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Original Article

Study of Proximal femoral Anthropometry in Population of Eastern Madhya Pradesh

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Abstract
Introduction: *The femur is the longest and strongest bone in the human body. It has a proximal rounded, articular head projecting medially from its short neck, which, in turn, is a medial extension of the proximal shaft.*
Material & Method: *One hundred twenty (120) dry femurs human Indian cadavers without any pathology obtained from the Department of Anatomy were utilised for this study. Femoral head diameter (FHD), Horizontal offset (HO), Neck shaft angle (NSA) and Femoral Neck Thickness (FNT) were measured.*
Results: *There was a significant difference between right and left side of femoral head diameter, femoral neck thickness, neck shaft angle and horizontal offset. The average femoral head diameter for the entire sample was 45 mm, average femoral neck thickness was 27.7 mm, average neck shaft angle was 128^0 and average horizontal offset was 39.8 mm.*
Conclusion: *The results of this study indicate that marked differences do exist in the dimensions between the femur of the Indian population and that of the populations of other regions of the world. For Indian population best fit prosthesis can be made with the help of the published data of proximal femur.*
Keywords: *Femoral head diameter (FHD), Horizontal offset (HO), Neck shaft angle (NSA) and Femoral Neck Thickness (FNT) were measured.*

Introduction

The femur is the longest and strongest bone in the human body[1,2,3]. The femur forms the skeleton of the thigh, carries body weight, supports the movements of leg and provides attachment to the muscles[4].

It has a proximal rounded, articular head projecting medially from its short neck, which, in turn, is a medial extension of the proximal shaft[1,2,3]. The neck of the femur in humans is an important functional modification after man attained erect bipedal posture[5]. The femoral neck is approximately 5 cm long, narrowest in its mid part and widest laterally, and connects the head to the shaft at an average angle of 135° (125^0 by Snells clinical anatomy[2]) (angle of inclination; neck–shaft angle): this facilitates movement at the hip joint, enabling the limb to swing clear of the pelvis. The neck also provides a lever for the action of the muscles acting about the hip joint, which are attached to the proximal femur. The neck–shaft angle is widest at birth and diminishes gradually until adolescence; it is smaller in females[1].

The study of morphological features of the proximal femur like Femoral head diameter (FHD), Horizontal offset (HO) and Neck shaft angle (NSA) are very essential component in preoperative planning prior to total hip arthroplasty because it is vital to match the dimension of the implant with those of the femur[6]. These implants are designed primarily for use in Western population, whose constitutional and biomechanical factors vary from those of Indian population[5]. Otherwise, inappropriate sized or incorrectly placed prosthesis might cause aseptic loosening and improper load distribution causing huge discomfort to the patient thus ultimately affecting long term success of the operation[6].

Material & Method

One hundred twenty (120) dry femurs human Indian cadavers without any pathology obtained from the Department of Anatomy of Shyam Shah Medical College, Rewa, (M.P.) were utilised for this study. We excluded the bones with visible osseous pathologies like tumours, deformities, fractures, and trauma. These are the ailments which could affect the result of the study[4].Out of 120 dry bones, 60 were of right side and 60 were of left side. Sex and age of the bones were not determined. Determination of the geometrical measurement of proximal end of femur was the main target[6].

The neck shaft angle (NSA) was measured by Goniometer (Fig 2) for which the axis of the neck was determined by a line dividing the anterior surface of the neck into two equal halves and the axis of the shaft was determined by the line dividing the anterior surface of the shaft in two equal halves[5].

Femoral head diameter (FHD) was measured by vernier calliper (Fig 2), and it was taken as mean of vertical diameter (distance between two extreme points along craniocaudal plane) and transverse diameter (distance between two extreme points along transverse plane).

Horizontal offset (HO) was measured by vernier calliper (Fig 3), and it was the horizontal distance among the centre of femoral head to the axis of femoral shaft[6].

Femur neck thickness (FNT) was thickness of neck of femur in antero posterior axis and was measured by vernier calliper[4] (Fig 4).

Results

The following parameters of the femur were measured for understanding the anthropometry and eventually designing a best-fit standard femoral stem for cement less insertion,

- Neck shaft angle (NSA)
- Femoral head diameter (FHD)
- Femoral neck thickness (FNT)
- Horizontal offset (HO)

There was a significant difference between right and left side of femoral head diameter, femoral neck thickness, neck shaft angle and horizontal offset. The average femoral head diameter for the entire sample was 45 mm, average femoral neck thickness was 27.7 mm, average neck shaft angle was 128^0 and average horizontal offset was 39.8 mm.

