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Original Research Article

A Cross Sectional Study on Morphometry of Proximal End of Femur on Dry Bones and Its Clinical Significance

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Abstract:
Hip joints have significant role in human locomotion. Measurement of different parameters of proximal ends of femur help the clinicians for treatment of proximal femur fractures and also helpful for biomechanical engineers to formation of prosthetic limb. To measure different parameters. 1.) Head Transverse Diameter, 2.) Neck Transverse Diameter, 3.) Femoral Neck Length, 4.) Head Vertical Diameter, 5.) Neck Vertical Diameter. Knowledge of the which may help the orthopedic surgeons to insert intramedullary nails, plates, screws, pins etc. more accurately to avoid neurovascular complications. A total of 83 dried non pathological femur bones of both right & left side collected from department of Anatomy of KPC Medical College and Hospital. Different parameters are measured by a digital vernier caliper. The variables Head Transverse Diameter, Neck Transverse Diameter, Femoral Neck Length, Head Vertical Diameter, and Neck Vertical Diameter are measured. Standard deviation and mean values are calculated accordingly of both sides of femur.

Keywords: Femur, Head Vertical Diameter, Neck Vertical Diameter, Head Transverse Diameter, Neck Transverse Diameter, Femoral Neck Length.

Introduction

The femur is the largest and strongest bone in the body and the structure of its proximal part allows the leg to move in three dimensions relative to the torso, thus serving as a linchpin of human mobility.[1] Intertrochanteric fractures with severe displacement and comminution are common in elderly patients .These patients have a poor bone quality and the fractures are often associated with complications such as nonunion, metal failure and femoral head perforation. [2,3]

Femoral neck fractures involve the narrow neck between the rounded head of the femur and the shaft. [4] To allow an earlier post-operative weight bearing and a rapid rehabilitation and to avoid excessive collapse at the fracture site, some surgeons have recommended prosthetic replacements for the treatment of unstable intertrochanteric fractures. [5,6,7] For position, structure and function the femur is subjected to various traumatic, inflammatory, degenerative and neoplastic process. For proper management and reconstruction surgery for joints and fractures, knowledge of anatomy regarding surface contours, curvatures, dimensions of the femur is essential for understanding the disease process. Proximal femur morphology is a necessary parameter for designing and implant development in the total hip replacement. Use of inappropriately designed implants and their size affects the outcome of the surgery with some complications such as micro motion, loosening and stress shielding .Implants which are designed based on morphology of their population. Previous research revealed that there are differences in anatomical profiles between Asian and Caucasian hip, and suggested smaller size component would be more appropriate for Asian population. [8] The hip joint is the articulation of the femoral head with the acetabulam. The junction location makes the femoral neck prone to fracture. Femoral neck fractures are a specific type of intracapsular hip fracture. The femoral neck connects the femoral shaft with the femoral head. Intertrochanteric fracture is the extracapsular fractures of the proximal femur that occur between the greater and lesser trochanter. The study will enlighten the implant designers to take a step on altering the designs of the implants that suits to our Asian need.

Materials and Methods:-

Type of Study: It is an observational descriptive study with cross sectional data collection.

Source of Data:

Dry non pathological femur bones collected from department of Anatomy of KPC Medical College and Hospital, Jadavpur

Sample Size: 83

Sample Size Calculation: The sample size was calculated based on

Sample Size Calculation

CONSIDERING 95% LEVEL OF CONFIDENCE, THE ABSOLUTE ERROR (d) = ± 1.5 and STANDARD DEVIATION (σ) = 6.7 (FNL)

[REF: DURGA P ET AL IN J ANAT RES 2019, VOL 7(1.1): 6045-49, ISSN 2321-4287]

$$n = \frac{(z\,\alpha/2)^2 \,.\, \sigma^2}{d^2}$$

$$= \frac{(1.96)^2 \times (6.7)^2}{(1.5)^2}$$

$$= \frac{3.8416 \times 44.89}{2.25}$$

$$= 76.64$$

$$\simeq 80$$

Where,

Standard deviation (σ) = 6.7

Absolute Error (d) = ±1.5

Z $\alpha/2$ = 1.96

α = 0.15

The minimum sample size obtained was 80 therefore a simple size of 83 was chosen.

Ethical clearance certificate number: KPCMCH/ IEC/2024/207, dated 31.05.2024

Inclusion Criteria: A total of eighty three dried, Intact, Non Pathological Fully ossified adult femurs.

Exclusion Criteria: Femur with any fracture, unossified or Pathological abnormalities like tumours, deformities will be excluded from this study.

