

**Original Article**

# Morphometric Study of Fully Ossified Femoral Head Diameters in Bangladeshi Population

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## Abstract

**Background:** Knowledge about diameters of head of the femur is necessary in order to reduce the risk of complications associated with surgical procedures performed in the area of hip joint due to vascular, metabolic or trauma causes, and to achieve an alignment of prosthesis to be implanted. This comprehensive studies and standardization of data for a study population have great importance, not only for anatomists and forensic experts but also for the determination of risk factors in pathological conditions (like osteoporosis, fractures etc), for preoperative planning and design of components of prostheses which may be used by the orthopedic surgeons in femoral head replacement surgery. **Objective:** To construct the baseline data on different diameters of the fully ossified femoral head, determine any significant differences between the right and left femur and correlate with the previous study. The aim of the study is to record morphometric measurement that can throw further light on the existing data. **Materials and Methods:** This cross-sectional, descriptive type of study was conducted in Department of Anatomy, Mymensingh Medical College, Mymensingh from January 2019 to December 2019 on 150 dry fully ossified femurs of both sides with unknown sex. Data were statistically analyzed by using SPSS software, version 27.0. The diameters of head of the femur were measured by digital slide caliper. **Results:** The means ( $\pm$ SD) of vertical diameters of head of right and left femurs were 39.59 ( $\pm$ 3.49) mm and 39.31 ( $\pm$ 3.59) mm, of transverse diameters of head of right and left femurs were 36.32 ( $\pm$ 3.79) mm and 34.81 ( $\pm$ 3.06) mm and antero-posterior vertical diameters of head of right and left femurs were 41.15 ( $\pm$ 3.18) mm and 41.20 ( $\pm$ 3.44) mm respectively. **Conclusion:** There is no statistically significant differences between the right and left femoral diameters.

**Key words:** Morphometry; Vertical diameter; Transverse diameter; Antero-posterior diameter of head of the femur

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## Introduction

Femur carries the body weight, supports movements of body and provides attachment for regional muscles is the longest and strongest bone in the human body. It is the typical long bone of the lower limb

extending from the hip joint to the knee, it contributes approximately one-fourth of the height of the individual and transmits body weight to the tibia. The femur consists of a shaft and two ends, proximal and

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distal. The proximal end of the femur consists of a head, neck, greater and lesser trochanters. The shaft of femur is gently convex in front and the convexity is maximum in the middle one-third where the shaft is the narrowest. Lower end is widely expanded as a bearing surface for transmission of weight to the tibia—it has two massive condyles which are partly articular. Anteriorly the condyles unite and continue into the shaft, posteriorly separated by a deep intercondylar fossa and projecting beyond the plane of the popliteal surface.<sup>1</sup> An articular surface connects the spherical head of the femur and the acetabulum of the pelvic bone. A roughened depression known as the fovea serves as the anchor for the circular ligament of the femoral head, which is located somewhat below and beyond the head's center. The head is attached to the femoral shaft by the neck, which is approximately 5 cm long and is directed upward, medially and slightly forward and making an angle about  $125^\circ$  with shaft.<sup>2</sup>

The knowledge about diameters of head of the femur is valuable in the diagnosis and treatment of fracture and dislocation of hip joint. The femoral normative values are also essential to plastic and reconstructive surgeons in their reconstruction and medical rehabilitation.<sup>3</sup>

The morphometry of head of femur is variable between different individuals with different nationality. Therefore, our study is a little attempt to gain knowledge about the metric standards of femoral head in Bangladeshi people and compare with other studies which will be helpful for future studies.

## Materials and Methods

This study was carried out on 150 fully ossified dry human femurs which were collected from 1<sup>st</sup> year MBBS students and the Department of Anatomy of Mymensingh Medical College, Mymensingh. Of 150 femurs, 64 were of right side and 86 of left side. The study was conducted from January to December 2019. Only fully ossified, dried and thoroughly cleaned femurs were included in the study while the femurs which were damaged and those having any deformity or pathology were excluded from the study.

Parameters were measured by using digital slide caliper and expressed in mm (Fig. 1,2,3). Data were

analyzed using SPSS version 27.0 and mean values are presented in tables.