Table: 1 Summary of measured parameters of both sides

Parameters	Side	Average	Range
Neck shaft angle (NSA)	Right	127^0	$120^0 – 135^0$
	Left	129^0	$118^0 – 138^0$
Femoral head diameter (mm) (FHD)	Right	44	38 – 50
	Left	46	37 – 52
Femoral neck thickness(mm) (FNT)	Right	28	23 – 33
	Left	26	23 – 31
Horizontal offset (mm) (HO)	Right	39	33 – 45
	Left	41	34 – 50

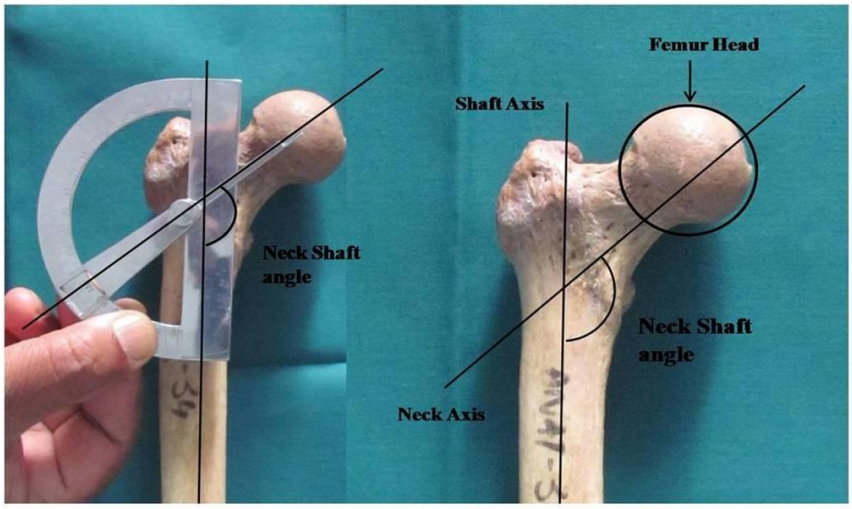

Fig: 1 Neck Shaft Angle (NSA) measured by Goniometer.

