

## MORPHOMETRIC STUDY OF LOWER END OF DRY FEMUR IN GUJARAT REGION AND ITS CLINICAL IMPLICATION

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### ABSTRACT

**Introduction:** Lower end of femur is major component of knee joint. 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 knee (femur and tibia) and according to gender will give better results in early mobility as well as fewer complications.

**Aim:** Present study was done to find out sexual dimorphism in lower end of femur as well as differences between morphometric data of lower end of femur between other populations of world and within India.

**Materials and Methods:** For the present study the material consisted of 120 dry femur of known gender were used. Out of them 60 were of male (30 of right side and 30 of left side) and 60 were of female (30 of right side and 30 of left side). We have selected six metrical parameters 1. Bicondylar width (BCW), 2. Medial condylar antero-posterior distance (MCAPD), 3. Lateral condylar antero-posterior distance (LCAPD), 4. Medial condylar transverse distance (MCTD), 5. Lateral condylar transverse distance (LCTD) and 6. Intercondylar notch width (ICW) for the present study based on which the prosthesis for knee joint replacement surgery is made.

**Results:** All six parameters which are chosen are found significantly larger in male than females. The findings are smaller than Caucasian population and found larger than other population of Andhra Pradesh and West Bengal.

**Conclusion:** Present study provides data of measurement of lower end of femur by direct observation which will be useful to select correct prosthesis according to measurements. We have also provided data for gender wise and on right and left side which will improve the longitivity of prosthesis, increased mobility and lifestyle of patient after knee replacement surgery.

**KEY WORDS:** Dry Femur, Lower End, Morphometry, Knee Prosthesis.

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### INTRODUCTION

Femur is the largest and longest bone in the body. The distal end of the femur is widely expanded, has two massive condyles – medial and lateral, and between condyles posteriorly there is intercondylar notch. The condyles of

femur are partly articular and make joint inferiorly with corresponding condyles of tibia and anteriorly with patella [1].

There is increased need of total knee replacement (TKR) as there is increased incidence of

osteoarthritis in increased incidence of obesity and rapidly aging population. Joint replacement has considered beneficial for removing pain and improve the lifestyle of patients in severe case of osteoarthritis [2].

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 [3,4]. Mismatch between Morphometric data and selected prosthesis may cause severe complications like anterior cruciate ligament rupture, soft tissue imbalance, decreased movements of knee and implant loosening. [3,5-9] So knee prosthesis made based on morphometric data of components of knee (femur and tibia) and according to gender will give better results in early mobility as well as less complications [2,4].

Recent studies are based on difference between gender and ethnic groups. [3,4,10-13] Most of the morphometric studies are done with measurement by radiographs, CT scans or Magnetic resonance imaging techniques [2,4,10-15]. There are few data available in which the study is done over dry femur by direct observations [3,16,17]. We have done morphometric study of lower end of dry femur and in known gender. The results will give basic data and exact measurements of lower end of femur gender wise and of India population especially the eastern part before the knee replacement surgeries done over it.

## MATERIALS AND METHODS

For study the material consisted of 120 dry femur of known gender were used. Out of them 60 were of male (30 of right side and 30 of left side) and 60 were of female (30 of right side and 30 of left side). Gender was assessed through the records available in Department of Anatomy, Government Medical College, Bhavnagar, Gujarat, India. All bones were on gross examination were fully ossified, had no evidence of fracture or any pathological or congenital anomalies. Damaged or bones with arthritic changes were excluded from the study. The study was done at Department of Anatomy, Government Medical College, Bhavnagar, Gujarat, India. The collected bones were

assessed with sliding caliper (Martin type, 0-200 mm). The parameters which were measured are as follows:

**Bicondylar width (BCW):** The maximum distance across femoral condyles in transverse plane (Figure-1)

**Medial condylar antero-posterior distance (MCAPD):** The maximum anteroposterior distance of medial femoral condyle (Figure-2)

**Lateral condylar antero-posterior distance (LCAPD):** The maximum anteroposterior distance of lateral femoral condyle (Figure-3)

**Medial condylar transverse distance (MCTD):** The maximum transverse distance of medial femoral condyle (Figure-4)

**Lateral condylar transverse distance (LCTD):** The maximum transverse distance of lateral femoral condyle (Figure-5)

**Intercondylar notch width (ICW):** The maximum distance of intercondylar notch between two condyles posteriorly (Figure-6)

The above data obtained and statistically analysed.



