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Original Research Article

A Cross Sectional Study on Morphology of Distal End of Femur in Dry Bones and Its Clinical Significance

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Abstract:
The femur forms knee joint at it's lower end by articulating with tibia and patella, which is a complex synovial joint. It plays a crucial role in weight bearing and undergoes severe wear and tear and age related changes that may require interventional surgeries. Morphometry of distal end of femur is vital for designing prosthesis for knee joint, considering the variations in different ethnic groups. The present study is designed to analyse the morphometric parameters of distal ends of 60 dry non-pathological femur using Vernier calipers. The results were analysed for statistical significance. The data obtained from the present study, when compared with those obtained from studies done on different ethnic population showed difference in measured parameters which must be kept into account while designing prosthesis for population of different countries.
Keywords: Femur, condyles, inter-condylar notch.

Introduction

The knee joint is formed at the lower end of femur that articulates with the upper end of tibia. The femur is the longest and strongest bone of the human body. The distal end of femur is composed of medial and lateral condyles.

An epicondyle projects from each of the condyle and gives attachment to the lateral ligaments of knee joint. The inter-condylar notch separates the lateral and medial condyles. [1] Both condyles articulate with the tibia and patella to form the knee joint. It has significant role in human locomotion. Because of its location, structure and function, the lower end of femur is subjected to traumatic, degenerative and neoplastic changes.

The articular surface for patella and tibia is a wide area like inverted 'U'. [2] The knee joint is a complex synovial joint and its incongruous design makes it unstable. It is the commonest joint to suffer trauma & degenerative changes. Knee replacement surgery is an upcoming treatment option for ailments related to knee joint. It requires correct positioning of well fitted implants and adequate soft tissue support. [3]

At erect posture, the plane of femoral condyles is horizontal to the surface of normal locomotion. [4] The distal femoral anatomy is critical for the development of complete joint replacement and internal fixation devices. [5] For successful joint replacement surgery, it is important to use correct femoral component to preserve the knee's usual functional movement range. [6,7] Selection of prosthesis that best fits the sizes of resected surfaces of distal femur and proximal tibia is very crucial. Any malfunction may lead to many difficulties, like soft tissue imbalance, impaired mobility and implant loosening. [8,9] The presently available prosthetic components were mostly designed according to western population parameters. Many studies have proved that Asian population has smaller knees due to their shorter physique in comparison to that of western population. [10-12]

So, it is necessary to re-adjust the design of existing prosthesis to meet the need of Asian population. The present study is to analyse the morphometric parameters of distal ends of femur for aiding biomechanical engineers in designing different femoral element prosthesis.

Material and Methods

An observational descriptive study with cross-sectional data collection was done on 60 adult dry femurs (38 right sided & 22 left sided). Samples were collected from KPC MEDICAL COLLEGE Anatomy department and 1st year MBBS students of the same college.

Inclusion Criteria – Dry, intact, non-pathological, adult femurs were included.

Exclusion Criteria – Femurs with any fractures, un-ossified parts or pathological anomalies like tumors, deformities has been excluded from the study.

The femur was placed on a smooth horizontal surface (a glass sheet on table). A smooth block (1 cm in thickness) was placed beneath the femoral condyles before measurements were taken.

Direct measurement has been carried out on dry femurs. The required parameters were measured using Vernier calipers, thread and scale (as applicable). The right and left sided data was recorded separately on Excel sheet and analysed using appropriate software for calculating mean +/- SD. The p-value was also been determined to establish statistical significance. The following parameters were measured in the selected dry specimens of femur:-

1. **Bicondylar Width (BCW)** – The maximum distance between medial & lateral epicondyles.
2. **Maximum Antero-Posterior Distance of Medial Femoral Condyle (MCAPD) –** The maximum distance between anterior and posterior surfaces of medial femoral condyle.
3. **Maximum Transverse Distance of Medial Femoral Condyle (MCTD) –** The maximum distance between medial and lateral surfaces of medial femoral condyle.
4. **Maximum Antero-Posterior Distance of Lateral Femoral Condyle (LCAPD)** – The maximum distance between anterior and posterior surfaces of lateral femoral condyle.
5. **Maximum Transverse Distance of Lateral Femoral Condyle (LCTD)** – The maximum distance between medial and lateral surfaces of lateral femoral condyle.
6. **Inter-Condylar Notch Width (ICNW)** – The maximum distance between medial and lateral surfaces of inter-condylar notch.