## Operational definitions

**Vertical, transverse and antero-posterior diameters of head:** The maximum diameters of the femoral head taken in vertical, transverse and antero-posterior planes.



Fig 1. Procedure of measurement of vertical diameter of head of the femur



Fig 2. Procedure of measurement of transverse diameter of head of the femur



Fig 3. Procedure of measurement of antero-posterior diameter of head of the femur

## Results

As shown in Table I and Fig. 4-9, the vertical diameter of head of the femur on the right and left side varied from 32.87 mm to 49.29 mm with mean $\pm$ SD 39.59 $\pm$ 3.49 mm and 33.84 mm to 47.55 mm with mean $\pm$ SD 39.31 $\pm$ 3.59 mm respectively. The transverse diameters of heads of the femurs on the right and left sides varied from 26.62

mm to 43.82 mm with mean $\pm$ SD 36.32 $\pm$ 3.79 mm and 25.74 mm to 42.45 mm with the mean 34.81 $\pm$ 3.06 mm respectively. The antero-posterior diameters of head of the femur on the right and left side varied from 35.28 mm to 48.24 mm with mean $\pm$ SD 41.15 $\pm$ 3.18 mm and 36.09 mm to 49.04 mm with mean $\pm$ SD 41.20 $\pm$ 3.44 mm respectively.