Study Variables and Parameters:

- To measure: HVD (Head Vertical Diameter)
- NVD (Neck Vertical Diameter)
- FNL (Femoral Neck Length)
- HTD (Head Transverse Diameter)
- NTD (Neck Transverse Diameter) of proximal end of femur.

Study Tools (Materials):

- Dried, intact, nonpathological fully ossified adult femurs.
- Digital Vernier Caliper
- Measuring Tape
- Coloured Thread

Procedure (Methods):

- Direct measurement on dry femurs was carried out with digital vernier calipers
- The femurs were placed on a smooth horizontal surface (A glass sheet on table)
- Two smooth blocks (1cm in thickness) were then placed one beneath the femoral condyles and other beneath the posterior aspect of the greater trochanter. –
- The parameters were measured by vernier caliper by direct measuring method.

Figure 1: Measurement of different parameters (NTD, HTD, HVD, and NVD) of femur

Result

The results were tabulated and analysed. The mean and standard deviation was calculated. Unpaired student's t-test was used to compare the means .And p-value >0.05 was considered which was statistically insignificant. The mean Head Transverse Diameter on the left side was 36.7±6.36mm, and on the right side, it was 37.82±4.95. [Table 1]

Table 1: Transverse diameter of Head on left and right side

Head Transverse Diameter (HTD) (mm)	**Left-Side**	**Right-Side**	**t-value**	**p-value**
	Mean± SD	Mean± SD		
	36.7±6.36	37.82±4.95	0.8965	p≥0.05

The mean Neck Transverse Diameter on the left side was 21.54±5.73 and on the right side it was 22.6±4.46 [Table 2]

Table 2: Transverse diameter of Neck on left and right side

Neck Transverse Diameter (NTD) (mm)	**Left-Side**	**Right-Side**	t-value	p-value
	Mean± SD	Mean± SD		
	21.54±5.73	22.6±4.46	0.9365	p≥0.05

The mean Femoral Neck Length on the left side was 44.2±7.16 and on the right side it was 43.82±5.336 [Table 3]

Table 3: Femoral neck length on right and left side

Femoral Neck Length (FNL) (mm)	**Left-Side**	**Right-Side**	t-value	p-value
	Mean± SD	Mean± SD		
	44.2±7.16	43.82±5.336	1.384	p≥0.05

The mean Head vertical diameter on the left side was 35.38±6.58 and on the right side it was 36.86±4.93 [Table 4]

Table 4: Head vertical diameter on right and left side

Head Vertical Diameter (HVD) (mm)	**Left-Side**	**Right-Side**	**t-value**	**p-value**
	Mean± SD	Mean± SD		
	35.38±6.58	36.86±4.93	1.1615	p≥0.05

The mean Neck vertical diameter on the left side was 28.7±4.7 and on the right side it was 26.61±6.46 [Table 5]

Table 5: Head vertical diameter on right and left side

Neck Vertical Diameter (NVD) (mm)	**Left-Side**	**Right-Side**	**t-value**	**p-value**
	Mean± SD	Mean± SD		
	28.7±4.7	26.61±6.46	1.16887	p≥0.05

Discussion

In past few decades researchers have used various methods to measure different dimensions of proximal end (Example: HVD, NVD, FNL, HTD, NTD) of femur. In the present study ,titled "A cross sectional study on morphometry of proximal end of femur on dry bones and its clinical significance," looked about to establish preliminary data on several measurements of the proximal end of femur and resolute whether there are any significant differences between right and left sided femur bones. Dwivedi et al [9] found that the mean vertical diameter of the right femur was 40.53±3.54 mm and of the left femur was 40.49±3.49 mm. Silva et al (2003) [10], in their study concluded that the average vertical diameter of the head of the right femur was 41.63 ± 3.20 mm and of the left femur was 42.96±3.59 mm. Kamdi et al [11] recorded a higher vertical diameter, while Sreekumar [12] recorded a lower vertical diameter than our study. Purkait [13] identified that the vertical head diameter of the right femur was significantly more significant than that of the left.

The present study shows that the mean transverse diameter of head of right sided femur bone was 37.82±4.95 mm and left side was 36.7±6.36 respectively and was found to be statistically non-significant. Dwivedi et al [9] that the mean transverse diameter of the right femur 40.59±3.45 mm and of the left femur was 40.30±3.48 mm. Rashid et al [14] who worked on the morphometry of the femur in the South Indian population and found the right femurs and left femurs transverse diameter were 42.65±3.25 mm and 42.36±3.69 mm respectively. Khalil et al [15] studied the proximal extremity of the femur and identified that the average transverse diameter of the head of the right femur was 37.86±3.06 mm and of the left femur it was 37.74±3 .05mm, there values are almost at par with comparison to present study. Deswal et al [16] recorded values higher than our study. Ziylan et al [17] found the average transverse diameter of head was 44.74±1 mm of the right femur and 44.33±3 mm of the left femur in the Anatolian population. These findings have much difference with the findings of present study. Which may have been caused by variation in population under study. [18]

