for orthopedic surgeon in case of internal fixation and hip replacement therapy.

METHODOLOGY

Goniometer and Vernier calipers were used to measure all the parameters. Values were analyzed by using

statistical software (SPSS programmed, version-17). The present study was done on adult femora available in the Anatomy department of different medical colleges in coastal Andhra Pradesh for a time period of one year (2012-2013). It was a descriptive, cross sectional type of study. Written permission from the competent authorities was obtained for inclusion of femora from different institutions. All together 220 adult femora were final sample size for the study. Only intact adult femora were taken after the determination of side. **Exclusion criteria:-**Young bones where epiphysis and diaphysis are not united**,** deformed bone or femur with marks of old fracture**,** any bones having marks of decay were excluded from this study**,** sex determination were excluded from the study. The anterior and posterior neck length were measured along long axis of the neck both anteriorly and posteriorly using Vernier calipers. For anterior neck length (ANL), a mid- point was determined on inter-trochanteric line and point on base of head of femur and then distance between two points were measured by using Vernier calipers [Fig.1]. Similarly posterior neck length (PNL) was measured on posterior aspect of neck. Diameter of neck (DON) was measured using Vernier calipers at the narrowest part of the neck [Fig. 2].The diameter of head (DOH) was measured using Vernier calipers at the widest part of head [Fig. 3]. Neck shaft angle was measured by using goniometer [fig. 4].

RESULTS

It is seen from analysis of tabular values that computation of 220 ungrouped data irrespective of side gives average value (mean) of neck-shaft angle as 126.65^{0}. Corresponding standard deviation and standard error are 5.92and 0.40 respectively. The average value (mean) with standard error of anterior neck length, posterior neck length, diameter of neck and transverse diameter of head are 2.95+/-0.04 cm, 3.16+/-0.04 cm, 2.36+/-0.03 cm and 4+/-0.03 cm respectively. Standard deviation for above mentioned cases is 0.53, 0.58, 0.47 and 0.52 respectively (Table 1).

Figure 1: Picture showing how to measure Anterior Neck Length (ANL)

Figure 3: Method of measurement of diameter of head

Figure 2: Measurement of diameter of neck by using Vernier caliper
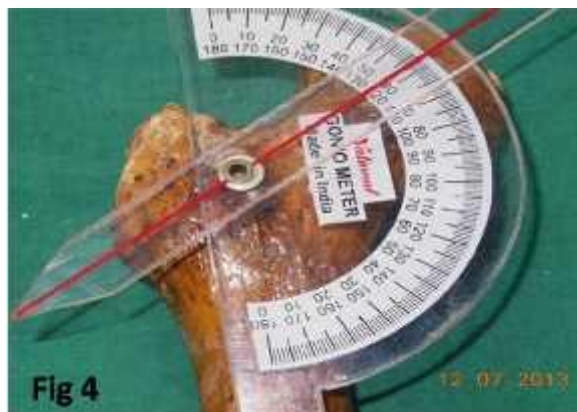

Figure 4: Picture showing the measurement of neck-shaft angle by Goniometer

Table 1: Measurements of Various Parameters of Dry Adult Femora (n-220)

Parameters	Mean	Std. Deviation	Std. Error of mean
Neck–shaft angle (deg)	126.65	5.92	0.40
Anterior neck length(Cm)	2.95	0.53	0.04
Posterior neck length(Cm)	3.16	0.58	0.04
Diameter of neck(Cm)	2.36	0.47	0.03
Transverse diameter of head(Cm)	4	0.52	0.03