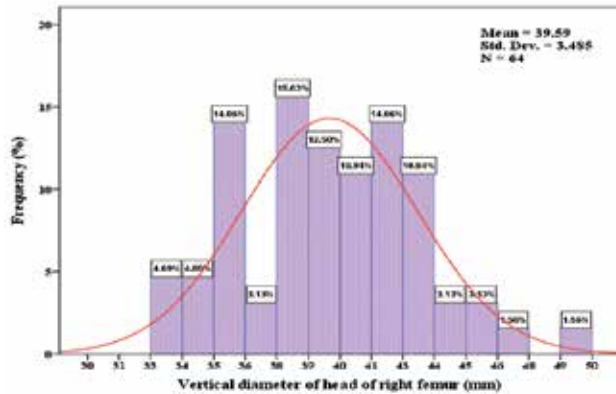


Fig 4. Distribution of vertical diameter of head of the femur on right side

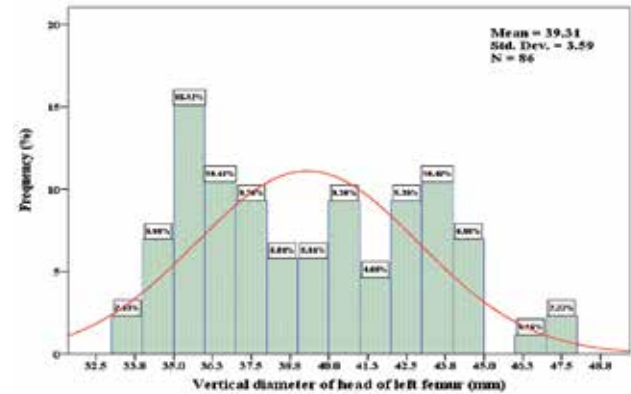


Fig 5. Distribution of vertical diameter of head of the femur on left side

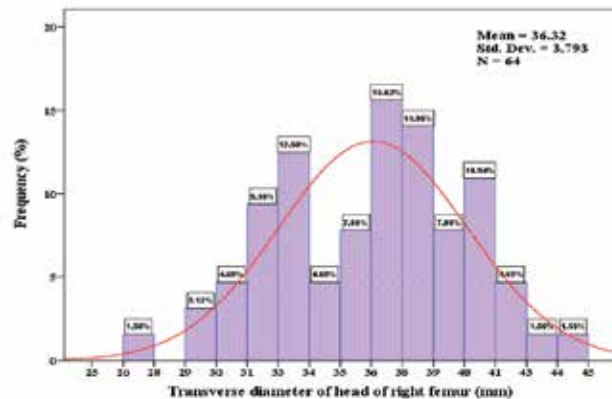


Fig 6. Distribution of transverse diameter of head of the femur on right side

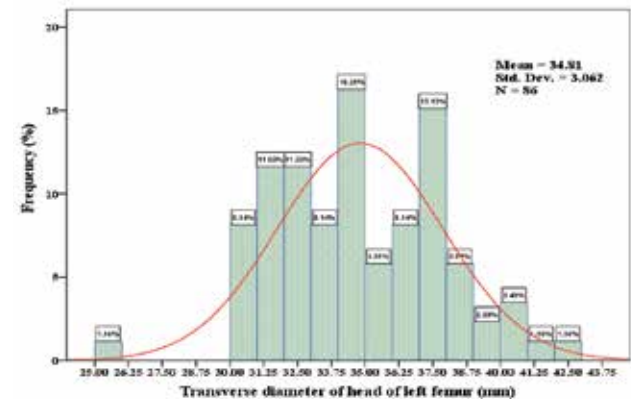


Fig 7. Distribution of transverse diameter of head of the femur on left side

Table I: Measurement of diameters of heads of the femurs

Variables	Sides	Range (mm)		Mean $\pm$ SD (mm)
		Minimum	Maximum	
Vertical diameters	Right	32.87	49.29	39.59 $\pm$ 3.49
	Left	33.84	47.55	39.31 $\pm$ 3.59
Transverse diameters	Right	26.62	43.82	36.32 $\pm$ 3.79
	Left	25.74	42.45	34.81 $\pm$ 3.06
Antero-posterior diameters	Right	35.28	48.24	41.15 $\pm$ 3.18
	Left	36.09	49.04	41.20 $\pm$ 3.44

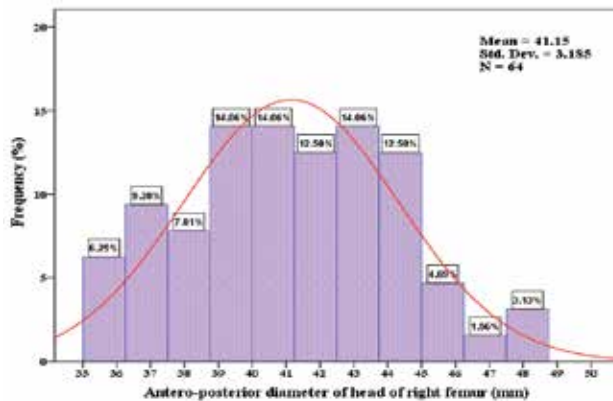


Fig 8. Distribution of antero-posterior diameter of head of the femur on right side

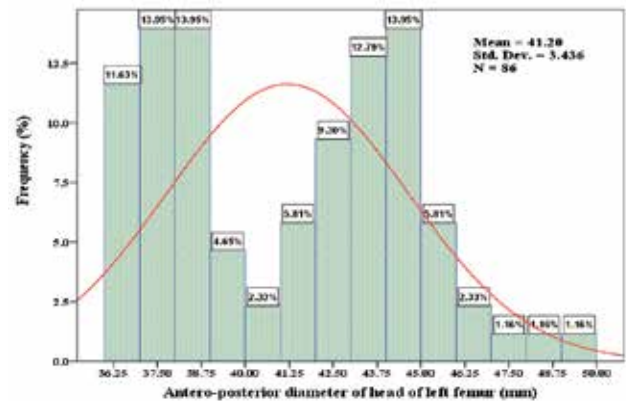


Fig 9. Distribution of antero-posterior diameter of head of the femur on left side

## Discussion

Many studies on adult femur have been carried out in different countries and many authors have studied using different materials and techniques such as cadaveric specimens, dry bone, computed tomography (CT) scan, magnetic resonance imaging (MRI) scans and plain radiographs. But we have used fully ossified dry human femur in this study.

In the present study, the mean (SD) of vertical diameter of head was 39.59 (3.49) mm for right femur and 39.31 (3.59) mm for left femur, the mean (SD) of transverse diameter of head was 36.32 (3.79) mm for right femur and 34.81 (3.06) mm for left femur and the mean (SD) of antero-posterior diameter of head of the femur on right side was 41.15 (3.18) mm and left side was 41.20 (3.44) mm.