Independent t-test was used to calculate difference in parameter of right and left femur. P-value < 0.05 is taken as significant.

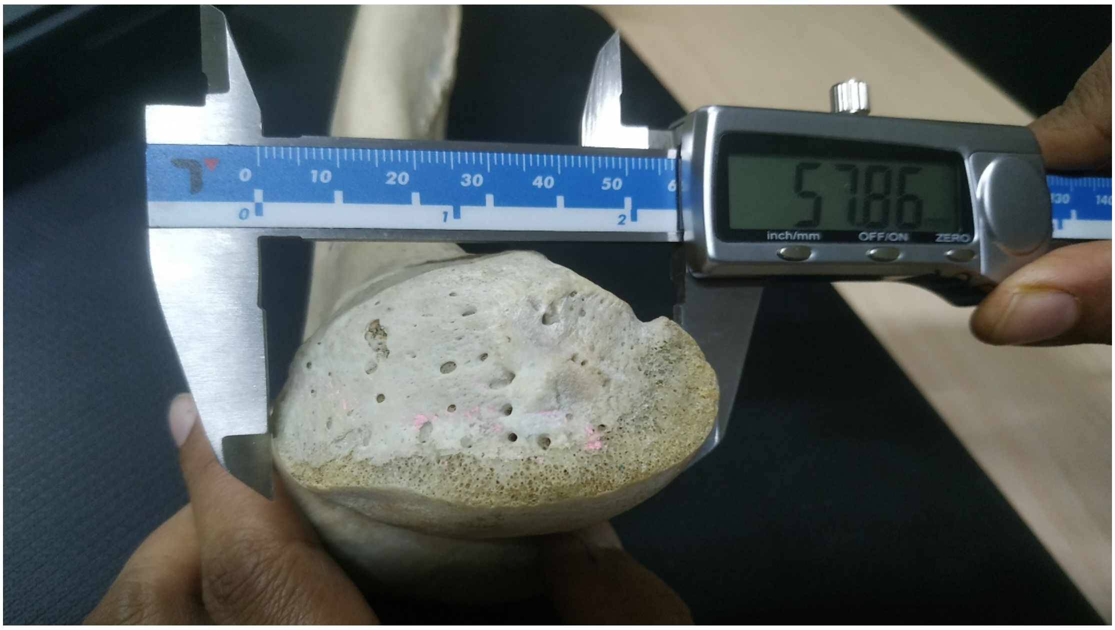

Figure 1: showing methods of measurements of some of the parameters of femur

Results:

80 dry femora were studied, out of which, 32 were of right side and 28 were of left side. The mean bicondylar width was 70.53±8.61mm on right side and 71.70±7.19mm on the left side.

The average inter-condylar notch width was 20.42±4.04mm on right side and 20.48±2.23 on the left side. For medial condyle, mean antero-posterior diameter came out to be 56.88±5.18mm on right side and 55.30±4.92mm on the left side. The same for the transverse diameter are 30.16±4.17 mm for right and 31.29±3.23mm on the left. The average measurements of lateral condyles were 58.35±4.60mm on the right side for anteroposterior diameter and that on the left side was 56.24±5.96mm.The mean transverse diameters of the lateral condyles were 31.55±2.91mm on right side and 31.13±3.08mm on left side. The details are provided in the following table:-

Table 1:

Parameter	Right Side				Left Side				t-value
	MIN	MAX	MEAN	S.D.	MIN	MAX	MEAN	S.D	
BCW	58.10	84.12	70.53	8.61	58.20	82.05	71.70	7.19	0.57
ICNW	10.25	27.70	20.42	4.04	17.14	24.75	20.48	2.23	0.07
MCAPD	50.17	68.15	56.88	5.18	45.12	63.13	55.30	4.92	1.21
MCTD	21.05	35.31	30.16	4.17	26.12	38.18	31.29	3.23	1.18
LCAPD	51.12	66.10	58.35	4.60	45.10	64.17	56.24	5.96	1.52
LCTD	26.11	36.42	31.55	2.91	26.15	35.50	31.13	3.08	0.55

‘t’ statistics was applied to test between right and left for all the parameters.

