

## Study of Dimensions of Head and Neck of Human Femur and its Clinical Significance

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### ABSTRACT

**Introduction:** The Study of dimensions of head and neck of femur is important for making of appropriate prosthesis in hip replacement surgery. Different size of dimensions of head and neck of femur can affect the hip joint movement. The dimensions of head and neck of femur is varies according to age, race, heredity, ethnicity and geographical factor. Length of femur and stature of an individual can be determined even if only a fragment of proximal end of femur is available.

**Objective:** To determine the functional implication of variation in dimension of head and neck of femur, which may be helpful for orthopaedic surgeons and forensic experts.

**Materials and Methods:** Fifty human femur bones (25 of each side) were used for the study. Measurement of dimensions of head and neck of femur was done to know the average length of femur, vertical and transverse diameter of head, head circumference, anterior and posterior neck length and neck shaft angle of femur. All the measurement were taken with the help of Osteometric board, Circumference measuring tape, Digital vernier calliper and Goniometer.

**Results:** The following mean values of dimensions of total 50 bones: Length of femur were  $435.1 \pm 26.0$  mm. Vertical and Transverse diameter of head of femur were  $40.97 \pm 3.46$  mm and  $41.74 \pm 2.76$  mm respectively. Head circumference were  $133.25 \pm 11.57$  mm. Anterior and Posterior Neck length were  $29.75 \pm 5.30$  mm and  $35.03 \pm 4.87$  mm respectively. Neck shaft angle were  $125.96 \pm 6.10$  degree .

**Conclusion:** Appropriate prosthesis for orthopaedic surgeries can be designed from the result of this study.

**KEYWORDS:** Femur, head and neck dimensions, hip replacement

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### INTRODUCTION

Femur or thigh bone is the longest and strongest bone in the human body [1]. Its length is about one-fourth of the height of individual. It consists of three parts, upper end, shaft and lower end. Upper end consists of head, neck, greater and lesser trochanter. Shaft of

the femur is convex anteriorly. Lower end consists of medial and lateral condyles. Head of femur is rounded proximal part. Neck of femur connects the head with shaft of femur. Head of femur articulates with the acetabulum of hip bone to form hip joint and lower end articulates with tibia and patella [2].

Femur transmits body weight from hip bone to tibia during standing, walking and running [3]. The long bone such as femur is significant in stature and sex determination by forensic experts [4]. Length of femur can be determined if only a fragment of proximal end available with head and neck of femur [5]. The dimensions of head of femur varies according to races, heredity, life style and other geographical factor. The study of dimensions of head of femur is important for making of appropriate prosthesis in total hip replacement surgery [6]. Neck of femur is most common site of fracture around proximal end of femur. Management of this may be non-operative or internal fixation or prosthetic replacement. If the size of implants are not proper there may be complications [7]. To lessen these complication knowledge of dimensions of head and neck of femur is required.

The main purpose of this study was to know the average length of femur, head circumference, vertical and transverse diameter of head of femur, anterior and posterior neck length and neck shaft angle which is helpful for forensic experts and orthopaedic surgeons.

## MATERIALS AND METHODS

The study was done on 50 bones (25 right and 25 left). Ethical approval was taken from institutional ethical committee for this study. (IEC No/2020/11). We do not know the age and sex of the bones. We excluded the bone which is incomplete, damaged, deformed and eroded for this study.

**The following parameters of femur were studied:**

**Length of femur:** It was measured as straight distance between the highest point of head and lowest point of medial condyle of femur (fig.1).

**Vertical diameter of head:** It was measured as distance between most superior and inferior point on articular margin of head in vertical plane (fig.2).

**Transverse diameter of head:** It was measured as maximum distance of femoral head on articular margin in horizontal plane (fig.3).

**Head circumference:** It was measured by winding flexible tape around circumference of head along its articular margin (fig.4).

**Anterior Neck length:** It was measured as the distance between the base of head and mid-point of intertrochanteric line anteriorly (fig.5).

**Posterior neck length:** It was measured as the distance between the base of head and mid-point of intertrochanteric crest posteriorly (fig.6).

**Neck shaft angle:** It is angle between the long axis of shaft of femur and axis of neck of femur (fig.7).

The length of femur was measured with the help of Osteometric board, head circumference by Circumference measuring tape and neck shaft angle by Goniometer. All other measurements were taken by using digital vernier calliper. All the measurements were tabulated and calculated by Microsoft excel.



Fig. 1: Measurement of length of femur



Fig. 2: Vertical diameter of head of femur



Fig. 3: Measurement of transverse diameter of head of femur



**Fig. 4:** Measurement of head circumference.



**Fig. 5:** Anterior neck length

**Fig. 6:** Posterior neck length



**Fig. 7:** Neck shaft angle.

Our study was performed on 50 bones, comprising of 25 each side. The results of femoral head and neck dimensions are presented in table.1. The total average value of different parameters are as follows: length of femur was  $435.1 \pm 26.0$  mm, Vertical diameter of head was  $40.97 \pm 3.46$  mm, Transverse diameter of head was  $41.74 \pm 2.76$  mm, Head circumference was  $133.25 \pm 11.57$  mm, Anterior Neck length was  $29.75 \pm 5.30$  mm, Posterior neck length was  $35.03 \pm 4.87$  mm, and Neck shaft angle  $125.96 \pm 6.10$  degree. Our study finding compared with previous study finding in table.2.