Khaleel & Shaik<sup>2</sup> conducted a study on 50 human femur and described the mean (SD) of vertical diameter of head as 42.243.53 mm, on right side as 41.633.09 mm and on left side as 42.963.92 mm and the mean (SD) of transverse diameter of head was 37.863.06 mm, on right side it was 37.743.05 mm and on left side it was 38.313 mm. Chowdhury et al<sup>3</sup> conducted a study on 199 (89 male and 110 female) left sided fully ossified human femurs and found the mean (SD) of vertical diameter of head of the femur in male 58.44.2 mm and in female 40.61.8 mm and the mean (SD) of transverse diameter of head of the femur (measured as antero-posterior diameter of head of femur) in male 58.21.9 mm and in female 42.12.0

mm. Ziylan & Murshid<sup>4</sup> studied on 72 (36 right and 36 left) intact human adult femur and found that the mean (SD) vertical diameter of head on right side was 45.24.0 mm and on left side was 43.43.2 mm and the mean (SD) of transverse diameter of head (measured as antero-posterior diameter of head of femur) on right side 44.74.1 mm and on left side 44.33.3 mm. Menezes et al<sup>5</sup> studied on 29 (11 right and 18 left) dry human femur and found the mean (SD) diameter of femoral head on cranio-caudal axis (vertical diameter or superior-inferior axis) 44.24.4 mm and the mean (SD) diameter of femoral head on sagittal axis (antero-posterior diameter of head) 43.84.7 mm. Afroze & Huda<sup>6</sup> conducted a study on radiographs of 123 (71 male and 52 female) paired human femurs of individuals whose ages ranged between 15 to 70 years. They found the mean vertical diameter of femoral head in male 51.6 mm on right side and 51.5 mm on left side and in case of female the diameter was 45.7 mm on right side and 45.6 mm on left side and the mean transverse diameter of femoral head in male as 42.3 mm on right side and 42.1 mm on left side and in case of female diameter was 37.6 mm on right side and 37.4 mm on left side. Caiaffo et al<sup>7</sup> conducted a study on 120 (58 from male and 62 from female cadavers) femurs and found that the mean (SD) diameter of femoral head on cranio-caudal axis (vertical diameter or superior-inferior axis) in male was 45.090.35 mm and in female was 40.650.20 mm and the mean (SD) diameter of femoral head on sagittal axis (antero-posterior diameter of head) in male as 48.260.35 mm and in female as 42.540.20

mm. Renu Kumari et al<sup>8</sup> carried out a study on 90 (47 right and 43 left) dry human femurs and described the mean (SD) vertical diameter of head on right side as 32.172.53 mm and on left side as 32.101.90 mm and the mean (SD) transverse diameter of head (measured as the maximum diameter of head in the transverse plane) on right side as 34.113.00 mm and on left side as 34.002.90 mm. Lee et al<sup>9</sup> studied on 100 (50 male and 50 female) Korean femurs and found the mean (SD) vertical diameter of head in male as 48.02.7 mm and in female as 43.12.4 mm.

The mean value of present study regarding vertical diameter of head of the femur was nearly similar to the value described by many other authors.<sup>2,4,5,7</sup> But the findings of present study in case of both sides were higher than those of Renu Kumari<sup>8</sup> and it was more or less equal to the value described by other authors.<sup>3,6,9</sup>

The mean value of present study regarding transverse diameter of head of the femur was nearly similar to the value described in different studies.<sup>2,6,8</sup> In case of antero-posterior diameter of head of the femur result was nearly similar to the described value by other authors<sup>4,5</sup> and more or less equal to the value described by Chowdhury et al<sup>3</sup> and Caiaffo et al.<sup>7</sup>

The results of the present study on 150 femurs revealed that the vertical, transverse and antero-posterior diameters of head of the femur were almost similar on right and left side. The femoral head diameters vary among modern humans but measurement problems and sampling limitations have precluded the identification of factors contributing to its variation at the population level. Nowadays total hip arthroplasty and hemiarthroplasty are currently common procedures in our setting, subluxation and periprosthetic fracture of the femur has been reported. This can be linked to undersize and oversize of the prosthesis since most of these prosthetics are western standardized. This is partly because of lacking data of the size of the proximal femur. Knowledge about the

different diameters of the head is essential in orthopedic surgery and radiology and forensic medicine.

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