Figure 1 Measurement of bicondylar width (BCW)



Figure 2 Measurement of medial condylar antero-posterior distance (MCAPD)



Figure 3 Measurement of lateral condylar antero-posterior distance (LCAPD)



Figure 4 Measurement of medial condylar transverse distance (MCTD)



Figure 5 Measurement of lateral condylar transverse distance (LCTD)



Figure 6 Measurement Intercondylar notch width (ICW)

The morphometric measurements of the lower end of the femur are summarized in Table 1.

**Table 1:** Measurements of lower end of the femur in mm.

Parameters	Side	Male (Mean±SD)	Combined (Male) (Mean±SD)	Female (Mean±SD)	Combined (Female) (Mean±SD)	p-Value*
BCW	Right	74.48±1.90	74.53±2.34	67.42±1.93	67.09±2.11	<0.05
	Left	74.59±2.75		66.75±2.59		
MCAPD	Right	57.21±2.53	57.49±2.34	53.44±1.82	53.91±2.05	<0.01
	Left	57.77±2.15		54.37±2.20		
LCAPD	Right	58.36±3.03	59.02±2.69	54.98±1.89	54.82±2.34	<0.05
	Left	59.68±2.16		54.66±2.87		
MCTD	Right	30.31±1.66	30.32±3.88	27.47±1.33	27.69±1.43	<0.05
	Left	31.32±1.35		27.91±1.52		
LCTD	Right	31.32±1.72	31.65±1.49	28.76±1.47	28.88±1.39	<0.01
	Left	31.99±1.15		28.96±1.33		
ICW	Right	20.31±2.94	21.11±2.02	19.42±2.32	19.35±2.52	<0.001
	Left	20.91±1.32		19.27±2.74		

\* The p-values are calculated for comparison across genders

According to Table 1 the mean bicondylar width (BCW) in Gujarat region in males was 74.53±2.34 mm (74.48±1.90 mm on right side and 74.59±2.75 mm on left side) while in females it was 67.09±2.11 mm (67.42±1.93 mm on right side and 66.75±2.59 mm on left side) [p<0.05]. The medial condylar anteroposterior distance (MCAPD) in males was 57.49±2.34 mm (57.21±2.53 mm on right side and 57.77±2.15 mm on left side) while in females it was 53.91±2.05 (53.44±1.82 mm on right side and 54.37±2.20 mm on left side) [p<0.01]. The lateral condylar anteroposterior distance (LCAPD) in males was 59.02±2.69 mm (58.36±3.03 mm on right side and 59.68±2.16 mm on left side) while in females it was 54.82±2.34 mm (54.98±1.89 mm on right side and 54.66±2.87 mm on left side) [p<0.05]. The medial condylar transverse distance (MCTD) in males was 30.32±3.88 mm (30.31±1.66 mm on right side and 31.32±1.35 mm on left side) while in females it was 27.69±1.43 mm (27.47±1.33 mm on right side and 27.91±1.52 mm on left side) [p<0.05]. The lateral condylar transverse distance (LCTD) in males was 31.65±1.49 mm (31.32±1.72 mm on right side and 31.99±1.15 mm on left side) while in females it was 28.88±1.39 mm (28.76±1.47 mm on right side and 28.96±1.33 mm on left side) [p<0.01]. The intercondylar width (ICW) in males was 21.11±2.02 mm (20.31±2.94 mm on right side and 20.91±1.32 mm on left side) while in females it was 19.35±2.52 mm (19.42±2.32

mm on right side and 19.27±2.74 mm on left side) [p<0.001].

## DISCUSSION

In this study we have selected six morphometric parameters of lower end of dry femur and data collected by using the sliding caliper by direct observation. Most of the morphometric studies are done with measurement by radiographs, CT scans or magnetic resonance imaging techniques which are indirect methods [2,4,10-15]. There are studies which suggest that indirect method of measurement are found inaccurate and not precise even though they are corrected by the projection method as well as by the resolutions. [2,17-19]. So direct method of measurement is beneficial over the indirect methods which gives the accurate morphometric data. Because the direct method of measurement is accurate we can match these morphometric data for making of prosthesis for joint replacement surgery with the resected surface of the knee that will improve factor for long term success of prosthesis and less complications in total knee joint replacement.