**DISCUSSION**

Our results (Table 1) are very helpful for surgeons, implant manufacturers and forensic expert. In our study length of femur was  $435.1 \pm 26.0$  mm which is similar to the value obtained by other studies [8,12,13] but higher than the value obtained by A K Dwivedi et al [10]. The vertical diameter of head of femur was  $40.97 \pm 3.46$  mm which is similar to the value obtained by A K Dwivedi et al [10], but lower than the value obtained by other studies [8,11,14]. The transverse diameter of head of femur was  $41.75 \pm 2.76$  mm which is similar to the value obtained by other authors [10,11] but greater than the value obtained by T J Pillai et al [8] and smaller than Katchy, et al [14]. The head circumference was  $133.25 \pm 11.57$  mm which is higher than the value obtained by A K Dwivedi et al [10], but lower than the value obtained by other authors [11,13]. In our study anterior and posterior neck length was  $29.75 \pm 5.30$  and  $35.03 \pm 4.87$  mm respectively which is almost similar to the value obtained by other studies [9,10].

**RESULTS**

**Table 1:** Different Parameters of femur.

| Parameters (mm)             | Mean $\pm$ SD      |                    |                    | Range       |             |             |
|-----------------------------|--------------------|--------------------|--------------------|-------------|-------------|-------------|
|                             | Right              | Left               | Total              | Right       | Left        | total       |
| Length of femur             | 434.6 $\pm$ 24.8   | 435.7 $\pm$ 27.6   | 435.1 $\pm$ 26.0   | 385 - 482   | 385 - 480   | 385 - 482   |
| Vertical diameter of head   | 41.25 $\pm$ 3.71   | 40.68 $\pm$ 3.23   | 40.97 $\pm$ 3.46   | 35.3 - 49.8 | 35.0 - 48.5 | 35.0 - 49.8 |
| Transverse diameter of head | 41.82 $\pm$ 3.01   | 41.66 $\pm$ 2.55   | 41.74 $\pm$ 2.76   | 36.5 - 46.5 | 36.9 - 45.7 | 36.5 - 46.5 |
| Head circumference          | 133.42 $\pm$ 11.80 | 133.08 $\pm$ 11.58 | 133.25 $\pm$ 11.57 | 116.5-152   | 117-151.5   | 116.5-152   |
| Anterior Neck length        | 29.51 $\pm$ 5.39   | 29.98 $\pm$ 5.32   | 29.75 $\pm$ 5.30   | 21.5-38.0   | 22.1-37.4   | 21.5-38.0   |
| Posterior neck length       | 34.93 $\pm$ 4.87   | 35.12 $\pm$ 4.97   | 35.03 $\pm$ 4.87   | 26.2-43.6   | 25.8-42.2   | 25.8-43.6   |
| Neck shaft angle            | 126.24 $\pm$ 6.19  | 125.68 $\pm$ 6.13  | 125.96 $\pm$ 6.10  | 116-140     | 117-138     | 116-140     |

**Table. 2:** Comparison of present study findings with previous study findings.

| Parameters (mm)             | T J Pillai et al (2014) [8] | Jaiswal et al (2017) [9] | A K Dwivedi et al (2019) [10] | Saima Rashid et al (2019) [11] | G Vinay et al (2020) [12] | Rajendran et al (2020) [13] | Katchy et al (2021) [14] | Present study (2021) |
|-----------------------------|-----------------------------|--------------------------|-------------------------------|--------------------------------|---------------------------|-----------------------------|--------------------------|----------------------|
| Length of femur             | 437.44 ± 31.44              |                          | 412.56 ± 30.34                |                                | 431.50±29.8               | 433.8 ± 31.4                |                          | 435.1 ± 26.0         |
| Vertical diameter of head   | 42.24 ± 3.53                |                          | 40.53 ± 3.51                  | 43.34 ± 3.59                   |                           | 39.90±3.42                  | 44.64± 3.13              | 40.97 ± 3.46         |
| Transverse diameter of head | 37.86 ± 3.06                |                          | 40.44 ± 3.47                  | 42.51 ± 3.44                   | 40.90±3.50                |                             | 44.55± 3.37              | 41.74 ± 2.76         |
| Head circumference          |                             |                          | 126.69 ± 10.55                | 137.9 ± 11.1                   |                           | 141.3 ± 10.4                |                          | 133.25 ± 11.57       |
| Anterior neck length        |                             | 28.79 ± 4.08             | 29.92± 4.04                   |                                | 26.40±3.70                |                             | 31.86± 5.38              | 29.75 ± 5.30         |
| Posterior neck length       |                             | 35.59 ± 3.74             | 35.23 ± 4.22                  |                                |                           |                             | 22.23± 5.52              | 35.03 ± 4.87         |
| Neck shaft angle            | 125.30±6.50                 | 124.95±6.09              |                               |                                | 120.13±5.72               | 146.25±4.18                 | 132.15±7.30              | 125.96±6.10          |

The posterior neck length value obtained by Katchy, et al [14] is lower than the value documented by our study. The neck shaft angle in our study was 125.96±6.10 degree which is similar to the value obtained by studies [8,9] but higher than the value obtained by G Vinay et al [12] and lower than other studies [12,13].

## CONCLUSION

This study provides data for surgeons to select the proper implant size for total hip replacement surgery in our population. It also provides data for implant manufacturers to design proper implants. These data is also helpful for forensic expert to know the length of femur and stature of an individual by proximal fragments. Limitations of our study was that sample size is small, we do not know the age and sex of bone. We also do not know the pairing of bones (right and left femur of same individual).

**Conflicts of Interests: None**

## Author Contributions

**Sanjeev Kumar Sinha:** Concept, Designing of the Study, Manuscript Correspondence. **Swati Suman:** Concept, Designing of the Study, Manuscript Correspondence.

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