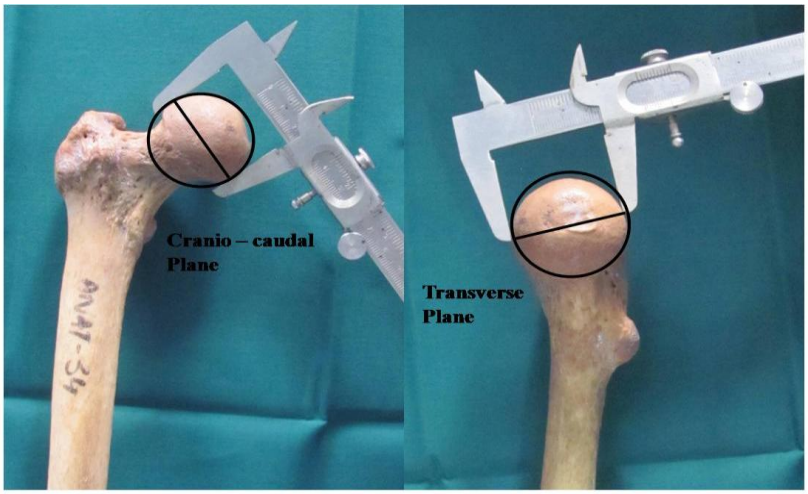

Fig: 2 Femoral head diameter (FHD) measured by vernier calliper

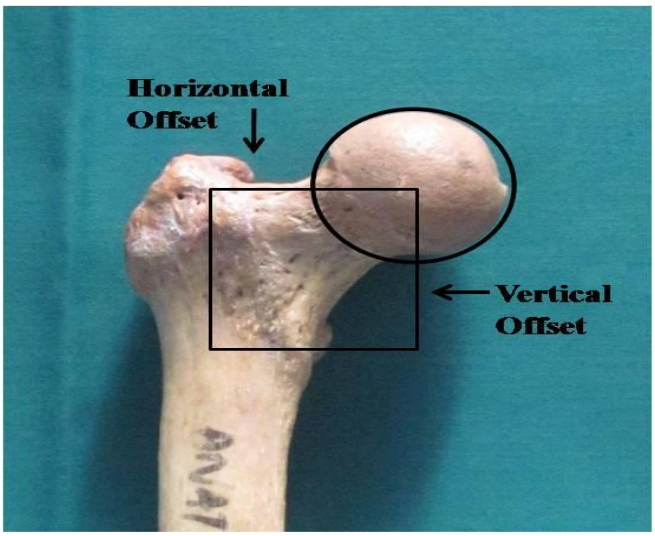

Fig: 3Horizontal offset (HO) measured by vernier calliper

Fig: 4 Femoral Neck thickness measured Antero – posteriorly by Vernier caliper

Discussion

The present study was undertaken to compare the differences in dimensions between femurs of Eastern Madhya Pradesh population and those of population from other regions in order to solve the problem of a possible geometric mismatch between a selected implant and the dimensions of the hip joint of the study population concerned[6].

The proximal femoral parameters are very important structural and functional specialization for mans erect posture[5].

The average neck shaft angle (NSA) in adults as 135^0 (grays anatomy 40 ed), Ravichandran et al. 2011 worked on 578 dry femora and found the average angle to be 126.55^0 (range 112 - 146^0)[5]. Sancheeta roy et al. 2014 had reported the average neck shaft angle in the West Bengal population as 131^0 and 130.37^0 in males and females respectively[6]. Pathrot et al. 2016[7], in their study on proximal femoral geometry for cephalomedullary nail placement have reported the values of neck shaft angle were between 121^0 and 140^0. Boese et al. 2016[8] studied the geometry of proximal femur in the German population by using CT scan and found mean NSA as 147^0. Jiang et al. 2015[9] in his retrospective analysis of neck shaft angle in Chinese healthy adults found to be 133.02^0. I Gilligen et al. 2013[10], in their study assemble a global NSA database comprising over 8000 femora representing 100 human groups. Results from the analyses show an average NSA for modern humans of 127^0 (range 105 - 148^0). The average angle in the present study is found to be 128^0 (range 118 - 138^0). Our results are similar to that of Ravichandran et al 2011, Sancheeta roy et al 2014 and I Gilligen et al. 2013 but differs from that of Boese et al. 2016 and Jiang et al. 2015.

Femoral head diameter (FHD) is another important parameter which is to be considered during prosthesis manufacture. In the present study mean head diameter is 45 mm which is more when compared with the observations of Verma M et al. 2017[4] who had observed it as 42.32 mm, Sancheeta roy et al. 2014[6] had reported the mean head diameter as 4.6 cm and 4.45 cm in male and females respectively. Rawal et al 2012[11], found the mean head diameter as 45.41mm. Sindhoorani et al. 2016[12], in their study on south Indian population have reported the mean head diameter as 41.77 mm. Our results are similar to that of Sancheeta roy et al. 2014 and Rawal et al 2012 but differs from that of Verma M et al. 2017 and Sindhoorani et al. 2016.

The average neck width in the present study is 27.7 mm and that of Verma M et al 2017[4] were 24.01 mm. Ravichandran et al 2011[5] had observed it as 3.097cms, Pathrot et al 2016[7] reported neck width of 27.5 mm in 25.6% of their cases.

Femoral horizontal offset restoration is also essential to improve function and longevity of hip arthroplasty (Sancheeta roy et al. 2014). In our study average horizontal offset was 39.8 mm. Sancheeta roy et al. 2014 showed that the average horizontal offset was around 3.85 cm and 3.57 cm in male and female respectively in west Bengal region. Verma M et al. 2017 [4] who worked on proximal femoral morphometry in Delhi region was recorded as 42.92 mm. Sindhoorani et al. 2016[12], reported the mean valve of horizontal femoral head offset as 40.75 mm in South Indian population. Our results are similar to that of Sancheeta roy et al. 2014 and Sindhoorani et al. 2016 but differs from that of Verma M et al. 2017.

There are regional differences in the stature of human beings so prosthesis should be designed according to specific population[4]. It is vital to match the dimensions of the implant closely with those of the femur, as some of the complications resulting from mismatch could be aseptic loosening, improper load distribution and discomfort[11].

Conclusion

The results of this study indicate that marked differences do exist in the dimensions between the femur of the Indian population and that of the populations of other regions of the world[11]. For Indian population best fit prosthesis can be made

with the help of the published data of proximal femur. These prostheses can also be used by other Asian countries as morphologically they are similar to Indian population[4]. The results of the present study could be used as a guide for future designs of the femoral prosthesis in Central Indian population.

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