DISCUSSION

The proximal end of femur has been the subject of much attention for orthopaedic surgeons as operation on proximal end of femur is one of commonest site in orthopaedic surgical practice and main aim of this operation is to remove pathology and restore normal anatomy as far as possible.[4] 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 patients, and a general knowledge of the variety of component designs and their strengths and weaknesses is an asset to the surgeon. Selection of implants is not only based on the patient's needs, and level of activity along with the bone quality but, also depends on dimensions of the proximal end of the femur and the experience of the surgeons. The size of the 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.[5] The present study aims at evaluation of the normal range of anterior and posterior neck length, the diameter of head and femur neck and the neck shaft angle of adult femora in South Indian population. The mean ANL & PNL in present study are 29.5 mm & 31.6 mm re-

spectively (table 2) that is similar to that obtained by D. Ravichandran et al[6] (average necklength – 31.88mm),Siwach[3] (average neck length is 37.2 mm). Ravi GO et al[7] found in their study that the average neck length of femur was 36.3+5.4mm. No significant difference observed among these parameters. The diameter of neck is 23.6mm in present study which is smaller than previous studies of India and outside India (table 3). Thus it is clear that the proximal femoral geometry varies among different ethnic groups.

Moreover it is observed from present study that the diameter of neck and cross sectional area of neck are lesser in South Indian population (table 3). Mishra A.K.et al[8] stresses that implant designs should be specific for Indian bones.The mobility of hip joints is also facilitated by the angle which allows the obliquity of the femur within the thigh and which helps the knees to be adjacent and inferior to trunk as stated by Ravi G O et al[7] . The neck shaft angle generally ranges from 115^0 to 140^0 in adults .The clinical importance of neck-shaft angle of femur lies in the diagnosis, treatment and follow-up of fractures of neck of femur, trochanteric fracture, slipped upper femoral epiphysis, developmental dysplasia, and any neuromuscular disorder involving of the lower extremities. According to K. L. Moore[9] neck shaft angle varies with age, sex and development of femur.

Table 2: Comparison of Present Studies with Other Studies in India

Different studies of India	Neck-shaft angle(degree)	Neck length (average) (mm)	Neck width (average) (mm)	DOH (mm)
Ravichandran et al	125-155 (commonly126.55)	31.88	30.99	-
RC Siwach,S Dahiya	114-136 (average123.5)	37.2	24.9	43.45
Ravi G.O. et al	136.8(average)	36.3+5.4	-	-
Present study	110-140 (average 126^0)	Anterior -29.5 Posterior-31.6	23.6	43.1

Table 3: Cross sectional area of femoral neck

Different study	Average neck diameter(mm)	Cross sectional area of neck(mm²)
Caucasian	31.5	778.92
Asian(Hongkong Chinese)	29	660.12
Previous study of India	28.39	633
Present study	23.6	437.21

N.B: Cross sectional area = $\pi(d^2/4)$ where d = diameter femoral neck

When this angle of inclination increased it is called coxavalga and when this angle decreased it is called coxavara. A varus angulation greater than 5° relative to the anatomic neck-shaft angle have been associated with an increased risk of implant failure as was reported by Chris Bailey[10].A.M. Fearon et al[11]evaluated by a prospective study that lower neck-shaft angle is a risk factor for greater trochanter pain syndrome in women.In present study the observed value of neck –shaft angle is 126^0. Other studies on neck-shaft angle reported by R.C.Siwach[3], D. Ravichandran[6], Saikia K.C.[12] showed values of 123.5^0, 126.55^0, 139.5^0 respectively. The proximal femur acts as a brace, and its biomechanical properties depend on the width and length of the femoral neck. It also helps the limbs to swing clear of pelvis. The trans cervical region of neck is the narrowest portion of femoral neck and is of particular importance while fixing the fracture neck femur with screw as large diameter screw can decancellate the neck to ensue tamponade effect and cause avascular necrosis of head resulting in non union of fracture neck femur as observed by Mishra A.K.et al [8]who stresses that implant designs should be specific for Indian bones The availability of morphometric data describing the proximal femur allows guidelines to be developed for the functional dimension of femoral component as these anatomic data also allow assessment of the match between the shape of existing components and the proximal femur as stated by Reddy et al.[13]

CONCLUSION

The present study was conducted to see the morphometric dimensions of the proximal end of femur in South Indian population in order to utilize thisknowledge for the selection of appropriate prosthesis as well as for the pre-operative planning of hip replacement surgeries. Implants that are designed by taking in to account anthropometric and bio mechanic data will help in designing patient-specific implants thereby minimizing the complications. However maximum functional end result will be achieved only when the specific type of implants required are used.

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