

OSTEOMETRIC STUDY OF TIBIOFEMORAL JOINT-
CLINICAL IMPORTANCEAnjali Sharan¹, Jolly Agarwal², Abhinav Kumar³, Puneet Chaudhary⁴,
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2023; 5 (5); 1639-1643¹Post Graduate Resident, Department of Anatomy, Government Doon Medical College, India.²Associate Professor, Department of Anatomy, Government Doon Medical College, Dehradun, Uttarakhand, India.³Post Graduate Resident, Department of Anatomy, Government Doon Medical College, India.⁴Post Graduate Resident, Department of Anatomy, Government Doon Medical College, India.⁵Assistant Professor, Department of Anatomy, Government Doon Medical College, Dehradun, Uttarakhand, India.⁶Tutor, Department of Anatomy, Government Doon Medical College, Dehradun, Uttarakhand, India.⁷Professor & Head, Department of Anatomy, Government Doon Medical College, Dehradun, Uttarakhand, India.**Abstract**

Background: Upper end of tibia and lower of femur form tibiofemoral joint. Accurate morphometric data of this joint are very important in designing total knee joint replacement prosthesis and can be used to guide treatment and monitor outcome of total knee replacement surgeries. The aim of present study is to assess different osteometric parameters of condylar and intercondylar surface of tibia and femur. **Materials and Methods:** The study was conducted on 30 femur dry bones and 56 dry tibia bones. Out of 30 femur bone, 15 were of left side and 15 were of right side, while 28 dry tibia bones out of 56 were of left side and 28 of right side. Six parameters for distal femur, and for proximal tibia seven parameters were taken. **Results:** It was found that both anteroposterior and transverse measurement were greater (r- 0.11 & p-value 0.01).) in medial condyle on both sides whereas, anteroposterior and transverse measurement of lateral femoral condyle of both the sides were greater (r- 0.33 & p-value 0.003). **Conclusion:** It was found that both anteroposterior and transverse measurement were greater (r- 0.11 & p-value 0.01).) in medial condyle on both sides whereas, anteroposterior and transverse measurement of lateral femoral condyle of both the sides were greater (r- 0.33 & p-value 0.003).

INTRODUCTION

The tibiofemoral joint is an important weight bearing joint which is formed in between the condyles of femur, condyles of tibia and intercondylar area. Because of change in lifestyle and sedentary habits, knee joint is involved in many diseases like rheumatoid arthritis, osteoarthritis etc. With the increase in age, there is increased chance in involvement of tibiofemoral joint (TFJ) diseases like osteoarthritis. In severe cases of arthritis, sometimes total knee replacement surgeries (TKRs) are required.^[1] The successful surgery depends upon the appropriate parameters of lower end of femur and upper end of tibia forming tibiofemoral joint.^[2] The distal end of femur is a widely expanded structure with two massive condyles, namely medial and lateral. The inter-condylar notch is located posteriorly between the two condyles. The condyles of femur are partly articular and make a hinge joint inferiorly with corresponding condyles of tibia and

anteriorly with patella, giving integrity and stability to the knee joint while walking and prolonged standing, whereas the proximal end of the tibia is widely expanded, has two condyles – medial and lateral, and between condyles there is intercondylar area.

The parameters of condyles of femur and tibia are important for providing data for prosthesis in total knee replacement surgeries. Therefore, present study was conducted to study morphometry of condyles of femur and tibia which will be helpful in manufacturing prosthesis for TKR surgeries in Indian setting. So, that management of patient during surgery will be improved and chances of complications will be less. Very few studies have been found for parameters of femur and tibia particularly in Indian population till date.

MATERIALS AND METHODS

Study type- cross sectional observational study.

The present study was done in Department of anatomy, Government Doon Medical College, Dehradun (Uttarakhand) on 57 femur bone and 56 tibia bone. The present study was exempted from institutional ethical clearance as all dry bones were obtained from museum of dept. of Anatomy.

Inclusion Criteria

All bones were grossly examined. Bones which were fully ossified, had no evidence of fracture or any pathological or congenital anomalies

Exclusion Criteria

Bones which were damaged, grossly and not ossified. The age, sex and race of the bones were not known. The various parameters of condyles of femur, tibia and intercondylar area were taken with help of digital vernier caliper as follows (fig.1 and 2).

Out of 57 dry femur bone, 24 were of right side and 33 of left side, whereas, 28 tibia bone out of 56 were of right side and 28 were of left side.

Statistical analysis- All data were tabulated in Microsoft excel sheet and statically analyzed. Findings were expressed in mean and standard deviation.

The following six parameters of femur were taken.^[3]

1. Bicondylar width (BW)-The maximum distance between medial and lateral condyles in transverse plane. (Fig.1-a).
2. Intercondylar notch width (IW) - the maximum distance of posterior aspect of medial and lateral surface of Intercondylar notch. (Fig.1-b).
3. Medial condylar transverse distance (FMT) -The maximum medial to lateral surface distance of medial femoral condyle. (Fig.1-c).
4. Medial condylar antero-posterior distance (FMAP) -The maximum anterior to posterior distance of medial femoral condyle. (Fig.1-d)
5. Lateral condylar transverse distance (FLT) -The maximum medial to lateral surface distance of lateral femoral condyle. (Fig.1-e).
6. Lateral condylar antero-posterior distance (FLAP)-The maximum anterior to posterior distance of lateral femoral condyle. (Fig.1-f).



