



Research Article

MORPHOMETRIC ANALYSIS OF DISTAL END OF ADULT DRY FEMUR AND ITS CORRELATION WITH THE LENGTH OF FEMUR - AN INSTITUTIONAL STUDY

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ABSTRACT

Background: -Femur is the longest and strongest bone of human body providing attachment to powerful muscles for locomotion and maintenance of erect posture. Morphometric anatomical data of the lower end of femur and gender morphometric differences are very important to make design of prosthesis used for knee joint replacement and internal fixation. **Aim:** Present study concentrates on morphometric analysis of distal end of adult dry femur as its dimensions are required for designing prosthesis used for total knee replacement. **Material and Methods:** A set of 75 undamaged adult human femur bones were chosen out of which 46 bones are of right side and 29 that of left side. All the bones that are fully ossified and free from any pathological defects are included. On femur bone, the following parameters were measured: BCW, MCAPD, LCAPD, MCTD, LCTD, ICW. **Results:** - BCW calculated for right side was 72.78 ± 4.62 and for left side was 74.46 ± 4.67 . Average MCAPD was found to be 58.00 ± 3.7 for the right side and 60.25 ± 4.2 . LCAPD was observed to be 58.72 ± 3.52 for the right side and 60.07 ± 3.12 for left side. MCTD for the right and left sides were computed to be 32.38 ± 2.93 and 30.64 ± 3.15 respectively. LCTD for the right and left sides were found to be 33.12 ± 5.40 and 32.64 ± 3.52 respectively. Average ICW for the right and left sides were 22.74 ± 3.26 and 23.46 ± 2.91 respectively. Mean Length of femur on right side was 413.19 mm and on left side was 437.85 mm. **Conclusion:** -This study may help orthopaedicians of the region to plan total knee replacement. It is considered as the gold standard treatment for management of patients with severe osteoarthritis of the knee joint. This would be beneficial in selecting accurate prosthesis, minimizing the mismatch and reducing the post-operative complications after total knee replacement surgery and in turn making the operation a successful one.

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INTRODUCTION

The thigh bone femur is the largest, longest and strongest bone of the human body providing attachment to powerful muscles for locomotion and maintenance of erect posture. The femur bone has two condyles which are the medial condyle and lateral condyle. The medial condyle is one of the 2 projections on the lower extremity of femur, the other being the lateral condyle¹. The medial condyle is larger than the lateral condyle due to more weight bearing caused by the centre of mass being medial to the knee^{2,3}. The femur articulates proximally with the acetabulum of the pelvis for in the hip joint⁴. According to the previous research or literature, the length of the condyles was taken, and the breadth of the condyles were taken and even the diameter of the femoral condyles were taken⁵.

The expanded condyles of femur articulate inferiorly with the corresponding condyles of tibia and anteriorly with patella to form the complex and compound variety of modified hinge

joint known as knee joint providing stability during locomotion and in long standing erect posture⁶. As regards its structure, position and function, the knee joint is very much vulnerable to traumatic and degenerative diseases especially in elderly persons. Often total knee replacement arthroplasty becomes necessary for individuals suffering from osteoarthritis for pain alleviation and better mobility. Anatomical knowledge of distal end of femur is very important for orthopedicians, as knee replacement surgery needs the implant to be placed accurately as far as possible⁷.

Accurate morphometric anatomical data of the lower end of femur and gender morphometric differences are very important to make design of total knee joint replacement and internal fixation material. Knee prosthesis made based on morphometric data of components of the knee (femur and tibia) and according to gender will give better results in early mobility as well as fewer complications.

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Non-invasive methods like radiography, MRI, CT scanning have been used for measurement of morphometric data of lower end of femur and upper end of tibia for making prosthesis required for total knee arthroplasty which are relatively indirect methods with higher inaccurate data^{8,9,10}. Discrepancy between the size of femoral condyles and the prosthesis may result in non-fitting of implant with impaired mobility^{11,12}. So it is necessary to design exact size of prosthetic femoral condyles for total knee arthroplasty which can be done by direct measurement of morphometric data in respect of lower end of femur. The intention of our study is to analyse the various parameters of morphometric data of lower end of femur and to find the relation between these parameters and the length of femur. It has an implication in forensic medicine. It helps the forensic scientists to get an indirect idea of the height of the individual which is directly related with the height of long bones especially femur. Moreover, damage to long bones occurs by accidents like plane crash, earthquakes or crush injuries, making them fractured; hence reconstruction of height of body becomes difficult. In such cases, the ratio between fragment of the long bone and length of that bone would help in estimating height of that individual.

MATERIALS AND METHODS

This study was conducted in the Department of Anatomy, Govt. Medical College, Srinagar. A total of 75 femur bones were used for the research study, among which 46 were right femur bones and 29 were left femur bone. The damaged femur bone was removed from evaluation. With the help of a sliding caliper the following parameters were measured and recorded

1. Bicondylar width (BCW): The maximum distance across femoral condyles in transverse plane.
2. Medial condylar antero-posterior distance (MCPD): The maximum anteroposterior distance of medial femoral condyle.
3. Lateral condylar antero-posterior distance (LCAPD): The maximum anteroposterior distance of lateral femoral condyle.
4. Medial condylar transverse distance (MCTD): The maximum transverse distance of medial femoral condyle.
5. Lateral condylar transverse distance (LCTD): The maximum transverse distance of lateral femoral condyle.
6. Intercondylar notch width (ICW): The maximum distance of intercondylar notch between two condyles posteriorly.