In present study the mean values of the circumference of HVD is 35.38±6.58 mm on left and 36.86±4.926 mm on right femoras respectively, and was found to be statistically non-significant. While Sampada V Late [18] found that the mean values of HVD was 41.46±2.77mm on left and 40.89±2.04 mm and on right femoras respectively and their values are slightly higher in comparison with our study and the difference of right and left sided femoras was identified statistically non-significant. Osorio et al [19] ,in their study , on circumference of femoral head ,found values of 14.49±0.94 cm on right and 14.17 ±1.56 cm on left side. While Dwivedi et al [9] discovered the circumference of head 126.5mm and 126.8mm of right and left femur respectively. In Sampada V Late et al 18 showed that the mean vertical diameter of the right femurs neck was 28.45±4.22mm, and of the left femur, it was 27.43±2.20mm and their difference was found to be statistically significant. While in present study NTD of right side 22.594±4.46 mm and 21.54±5.73mm respectively and their values are found to be statistically insignificant.

This finding demonstrates that the mean vertical diameter of the right femur's neck was 28.45±4.22 mm, and of the left femur, it was 27.43±2.20 mm, and their difference was found to be statistically significant. Dwivedi et al. [9] prove that the mean vertical diameter of the neck of the right femur was 27.78±4.22 mm, and of the left femur was 27.43±2.20 mm is almost in concurrence with our study. Ziylan et al. [17] reported the morphometry of the Anatolian femur and quoted the result of vertical neck diameter on the right side as30.6±3.0 and on the left side as 30.7±3.6 mm. Due to the variation in the population, Ziylan et al.'s results were contrasting with our study. Verma et al. [20] recorded the vertical diameter of the neck as 34.23 and31.73 mm of the right and left femur, respectively, higher than our study. In males, neck thickness increases with an increase in age due to cam impingement which contributes to the development of osteoarthritis [19]. The difference between the transverse diameters of the neck of the femora on the right side was observed as 22.33±1.24 and on the left side was 23.25±3.22 mm respectively, and their difference was found to be statistically non-significant. Dwivedi et al. (2019) [9] Found that the mean transverse diameter of the neck of the right femur was 23.28±2.85 mm, and of the left femur was 23.13±2.83 mm is almost in concurrence with our study. Our findings also correlate with Verma et al. (2017) [20]. Ziylan et al. (2002) 17studied analysis of the Anatolian femur and reported that the values of the transverse diameter of the neck of the right femur were 25.5±2.7 mm, and of the left femur it was 26.3±3.1; the results obtained by Ziylan et al. [17] was contrasting to our results. This may be due to variations in the population studied [16].

The mean circumference of the neck of the femur on the right side was 9.73±7.93 cm, and that on the left side was 8.93±0.43 cm, and their difference was found to be statistically non-significant. Osorio et al. [19] Found mean values of the circumference of the neck of the femur as 9.72 and 9.68 cm on the right and left side, respectively, and it is in concurrence with our study. Ziylan et al. [17] found higher values, while Khanal et al [21] recorded values lower than our study.

The mean anterior length of the neck of the femur on the right side was 2.86±0.36 cm, and that on the left side was 4.00±12.02 cm, and their difference was found to be statistically significant. Our study results agree with the studies of Dwivedi et al. [9] In the right femur, but we found a slightly higher value in the case of the left femur. The values obtained from the studies by Verma et al. [20]

India, were more significant than our study. Ozandac et al. [22] recorded values lower than our study. Hence, it indicates that the values are different in different regions of India, which shows regional variations. Caucasian postmenopausal women have a longer femoral neck length with femoral fractures when compared to women without fractures in a retrospective study conducted by El-Kaissai et al. [23]

According to Calis ET al. [24] study on Turkish women, patients with hip fractures had considerably wider femoral necks and more acute angles. The femoral neck angle and neck length substantially correlate. Shorter people have more oblique femoral necks because their femurs are shorter, their femoral necks are shorter, and their neck-shaft angles are smaller. As a result, the taller person will have a more noticeable femoral neck [16].

Conclusion

After statistical analysis it is found that there is no significant difference between different parameter of right and left femur. The normative data will give an insight that there is racial variations of different parameters of proximal end of femur. The morphometric data revealed from this study will be helpful in designing of implants suitable for Asian population and also to the orthopedicians to deal more accurately for prevention and management of hip injuries.

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