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

**Table 2:** Comparison of studies of various authors on morphometric study of lower end of femur (data in Mean±SD in mm).

Sr. No.	Author, year and method of study	Country and region	BCW	MCAPD	LCAPD	MCTD	LCTD	ICW
1	Magetsari R et al [2], 2015, CT scan	Indonesia males	70.56±5.17	44.27±4.91	43.30±6.75			
		Indonesia females	61.40±4.01	40.85±5.73	40.95±5.17			
2	Terzidis I et al [3], 2012, dry femur	Greek males	88.6±0.42	61.1±0.34	61.1±0.33			22.0±0.18
		Greek females	78.5±0.30	55.9±0.29	55.4±0.21			18.7±0.10
3	Cheng FB et al [4], 2009, CT scan	Chinese males	74.4±2.90		66.60±2.40			
		Chinese females	66.8±3.11		61.0±2.46			
4	Hussain F et al [14], 2013, CT scan	Malaysian males	74.91±3.52		64.02±3.38			
		Malaysian females	64.53±3.07		57.33±3.26			
5	Moghtadaei M et al [15], 2016, CT scan	Iranian males			63.35±3.1	24.61±1.9	24.42±2.0	21.76±3.0
		Iranian females			56.53±2.98	21.33±0.2	21.37±1.6	17.37±2.5
6	Neelima P et al [16], 2016, dry femur	India (Andhra Pradesh)		57.83±0.69	58.0±0.51	21.33±0.43	21.08±0.44	22.83±0.41
7	Biswas A et al [17], 2017, dry femur	India (West Bengal) Right side	71.71±4.50	52.97±3.77	56.20±3.36	25.48±2.05	27.80±2.91	20.86±2.52
		India (West Bengal) Left side	70.71±5.25	54.74±3.85	56.05±4.29	27.28±2.29	28.03±2.56	19.45±2.57
8	Present study	India (Gujarat) males	74.53±2.34	57.49±2.34	59.02±2.69	30.32±3.88	31.65±1.49	21.11±2.02
		India (Gujarat) females	67.09±2.11	53.91±2.05	54.82±2.34	27.69±1.43	28.88±1.39	19.35±2.52

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. (Table 2)

The bicondylar width in male was 74.53±2.34 mm and in female was 67.09±2.11 which was significantly greater in male than females (p<0.05). The measurements are very high in Greek (Caucasian) population in male as well as females. [3] These measurements were almost similar to other populations of Asia [4,14] but higher than population of West Bengal [17] and Indonesia [2] .

The medial condylar anteroposterior distance (MCAPD) in males was 57.49±2.34 mm while in females it was 53.91±2.05) which was significantly higher in male than female (p<0.01). The lateral condylar anteroposterior distance (LCAPD) in males was 59.02±2.69 mm while in females it was 54.82±2.34 mm which was significantly higher in male than female (p<0.05). These measurements were lower than Greek (Caucasian) [3], Chinese [4] and Malasian [14] populations but higher than Indonesian population [2]. It is found similar to the population of Andhra Pradesh [16] but slightly higher in male and lower in females than population of West Bengal [17].

The medial condylar transverse distance (MCTD) in males was 30.32±3.88 mm while in females it was 27.69±1.43 mm which was significantly

higher in male than female (p<0.05). The lateral condylar transverse distance (LCTD) in males was 31.65±1.49 mm while in females it was 28.88±1.39 mm which was significantly higher in male than female (p<0.01). These combined data of MCAPD and LCAPD were higher significantly than population of Andhra Pradesh [16] and Iran [15]. As compared the population of West Bengal [17] the there is much difference found in males while the females have similar measurements.

The intercondylar width (ICW) in males was 21.11±2.02 mm while in females it was 19.35±2.52 mm which was significantly higher in male than female (p<0.001). There is not much difference in measurement data between population across globe and found highest in Andhra Pradesh.

## CONCLUSION

Present study provides data of measurement of lower end of femur by direct observation which will be useful to select correct prosthesis according to measurements. We have also provided data for gender wise and on right and left sides which will improve the longevity of prosthesis, will increase mobility and improve lifestyle of patient after knee replacement surgery. Females will definitely benefit from newly designed gender-specific prosthesis.

**Conflicts of Interests: None**

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