Length of the dry Femur.



Figure1. Images showing bicondylar and intercondylar width



Figure 2 An image of the femur bone showing the measurement of antero-posterior distance and transverse distance of lateral condyle



Figure 3 An image of the femur bone showing measurement of antero-posterior and transverse distance of medial condyle



Figure 4 showing Length of femur

RESULTS

Table 1 showing different parameters showing mean (mm), S.D and p value

PARAMETERS	SIDE	N	MEAN (mm)	S.D	P VALUE
BICONDYLAR WIDTH	RIGHT	47	72.78	4.6	
	LEFT	28	74.46	4.6	0.13
MEDIAL CONDYLAR AP DISTANCE	RIGHT	47	58.00	3.7	
	LEFT	28	60.25	4.2	0.01
LATERAL CONDYLAR AP DIAMETER	RIGHT	47	58.72	3.5	
	LEFT	28	60.07	3.1	0.09
MEDIAL CONDYLAR TRANSVERSE DIAMETER	RIGHT	47	32.38	2.9	
	LEFT	28	30.64	3.1	0.01
LATERAL CONDYLAR TRANSVERSE DIAMETER	RIGHT	47	33.12	5.4	
	LEFT	28	32.64	3.5	0.67
INTERCONDYLAR NOTCH WIDTH	RIGHT	47	22.74	3.2	
	LEFT	28	23.46	2.9	0.34
LENGTH OF FEMUR	RIGHT	47	413.19	28.9	
	LEFT	28	437.85	26.9	0.00*

*P VALUE ≤0.05 is considered significant

According to Table 1 the mean bicondylar width (BCW) calculated for right side was 72.78 and for left side was 74.46 with a SD of 4.62 and 4.67 respectively having a p-value of 0.13. Average Medial condylar antero-posterior diameter was found to be 58.00 mm for the right side and 60.25 mm for left sides with a SD of 3.7 and 4.2 respectively having a P-value of

0.01. Mean Lateral condylar antero-posterior distance was observed to be 58.72 mm for the right side and 60.07 mm for left sides with a SD of 3.52 and 3.12 respectively having the P-value 0.09. Mean Medial condylar transverse distance for the right and left sides were computed to be 32.38 mm and 30.64 mm respectively, with respective SD of 2.93 and 3.15 having a p-value of 0.01. Mean Lateral condylar transverse distance for the right and left sides were found to be 33.12 mm and 32.64 mm respectively, with respective SD of 5.40 and 3.52 having a P-value of 0.67. Average Inter condylar notch width for the right and left sides were 22.74 and 23.46 mm respectively, with respective SD of 3.26 and 2.91 having a P-value of 0.34. Mean Length of femur on right side was 413.19 mm and on left side was 437.85 with respective SD of 28.97 and 26.99 having a P-value of 0.00.

DISCUSSION

In this study we have selected six morphometric parameters of lower end of dry femur and data collected by using the sliding calliper by direct observation. Most of the morphometric parameters are measured by indirect radiological methods which are found to be inaccurate and imprecise. So direct method of measurement is beneficial over the indirect methods which gives the accurate morphometric data. As the direct method of measurement is accurate, the morphometric data can have an important implication in orthopaedic surgeries like making of prosthesis for joint replacement surgery that will improve the success of joint replacement surgeries and will minimize the rate of complications.

There are several studies done which are based on western population and also the prosthesis available in market is based on western population [9, 11] although the Indians have smaller knees as compared to them. This study will provide data and will influence in the clinical outcome to design improved prosthesis based on our knee measurements. There is significant difference in morphometric data of the lower end of femur in various populations of countries across world as well as populations within India. In our study the mean bicondylar width of all specimens was found to be 72.7872 ± 4.62 mm on right side and 74.4643 ± 4.67 mm on left side. Similar results were found in Gujarati population studied by Zalawadia *et al.*11 where mean bicondylar width was 74.48 ± 1.90 on right side and 74.59 ± 2.75 on left side. Our results were also comparable with studies conducted by Mistri *et al.*10, Ravichandran *et al.*12 and Shweta *et al.* Similar studies done abroad by Terzidis *et al.*3 showed higher values than our study. In this study statistically significant difference between right and left sides for bicondylar width was not observed.

The mean medial condylar antero-posterior distance of the present study on right side is 58.00 ± 3.70 mm and on left side it is 60.25 ± 4.20 . Zalawadia *et al.*14 also observed similar results in their study. Mahalakshmi Rajan *et al.* Neelima *et al.*, also observed similar results in their studies.

