# DIMENSIONS OF THE LOWER END OF THE FEMUR IN EASTERN INDIA

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**ABSTRACT**

**BACKGROUND**

The knee joint is a major joint of the body, and one of the most commonly affected by pathology. It is also the most common joint to be operated upon, modified and partially replaced with prosthetic implants. In such scenario, the measurements of the lower end of the femur assume importance in the manufacture of implants and their proper coaptation to the condyles of the femur. The present study is an exploration of such measurements of the lower end of the femur.

**MATERIALS AND METHODS**

70 dry unclassified adult femora were studied. Condylar dimensions were measured using Martin's slide calipers and a diaptograph. Antero-posterior, vertical and transverse dimensions of both condyles, bicondylar width & the bicondylar angle were determined.

**RESULTS**

Antero-posterior, vertical and transverse condylar dimensions varied from 50-65 mm, 22-35 mm and 27-42 mm respectively for the lateral condyle, and 47-64 mm, 22-34 mm, & 27-39 mm respectively for the medial condyle. Both the bicondylar width and the bicondylar angle were greater in right femora.

**CONCLUSION**

Condylar dimensions exhibited only minor differences. Antero-posterior and transverse dimensions of the lateral condyle were greater than the medial. The bicondylar angle was greater on the right side. This study may contribute in a small way to the database of information on the knee region for the population of Eastern India.

**KEYWORDS**

Femur, Femoral Condyle, Bicondylar Width, Bicondylar Angle, Knee Joint.

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## BACKGROUND

The knee joint is the largest joint of the body and the femur is the largest human bone. Moreover, the knee joint is a complex and modified hinge joint. This means that in addition to the usual flexion and extension movements of the knee, it also has both passive and active rotation. The components of these movements are a result of spinning (rotation) and gliding (translation). To efficiently carry out these varied movements, some amount of component separation is achieved by the insertion of the menisci within the knee joints, separating it into menisco-femoral and menisco-tibial compartments. All of these movements have to be carried out under the stress of the body weight - half the weight on standing on both legs, the total weight on standing on one leg and more than the body weight during movements of running and jumping.

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The above-mentioned movements put a huge amount of strain on the knees which makes the knee joint a common site of osteoarthritic changes. The anatomical changes of osteoarthritis makes the knee joints painful, the surfaces irregular and the function compromised, especially when negotiating inclined surfaces. Medical therapy for osteoarthritis is temporary and inconclusive, the definitive treatment being surgical. Prosthetic replacement of the knee joint offers the only realistic hope of long term relief from pain and disability. Design of metal and ceramic prosthesis of the femoral component of the knee joint takes into account the basic measurements of the condyles of the femur and the intercondylar notch. Measurements of the lower femur vary considerably among different populations and so the problem of standardization of the implant size is quite acute. Different manufacturers make femoral implants according to different specifications and the results of larger number of studies from local populations are required for accuracy in implant design. Standardization of implant size will only come about after compiling the data generated from large series of studies on different sets of femora obtained from various collections of osteological specimens. The present study of measurements of the lower ends of the femora is a small step in the realization of that goal.

*Aims and Objectives*

The present study aims to measure some specific skeletal parameters at the lower ends of the femur from a collection of specimens in a tertiary care Medical College in West Bengal. The measurements pertain to the condyles of the femur and the intercondylar notch. The data generated from the present study have been compared with similar studies on specimens of femora from collections in India. These observations will help in creating a large database on which design and manufacture of femoral implants may be based in future.

## MATERIALS AND METHODS

The present descriptive study was carried out on a collection of 70 dry specimens of femora to measure certain specific parameters of the lower femur including the dimensions of the femoral condyles and intercondylar notches. The measurements were carried out at the Department of Anatomy, Institute of Post Graduate Medical Education and Research, Kolkata. All the specimens were of mature adults.

Direct measurements were made using Martin's slide calipers. For the individual femoral condyles, the parameters measured were anteroposterior, vertical and transverse dimensions. Bicondylar width was measured as the mediolateral breadth between the two epicondyles.

The bicondylar angle was measured indirectly with the help of a diaptograph which is a variation of pantograph used for outlining various solid objects at actual or magnified size. Using this instrument, an outline of the femur was drawn on chart paper. On this outline, a line was drawn as a tangent connecting the lower ends of the femoral condyles (AB). The shaft of the femur was demarcated by drawing two transverse lines - one just below the lower end of the lesser trochanter (CD) and one just above the femoral condyles (EF). The line (XY) joining the midpoints of AB and EF represents the axis of the shaft which was prolonged to join the infracondylar line at the point Z. A perpendicular line (WZ) was drawn on the line AB at the point Z. The angle formed between the lines XZ and WZ represents the bicondylar angle.

The measurements obtained were arranged in a tabular form. An attempt was made to estimate whether there was any significant difference between the parameters on the right and the left side.

*Inclusion Criteria*

As the collection was mixed and unclassified, specimens were included irrespective of age and sex.

*Exclusion Criteria*

All specimens in the collections which showed non-united epiphyses, evidence of bony deformities, fractures and other evidence of bone pathology were excluded from the study.

