Original Article

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A Study on Anthropometric Measurements of Lower end of Indian Femora

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Abstract

Background: The knee joint is a complex, compound synovial joint, providing hinge movements useful to give stability and support to body weight. Common knee problems happen due to injuries and diseases of the knee. To the best of my knowledge, the anthropometric measurement on the lower end of the femur is not available for Madhya Pradesh population. The present study aims to measure various parameters of femoral condyles and intercondylar area which would be useful in the placement of the femoral compartment of knee prosthesis. **Subjects and Methods:** To conduct the Present study a total of 65 human dried femora were measured in the department of Anatomy, IMCH & RC, Indore, MP. Parameters & measurements recorded at the lower end of the femur were Anteroposterior & transverse diameters of medial and lateral condyles, intercondylar notch depth, width & bicondylar width. **Results** will be analyzed with the help of statistical calculations. **Conclusion** The present study may be useful to orthopeditians and surgeons to select the accurate size of the prosthesis during knee arthroplasty surgeries.

Keywords: Arthroplasty, Femoral, Intercondylar Area, Knee Joint

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Introduction

"Anthropometric" has originated from Greek, Anthropos meaning human and metron meaning measure. Anthropometry is a scientific study of measurements and proportions of the human body.[1] The most essential joint needed for locomotion is the knee joint. For the same reason, it is also the most commonly affected joint by degenerative diseases.[2] The Knee joint acts as a pivot between the longest bones in the body it is subjected to a good amount of loads in locomotion & the joint is potentially unstable.[3] The knee joint is a bicondylar joint formed by the femoral and tibial condyles and posterior articular surface of the patella. The femur is the longest [45cm] and strongest bone in the human body which constitutes one-fourth of the height of an individual. The length of the femur is associated with striding gait.[4] In biphasic and bipedal locomotion of the human body, the femur plays an important role.[5] The distal end of the femur is widely expanded to form condyles that help in weight transmission to the tibia. Both the condyles are confluent and continuous with the shaft anteriorly. Posteriorly the femoral condyles are separated by a deep intercondylar fossa. Anthropometric measurements of femoral condyles will help in designing knee prostheses. The appropriate sized femoral component of prosthetics helps in the normal range of function in a prosthetic knee. Undersized femoral components will cause loosening of implants while oversized prosthesis causes impingement of soft tissues surrounding the knee joint. Therefore the usage of appropriate size of knee implants is essential for the success of total knee arthroplasty TKA.[6]

Knee Arthoplasty is a surgical procedure in which the weight-bearing surfaces of the knee joint are replaced for pain relief and disability. The commonest indication for knee arthroplasty is osteoarthritis, rheumatic and psoriatic arthritis.[7] Usually, osteoarthritis is treated by Total Knee Arthoplasty [TKA] or Unilateral Knee Arthoplasty [UKA]. There is precise soft tissue balancing along with resection of bone thickness equally with the thickness of prosthetic component implant in TKA. This helps in equal spacing for flextion extension and permits joint stability throughout the range of motion. From the 1950s TKA prosthetics designing has been evolving. It started with Walldius's design of hinged knee replacement. In the 1970s, Total condylar prosthesis (TCP) was the first TKA prosthesis in which all three compartments of the knee were resurfaced.

Various categories of prosthetic designing in TKA are Cruciate Retaining, Posterior Stablity, Constrained Non-hinged Design and Constrained Hinged Design.[8]

The osteometric parameters required for developing prosthetics for TKA are obtained from the data of studies conducted in the Caucasian population. Hardly few studies on the morphometric measurements of the femur in the Indian population. The postoperative success and patient acceptability depends on femoral components. As per research studies there is significant ethnic variation in femoral anatomy. As per study reports, TKA's oversized components are in between 66 - 76%.[9]

The studies are available from the European population on age-related differences and its three–dimensional geometric morphological analysis suggests that, designing of the knee prosthesis is done according to age differencs like subjects under the age of 40 require differet sizes of knee prostheses, than in older patients because of degenerative changes in bones.[10,11]

Many authors have also proposed studies based on anthropometric measurements of the knee joint in the Indian population and corelated them with data obtained after performing MRI scan, computed tomography scan on patients diagnosed with bilateral primary arthritis, tumors, post-traumatic fractures etc. suggests that prostheses available presently have differences from knee morphometry of Indian population.[12]

Subjects and Methods

The present study was conducted in the Department of Anatomy, Index Medical College and Research Centre, Indore, Madhya Pradesh on 65 dried human femora [34 right & 31 left] of unknown age and sex were analysed. Samples were collected and studied from Index medical college and Sri Aurobindo Institute of Medical Sciences, Indore, Madhya Pradesh. Bones with broken ends or, Damaged, and unossified bones were excluded from the study. Using standard digital vernier caliper dimension values were measured in Millimeter (mm).