The mean lateral condylar antero-posterior distance of the present study was 58.72 ± 3.52 mm on right side and 60.07 ± 3.12 on left side. Similar results were observed by Zalawadia *et al.*, Neelima *et al.*, in their studies. Mahalakshmi Rajan *et al.*17 noted higher values and Chavda *et al.*11 had lower values than the present study. CT scan values of Magetsari *et al.*16 had lower values and those of Moghtadaei *et al.*18 had higher values than the present study. In this study,

the mean medial condylar transverse distance was 32.38 ± 2.93 mm on right side and 30.64 ± 3.15 on left side. Similar values were seen in Zalawadia *et al* in Gujarati population.

The mean Lateral condylar transverse distance observed in our study was 33.12 ± 5.40 mm on right side and 32.64 ± 3.52 mm on left side. Chavda *et al.*11 and Zalawadia *et al.*14 observed same values. The average Intercondylar width in our study was 22.74 ± 3.26 on right side and 23.46 ± 2.91 mm on left side. Similar values were found by Zalawadia *et al* Mahalakshmi Rajan *et al* and Biswas *et al.*15 Moghtadaei *et al.*18 studied CT scan in Iranian population who showed similar values. Lower values were reported by Ameet *et al.*19

References

1. Moore KL, Agur AM, Dalley AF. Clinically Oriented Anatomy. Wolters Kluwer: Lippincott Williams and Wilkins; 2014. p. 516–520.
2. Gray's Anatomy. The anatomical basis of clinical practice. Elsevier Churchill Livingstone. 2005; 39: 1434-1435.
3. Terzidis, I., Totlis, T., Papathanasiou, E., Sideridis, A., Vlasis, K., Natsis, K. Gender and side-to-side differences of femoral condyles morphology: osteometric data from 360 caucasian dried femori. Anatomy Research International. 2012; 2012: 679658.
4. Cheng, F. B., Ji, X. F., Lai, Y., Feng, J. C., Zheng, W. X., Sun, Y. F., *et al.* Three dimensional morphometry of the knee to design the total knee arthroplasty for Chinese population. Knee. 2009; 16(5): 341-347.
5. Lombardo, S., Sethi, P. M., Starkey, C. Intercondylar notch stenosis is not a risk factor for anterior cruciate ligament tears in professional male basketball players: an 11-year prospective study. American Journal of Sports Medicine. 2005; 33(1): 29-34.
6. Urabe K, Mahoney OM, Mabuchi K, Itoman M. Morphologic differences of the distal femur between Caucasian and Japanese women. Journal of Orthopaedic Surgery 2008;16(3):312–315.
7. Insall J. Surgical techniques and instrumentation in total knee arthroplasty. 5th ed. New York: Churchill Livingstone; 2012., 5th Ed.
8. Shahi AS, Masoudi A, Kazemiaghgh A, Hr, Hosseinzadeh H, Yeganeh M. Intech Open Access Publisher; 2013.
9. Pope, M. H., Crowninshield, R., Miller, R., Johnson, R. The static and dynamic behaviour of the human knee in vivo. J Biomech. 1976; 9: 449-452.
10. Mistri S. A study of femoral condylar morphometry. Indian J Basic Appl Med Res; 2015(4):500–510.
11. Chavda, H. S., Jethva, N. K., Gupta, S. A study of Morphometric analysis of condyles of adult femur of humans in Gujarat region. International Journal of Anatomy, Radiology and Surgery. 2019; 8(3): AO01-AO05.
12. Ravichandran D, Melanie R. Morphology of the intercondylar notch and its clinical significance. IJAS. 2010; 1:26–30.
13. Shweta, J., Renu, C. Morphometric analysis of Condyles and Intercondylar notch of femur in North Indian population and its Clinical significance. J Evolution Med Dent Sci. 2017; 6(32): 2605-2608.

15. Zalawadia, A. Z., Parekh, D. H., Patel S. M. Morphometric study of lower end of dry femur in Gujarat region and its Clinical implication. *Int J Anat Res.* 2017; 5(4.2): 4595- 4599.
16. Biswas A, Bhattacharya S. A morphometric and radiological study of the distal end of femur in West Bengal population. *Italian Journal of Anatomy and Embryology* 2017;122(1): 39-48.
17. Magetsari, R., Suyitno, Dharmastiti, R., Salim, U. A., Hidayat, L., Yudiman, T., *et al.* Three dimensional morphometry of distal femur to design knee prosthesis for Indonesian population. *Int J Morphol.* 2015; 33(4): 1255-1260.
18. MahalakshmiRajan, Kalpana Ramachandran. Morphometric analysis of lower end of adult dry femur in south Indian population – A cross-sectional observational study and its clinical significance. *Biomedicine:* 2020; 40(2): 128- 133
19. Moghtadaei M, Moghimi J, Shahhoseini G. Distal Femur Morphology of Iranian Population and Correlation withCurrent Prostheses. *Iran Red Crescent Med* 2016;18(2): e21818. Published online 2016 Jan 6. doi: 10.5812/ircmj.21818.
20. Ameet, K. J., Murlimanju, B. V. A Morphometric Analysis ofIntercondylar Notch of Femur with Emphasis on Its Clinical Implications. *Med and Health.* 2014; 9(2): 103-108.

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