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Anatomy

Study of Morphometric Analysis of Distal End of Femur in the North Indian Population

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Abstract **Original Research Article**

Knee joint is one of the most important joint needed for locomotion but unfortunately it is commonly affected by degenerative diseases, which ultimately lead to joint replacement surgery. In such cases, measurements of lower end of femur has great importance in designing of implants. Prosthesis based on accurate morphometric data of components of knee; femur and tibia, plays a crucial role, which will ensure early mobility as well as fewer complications after arthroplasty. The present study was done to obtain certain morphometric data of femoral condyles by direct method and to determine differences on right and left side. It was carried out on 73 dried femurs of unknown sex in the department of Anatomy, regional Institute of Medical Sciences, Imphal. Measurements were taken by using the digital Vernier Caliper. Statistical analysis was done using SPSS software. The results obtained were, mean bicondylar width R:75.34±5.86,L:74.94±6.67; AP diameter of medial condyle, R:57.29±4.94,L:56.39±5.40;Lateral condyle, R:59.44±4.99, L:58.04±4.10; Transverse diameter of medial condyle, R:21.62±2.84, L:22.24±2.89; Lateral condyle, R:23.29±3.05, L:23.76±2.24; Intercondylar width, R:22.41±2.97,L:22.26±3.77. This morphometric data of the lower end of the femur can aid in the design of implants suitable for the North Indian population.

Keywords: Knee joint, Knee prosthesis, Femoral condyle, Bicondylar width, AP diameter, Transverse diameter, Intercondylar width.

INTRODUCTION

The knee joint is a complex synovial joint consisting of the tibiofemoral and patellofemoral articulations. It functions to control the centre of body mass and posture in the activities of daily living. This necessitates a large range of movement in three dimensions coupled with the ability to withstand high forces. These conflicting parameters of mobility and stability are only achieved by the interactions between the articular surfaces, the passive stabilizers and the muscles that cross the joint [1].

There is an increase in the incidence of osteoarthritis affecting knee joint with advancing age and also in obese persons. As osteoarthritis is a very painful condition it adversely affects the day to day activities of the patient. Total Knee Arthroplasty or Total Knee Replacement are beneficial in patients with severe osteoarthritis. Success of this operation largely depends on accurate size and proper selection of prosthesis as well as proper placing of components [2, 3].

The anatomy of the distal femur has important implications in total knee replacement, which aims to restore the morphology of the distal femur to as normal as possible [4]. Morphometric studies have been conducted by indirect methods of measurements like radiography, computerized tomography and magnetic resonance imaging [5, 6]. However, even after correcting the magnification, technique and projection, it is found that these indirect methods are inaccurate [7, 8]. Mismatch of selected prosthesis may lead to complications like loosening of implant or impingement of surrounding soft tissue [9].

The conventional prosthesis available in the market are designed for the Caucasians. When compared to the Caucasians, North Indian population have smaller anatomical measurements. By using the measurements and proper guidelines, knee prosthesis best suited for North Indian population can be designed. This also ensures long term utilization of prosthesis.

MATERIALS AND METHODS

The present study was carried out on 73 adult dried femurs (40 right, 33 left) of unknown age and sex available in the department of Anatomy, Regional Institute of Medical Sciences, Imphal. Only complete and fully ossified bones were included and bones showing damage, deformity or arthritic changes were excluded from the study.

Following parameters were measured with the help of digital vernier caliper.

1. Bicondylar width – Maximum distance between both femoral epicondyles (BCW): Maximum distance between medial and lateral epicondyles in transverse plane.
2. Maximum anteroposterior distance of lateral femoral condyle (LCAP): Maximum distance between anterior and posterior surface of lateral condyle.
3. Maximum anteroposterior distance of medial femoral condyle (MCAP): Maximum distance between anterior and posterior surface of medial condyle.
4. Maximum transverse distance of medial femoral condyle (MCT): Maximum distance between medial and lateral surface of medial condyle.
5. Maximum transverse distance of lateral femoral condyle (LCT): Maximum distance between medial and lateral surface of lateral condyle.
6. Intercondylar Notch Width (ICW): Maximum distance between medial and lateral surface of intercondylar notch posteriorly.