The parameters measured were: Bicondylar Width (BCW): In a transverse plane, the maximum distance across the femoral condyles Medial condylar anteroposterior diameter [MCAP]: maximum anteroposterior distance of medial condyle of the femur.[13]

Lateral condylar anteroposterior diameter [LCAP]: Maximum anteroposterior distance of lateral condyle of the femur.[14]

Medial condylar Transverse diameter [MCTD]: Maximum Transverse distance of medial condyle of the femur.

Lateral condylar Transverse diameter [LCTD]: Maximum Transverse distance of lateral condyle of the femur.

Intercondylar notch width [ICW]: Maximum Transverse distance of intercondylar notch.

Intercondylar notch depth [ICD]: Maximum height of the intercondylar notch.[15] All the parameters were measured by the same person to prevent inter-observer error. Data obtained were tabulated and statistical analysis was performed by SPSS and students t-test is applied. A p-value less than 0.05 is considered significant.

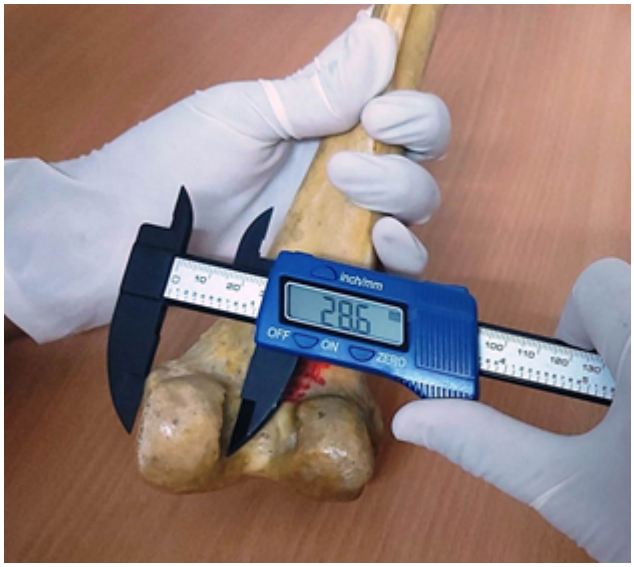

Figure 1: Measurement Of Medial Condyle of femur – TD

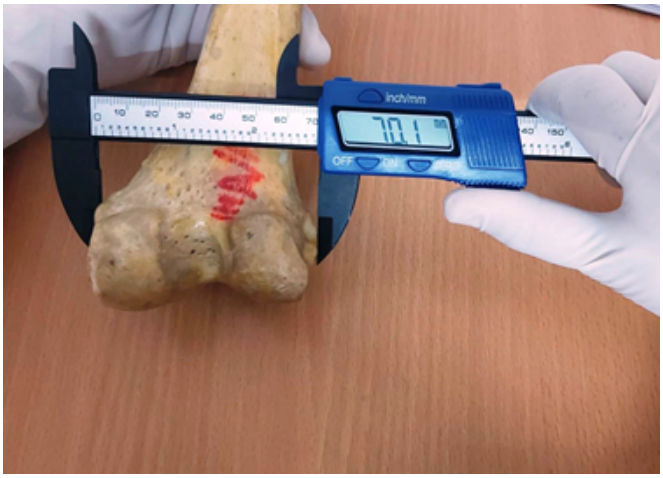

Figure 2: Measurementof Bicondylar width of the femur

Table 1: Measurements of parameters of femoral condyles

Side of femur	Medial condyle		Lateral condyle		Intercondylar region		Bicondylar
	MCAP	MCTD	LCAP	LCTD	Depth	Width	
Right	54.61 ± 3.38	28.14 ± 1.91	56.09 ± 3.57	29.97 ± 2.28	24.53 ± 2.57	20.92 ± 2.95	70.91 ± 5.21
Left	55.94 ± 4.5	28.94 ± 2.82	55.64 ± 4.17	30.41 ± 2.31	24.5 ± 2.43	20.80 ±2.65	71.01 ± 5.20

Table 2: Comparison of measurements between right and left femur

Parameter	Range Right (Mean ±SD)	Range left (Mean ±SD)
Medial condyle AP diameter	54.61 ± 3.38	55.94 ± 4.5
Lateral condyle AP diameter	56.09 ± 3.57	55.64 ± 4.17
Medial condyle TD	28.14 ± 1.91	28.94 ± 2.82
Lateral condyle TD	29.97 ± 2.28	30.41 ± 2.31
Inercondylar Depth	24.53 ± 2.57	24.5 ± 2.43
Intercondylar Width	20.92 ± 2.95	20.80 ± 2.65
Bicondylar Width	70.91± 5.21	71.01 ± 5.20