## RESULTS

The parameters of the lower ends of the femur as measured during the study (70 femora, 35 of each side) are represented in the following tables.

| Left Femur | | | | | | |
|---|---|---|---|---|---|---|
| | Lateral Femoral Condyles | | | Medial Femoral Condyles | | |
| **Dimension** | **Antero-posterior** | **Transverse** | **Vertical** | **Antero-posterior** | **Transverse** | **Vertical** |
| Range | 50 - 65 | 24 - 34 | 27 - 42 | 49 - 62 | 24 - 34 | 27 - 39 |
| Mean | 56.05 | 28.03 | 33.05 | 54.74 | 27.28 | 32.48 |

***Table 1. Measurements of the Condyles of Left Femora (in mm, n = 35)***

| Right Femur | | | | | | |
|---|---|---|---|---|---|---|
| | Lateral Femoral Condyles | | | Medial Femoral Condyles | | |
| **Dimension** | **Antero-posterior** | **Transverse** | **Vertical** | **Antero-posterior** | **Transverse** | **Vertical** |
| Range | 50 - 63 | 22 - 35 | 28 - 36 | 47 - 64 | 22 - 28 | 30 - 37 |
| Mean | 56.20 | 27.80 | 32.51 | 52.97 | 25.48 | 34 |

***Table 2. Measurements of the Condyles of Right Femora (in mm, n = 35)***

| Right Femur | | | Left Femur | | |
|---|---|---|---|---|---|
| **Maximum** | **Minimum** | **Mean** | **Maximum** | **Minimum** | **Mean** |
| 79 | 61 | 71.7 | 82 | 64 | 70.7 |

***Table 3. Bicondylar Width (in mm, n = 70)***

| Left Femur | | | Right Femur | | |
|---|---|---|---|---|---|
| **Maximum** | **Minimum** | **Mean** | **Maximum** | **Minimum** | **Mean** |
| 12.5 | 06 | 9.23 | 14 | 06 | 9.77 |

***Table 4. Bicondylar Angle (in Degrees)***

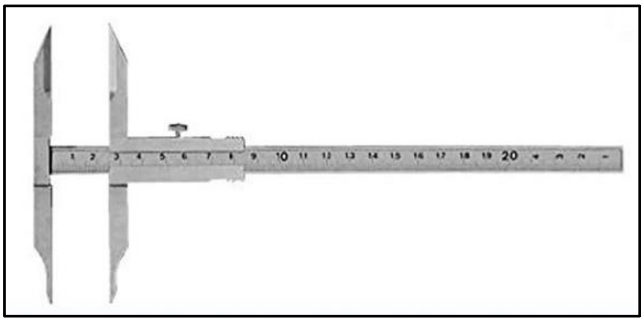

*Figure 1. Martin's Slide Calipers*

*Figure 2. Diaptograph*

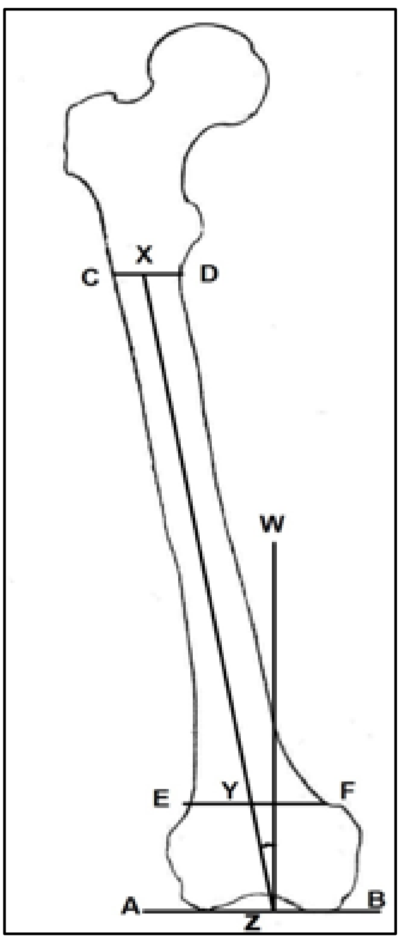


*Figure 3. Bicondylar Angle*

**DISCUSSION**

The present study found that the dimensions of the femoral condyles exhibits minor differences between the right and left sides, the difference being of the order of 2-3 mm. Therefore, it is expected that the manufacture of implants for the right and left knees will conform to the same size. However, it is seen that of the two condyles, the antero-posterior and transverse measurements of the lateral condyles are definitely greater than that of the medial one. The vertical measurements of both the medial and lateral condyles are similar. Again, the shaft of the femur is oblique, but the lower ends of the condyles are in the same horizontal plane. Therefore, the distal ends of the medial condyles are expected to project more distally. This has also been confirmed by the studies of Singh et al.[1]

The bicondylar width was appreciably greater in the right femora as compared to the left. The bicondylar angles were also greater in the right femora, signifying a greater obliquity of the femoral shafts. This results in greater pressure on the lateral condyles, which is probably responsible for its greater size.[2] In properly sexed femora we also expect a greater bicondylar angles in female specimens. Terzidis et al detected no appreciable difference in dimensions of both sides.[3]

Due to the unsorted nature of the collection of specimens, sexual dimorphisms could not be ascertained. Such features have been found in the measurements of A.M.Pandya et al.[4]

Indirect morphometry of the knee using x-ray, CT, MRI, have been found to be less accurate than direct measurement, although these methods allow for larger sample sizes.[5-8]

The morphometric data from the present study may be correlated with dimensions of resected distal femora during knee replacement operations, which may be used as a guideline to determine the size distributions of femoral implants. Data from a few such studies are available but more studies are required for increased accuracy.[9]

**CONCLUSION**

Direct morphometry of the lower end of the femur, which participates in formation of the knee joint, generates data which may be of use in design of knee prostheses, and planning of knee surgery. Dimensions vary, even between right and left sides, as well as between populations. This study may contribute in a small way to the database of information on the knee region in the Indian population, and more specifically, that of Eastern India.

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