All measurements were taken by single author for consistency. All the measurements for right and left femur were recorded separately. The data was recorded in MS Excel Sheet and analysed using SPSS Software v 20 for mean and SD. Independent t – test was used to calculate the differences in the parameters of right and left femur. The p-value < 0.05 was considered statistically significant.

Fig-1: Measurement of bicondylar width (Maximum distance between both femoral epicondyles)

Fig-2: Measurement of maximum anteroposterorior distance of medial femoral condyle

Fig-3: Measurement of maximum transverse distance of lateral femoral condyle

Fig-4: Measurement of intercondylar notch width (Maximum distance of intercondylar notch between two condyles anteriorly)

Out of 73 bones studied, 40 bones belong to right side and 33 bones belong to the left side. Mean bicondylar width was 75.34 ± 5.86 on right side and 74.94 ± 6.67 on left side (p>0.05). Mean anteroposterior distance for medial condyle was 57.29 ± 4.94 on right

side and 56.39 ± 5.40 on left side (p>0.05). Mean anteroposterior distance for lateral condyle was 59.44 ± 4.99 on right side and 58.04 ± 4.10 on left side (p>0.05). Mean transverse distance for medial condyle was 21.62 ± 2.84 on right side and 22.24 ± 2.89 on left side (p>0.05). Mean transverse distance for lateral condyle was 23.29 ± 3.05 on right side and 23.76 ± 2.24 on left side (P>0.05). Mean intercondylar notch width was found to be 22.41 ± 2.97 on right side and 22.26 ± 3.77on the left side (p>0.05).

The mean and SD values of all the bones included in the study are tabulated in Table 1.

Table-1: Showing mean, standard deviation and p-value of various parameters of right and left sides

Parameter	Side of femur bone(mean ±SD)(mm)		p-vaiue
	Right (N=40)	Left (N=33)	
BCW	75.34±5.86	74.94±6.67	0.838
MCAP	57.29±4.94	56.39±5.40	0.864
LCAP	59.44±4.99	58.04±4.10	0.89
MCT	21.62±2.84	22.24±2.89	0.938
LCT	23.29±3.05	23.76±2.24	0.952
ICNW	22.41±2.97	22.26±3.77	0.908

DISCUSSION

The stability of knee joint is determined by the morphology of femoral condyles and intercondylar notch. In the treatment of knee joint degenerative diseases, knee joint arthroplasty has become popular. The proper use of morphometrical matched prosthesis is the key to success of knee arthroplasty [10]. It is therefore very important to have knowledge of reliable morphometric data for designing and selection of implant size. Morphometric data were calculated using Vernier caliper by direct observation. In this study, although the right femora showed somewhat larger values than the left femora, they were not statistically significant.

In table 2, we have compared our findings of the present study with other studies on dry femur published in literature.

In our study, the average bicondylar width was 75.34 ± 5.86 on right side and 74.94 ± 6.67 on the left side. This value is slightly higher than the values obtained by other studies done in other parts of Indian population. But higher values were obtained in similar study done by Terzidis l *et al*., in the Greek bones where bicondylar width was recorded 84.1 ± 0.63 on right side and 83.7 ± 0.63 on left side. Higher values were also recorded by Taner Z *et al*., in study done on Anatonian bones where BCW was 76.8 ± 5.9 on right side and 77.3 ± 5.2 on left side.

In our study, average value of MCAP was 57.29 ± 4.94 on right side and 56.39 ± 5.40 on left side. This value is lower than obtained by Terzidis l *et al*., where MCAP was recorded 58.6 ± 4.1 on right side and 58.7 ± 4.1 on left side, while Biswas A *et al*., in their study done in West Bengal population, recorded lower values of 52.97 ± 3.77 on right side and 54.74 ± 3.85 on left side.