‘p’ values were observed to be insignificant, which means there are no significant differences between right and left parameters at 5% level of significance.

Discussion:

The femur takes part in formation of two very important joints of human body, namely, knee and hip joint. The distal end constitute part of knee joint. This bone is important I many disciplines like Forensic medicine, Anthropology, Orthopedics, etc. Anthropological researches involves determination of differences in femur with respect to population, sex, age, ethnicity, etc. On the other hand, orthopedic researches involve proximal part of femur and medullary canal for hip joint study [13,14] and distal part for knee joint study [15,16].

The stability of knee joint is determined by the femoral condyles and intercondylar notch. Knee joint arthroplasty is gaining popularity in treatment of degenerative diseases of knee joint. The proper use of morphometrical matched prosthesis is the key to success for knee arthroplasty.3 Therefore, the knowledge of reliable morphometric data is essential for selection of proper prosthesis designing.

In the present study, the average bicondylar width came out to be 70.53±8.61mm on right side and 71.70±7.19mm on the left side. Biswas et al [17] found the same to be 71.71±4.5mm on the right side and 70.7±5.25mm on the left side in Bengali population. These values are comparable with our study outcome. Mistri et al [3], Ravichandran et al 18 and Sweta et al 19 conducted studies among different populations of India and the results were slightly higher than the present study. Terzidis et al [5], Taner et al 20 and Cheng FB et al [21] conducted similar studies in different population groups like Greek, Chinese, etc and the values were on the higher side. But, there were no statistically significant difference right and left sided data. Chavda et al 22 conducted the study among Gujrati population, and the bicondylar width was 72.82±3.89mm on right side and 71.62±5.67mm on the left side and these values showed significant differences between the two sides.

The intercondylar notch measured 20.42±4.04 mm on right side and 20.48±2.23 mm on left side which were more or less comparable with studies in Indian population. Terzidius et al [5] found it to be 22.0±0.18 in males and 18.7±0.10 in females. Narrowing of intercondylar notch may give rise to 'Inter-condylar notch stenosis', leading to anterior cruciate ligament tear. [23]

In the present study, the mean antero-posterior diameter of medial condyle are 56.88±5.18mm on the right and 55.30±4.92mm on the left side. These values came out to be slightly higher than the other studies done in Indian population like Biswas et al [17]. These studies done on populations of other countries of the world are higher than the present study.

The average values of transverse diameter of medial condyle came out to be 30.16±4.17mm on right side and 31.29±3.23mm on left side which were a bit higher than other Indian studies, though the difference does not have any clinical significance. The mean antero-posterior diameter of lateral condyles was 58.35±4.60mm on the right side and 56.24±5.96 mm on the left side, without any statistically significant difference. These values were more of less same as found by Biswas et al [17] but lesser than that conducted by Terzidius et al [5] on Greek population. The average measurements of transverse diameter of lateral condyles were 31.55±2.91 mm on the right side and 31.13±3.08 mm on left side without any statistical significance.

Different ethnicities have different measurements due to change in environmental factors, lifestyle, hereditary factors etc, which may affect the built, stature and composition of human body. [24]

Conclusion:

In the present study, the different parameters of lower end of femur are measured directly and recorded. Though there were no statistically significant differences between the right and left sided values, it is clearly evident that there are ethnic variances between different population groups. Hence, selection of appropriate implant and prosthesis according to different ethnic specification will minimize mismatch and improve surgical outcome.

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