Figure 3: Measurement of Medial Condyle A-P Diameter

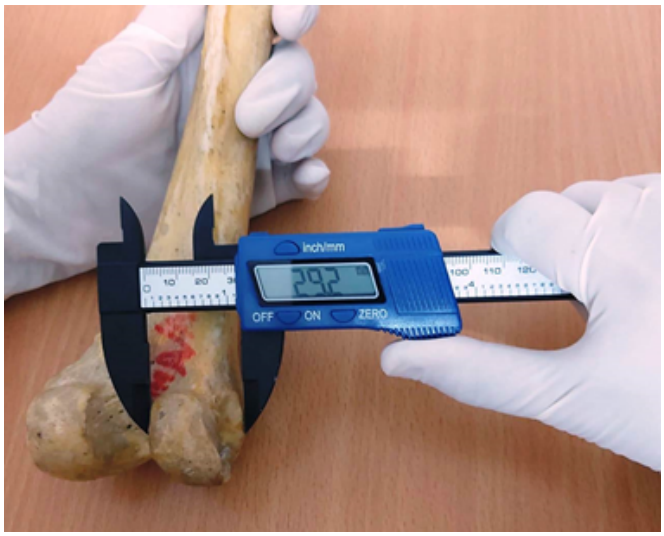

Figure 4: Measurement of Lateral Condyle T-D Diameter

Results

All measurements are represented in mm. & in terms of Mean ± Standard Deviation.

All parameters are recorded in mm. and represented as Mean ± SD. As we compared the mean values of all parameters from the above table, the medial condylar AP length of the femur on the right side was 54.61 ± 3.38 mm and on the left side, it was recorded as 55.94 ± 4.5 mm. with (p value= 0.189). Which is not considered statistically significant.

The mean values of medial condylar TD length on the right side were measured as 28.14 ± 1.91 mm while on the left side it was observed 28.94 ± 2.82 mm while (p = 0.194) by conventional criteria, this difference is considered to be not statistically significant.

Similar to the findings of medial condyle, the mean values of lateral condylar AP length on right side as LCAPD = 56.09 ± 3.57 mm and on left side LCAPD =55.64 ± 4.17 mm. with (p= 0.646) and the mean values of lateral condylar TD

Figure 5: Measurement of Lateral Condyle A-P Diameter

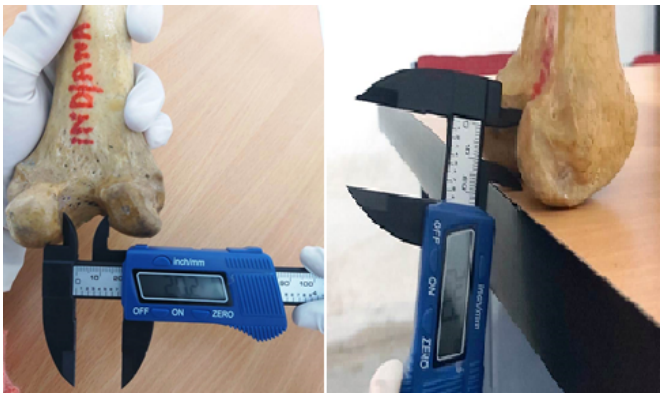

Figure 6: Measurement of Intercondylar width & depth

length on right side LCTD = 29.97 ± 2.28 mm and on left side LCTD =30.41 ± 2.31 mm & (p = 0.45) which is considered as statistically not significant.

Measurements of intercondylar depth on right side was 24.53 ± 2.57mm & on left side 24.5 ± 2.43 mm. for which p value calculated as (p = 0.969) whereas, intercondylar width measures 20.92 ± 2.95 mm on right side & 20.80 ± 2.65mm on left side. (p = 0.869) which is not statistically significant. Bicondylar width on right side was measured as 70.91± 5.21 mm while on left side 71.01 ± 5.20 mm with (p = 0.938).this difference is considered not statistically significant.

Discussion

In the Present study different parameters based on morphometric measurements of the lower end of the femur are recorded. According to many studies performed in India which were by indirect methods shows inaccurate methods which have to be corrected by projection or resolutions methods.

The study was done in the eastern Indian population on 70 dry femurs of unknown sex and also 50 digital radiographic plates of known age & sex by Ananya Biswas shows mean LCAPD= 56.20mm & LCTD=28.03mm, MCAPD=54.74mm & MCTD=27.2mm, BCW=71.71mm. So, the present study dimenstions are highly correlated with the above study.[16] Another study from the Gujarat population was performed by Ankur Zalawadia based on 120 dry femursof known gender were used, the present study also shows correlation with the aftermentioned study.[17]

Conclusion

The data generated from the present study may be useful to orthopeditians and surgeons to select the accurate size of the prosthesis during knee arthroplasty surgeries. Also, measurements of the intercondylar notch from our study may assist in surgeries of ACL inury, tears & diseases of anterior crusciate ligaments during the ACL reconstruction procedures.

The data from the present study may be helpful for Indian biomechanical engineers to meet the demands of appropriate size of the prosthetic component to be used instead of the oversized or small-sized prosthesis and to prevent complications like loosening due to undersized or causing impingment of the soft tissue due to incorrect knee prosthesis available.

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