In the present study, average value of LCAP was 59.44 ± 4.99 on right side and 58.04 ± 4.10 on left side. This value is higher than that recorded by Biswas A *et al*., and Hiren S Chavda *et al*., but lower than that obtained by Terzidis l *et al*.,

The average value of MCT was 21.62 ± 2.84 on right side and 22.24 ± 2.89 on left side in the present study. Biswas A et al and Hiren S Chavda et al recorded higher values in their study.

The average value of LCT is lower than that recorded by Biswas et al and Hiren S Chavda *et al*., We found the average value of ICW to be 22.24 ± 2.97 on right side, 22.26 ± 3.77 on left side. This value is slightly higher than that recorded in previous studies done by Mistri S *et al*., Ravichandran D *et al*., Ameet KJ *et al*., Shweta J *et al*., Biswas A *et al*., Hiren S Chavda *et al*., Terzidis l *et al*., and Taner Z *et al*.,

Table-2: Showing comparison of various parameters of femoral condyles with other studies on dry femur (values are expressed in mm)

Year of study and population studied	BCW		MCAP		LCAP		MCT		LCT		ICW	
	R	L	R	L	R	L	R	L	R	L	R	L
Taner Z *et al*., 2002 Anatonian 72 bones(36R ,36L)	76.8±5.9	77.3±5.2	-	-	-	-	-	-	-	-	-	-

Year of study and population studied	BCW		MCAP		LCAP		MCT		LCT		ICW	
	R	L	R	L	R	L	R	L	R	L	R	L
Ravichandran D *et al.*, 2010, South India(200 bones,106R, 94L)	74.58±0.57	73.97±0.61	-	-	-	-	-	-	-	-	18.89±0.29	18.65±0.27
Terzidis L *et al.*, 2012, Greek 360 bones(180 R,180L)	84.1±0.62	83.7±0.63	58.6±4.1	58.7±4.1	58.4±4.0	-	-	-	-	-	20.5±2.3	20.5±2.2
Ameet KJ *et al.*, 2014,97 bones(45R ,52L)	72.5±5.3	73.3±5.3	-	-	-	-	-	-	-	-	18.0±3.0	17.9±2.5
Mistri S *et al.*, 2015, West Bengal 127 bones(65R,62L)	74.43±6.10	73.98±5.99	-	-	-	-	-	-	-	-	19.12±2.5	18.65±2.8
Shweta J *et al.*, 2017 North India 100bones (51R,49L)	73.1±6.14	72.16±6.58	-	-	-	-	-	-	-	-	20.82±2.57	21.03±3.13
Biswas A *et al.*, West Bengal 70 bones (35R,35L)	71.71±4.50	70.71±5.25	52.97±3.77	54.74±3.85	56.20±3.36	56.05±4.29	25.48±2.05	27.28±2.29	27.80±2.91	28.03±2.56	20.86±2.52	19.45±2.57
Hiren S *et al.*, 2018 Gujarat 74 bones(37R ,37L)	69.6±5.04	69.8±4.96	52.9±4.99	53.5±4.15	54.7±4.01	55.0±4.31	26.7±2.03	26.9±2.23	30.3±3.05	29.6±2.23	20.4±3.17	18.7±3.53
Present study, North India 73 bones(40R,33L)	75.34±5.86	74.94±6.67	57.29±4.94	56.39±5.40	59.44±4.99	58.04±4.10	21.62±2.84	22.24±2.89	23.29±3.05	23.76±2.24	22.41±2.97	22.26±3.77

CONCLUSION

The current study has elucidated the dimensions of the distal femur in adult North Indian population. The values obtained indicate that there are ethnic variances between different populations. This morphometric data of the lower end of the femur can therefore aid in the design of implants suitable for the North Indian population. Selection of appropriate implant according to different ethnic specifications will minimize mismatch and will increase clinical outcome. However, the present study was conducted on only 73 bones which is small sample for the study to represent the entire North Indian population. Also, in the present study, we could not conduct evaluation on the basis of gender because the bones available in the department were of unknown sex. Further larger studies involving more bones of known sex from different regions are advised to increase the knowledge of the subject.

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