Fig.1- a- Bicondylar width (BW), b- Intercondylar notch width (IW), c-Medial condylar transverse distance (FMT), d-Medial condylar antero-posterior distance (FMAP), e- Lateral condylar transverse distance (FLT), f- Lateral condylar antero-posterior distance (FLAP).

For tibia, seven parameters were taken.^[8]

1. Anteroposterior measurements of superior articular surface of medial condyle (TMAP): The maximum distance between anterior and posterior borders of superior articular surface of medial condyle. (Fig.2- a).
2. Tibial Intercondylar Transverse Diameters (TIT): The maximum distance between anterior and posterior borders. (Fig.2- b).
3. Anteroposterior measurements of superior articular surface of lateral condyle (TLAP): The maximum distance between anterior and posterior borders of superior articular surface of lateral condyle. (Fig.2- c).
4. Anterior-Posterior Anterior Intercondylar Diameter (AP-AICA): The maximum distance between anterior border of intercondylar area to a line joining intercondylar eminence. (Fig.2- d)
5. Transverse measurements of superior articular surface of lateral condyle (TLT): The maximum transverse diameter of superior articular surface of lateral condyle. (Fig.2- e)
6. Transverse measurements of superior articular surface of medial condyle (TMT): The maximum transverse diameter of superior articular surface of medial condyle. (Fig.2- f)
7. Anterior-Posterior Posterior Intercondylar Diameter (AP-PICA): The maximum distance between a line joining intercondylar eminence and posterior border.

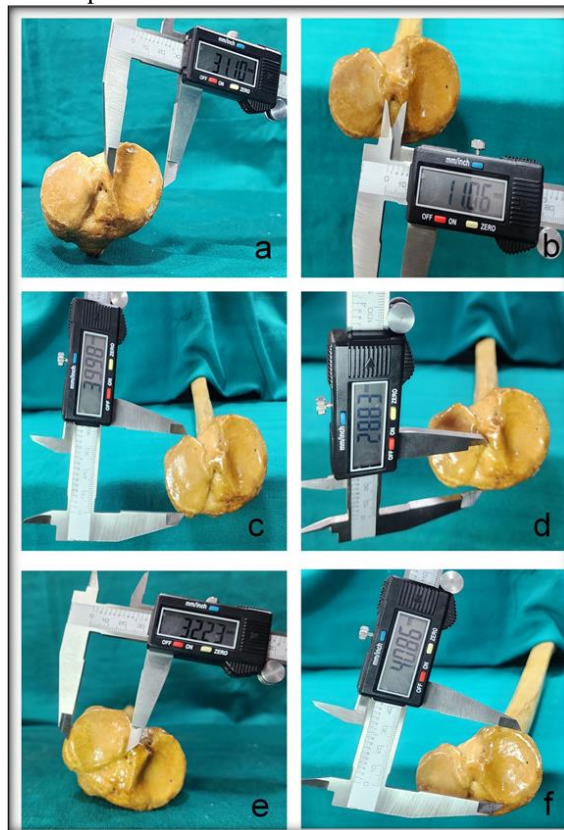
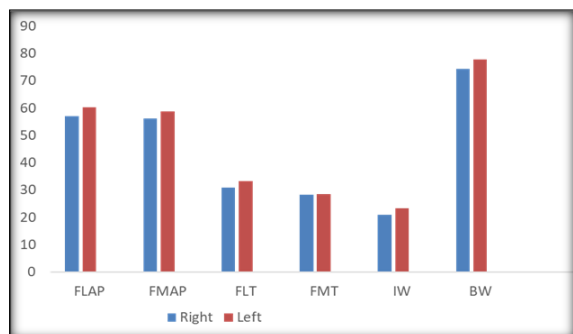


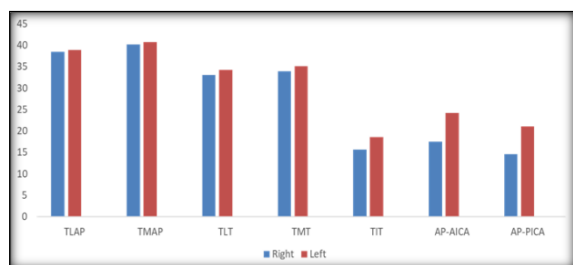
Fig.2- a- Anteroposterior measurements of superior articular surface of medial condyle (TMAP), b- Tibial Intercondylar Transverse Diameters (TIT), c- Anteroposterior measurements of superior articular surface of lateral condyle (TLAP), d- Anterior-

Posterior Anterior Intercondylar Diameter (AP-AICA), e- Transverse measurements of superior articular surface of lateral condyle (TLT), f-Transverse measurements of superior articular surface of medial condyle (TMT).

RESULTS



Graph 1: Showing the values of right and left femur



Graph 2: Showing the values of right and left tibia

The present study was done on 57 femur bone and 56 tibia bone. Out of which, 24 right and 33 left femur bones were studied. 28 right and left tibia were studied. The mean value of transverse and antero-posterior diameter of right side of femoral medial condyle is $28.32 \pm 5.8\text{mm}$ and $56.22 \pm 3.5\text{mm}$ respectively whereas, transverse and antero-posterior diameter of right side of femoral lateral condyle is $30.90 \pm 1.0\text{mm}$ and $57.12 \pm 2.2\text{mm}$ respectively. And transverse and antero-posterior diameter of left side of femoral medial condyle is $28.47 \pm 1.3\text{mm}$ and $58.70 \pm 2.0\text{mm}$ respectively whereas, transverse and antero-posterior diameter of left side of femoral lateral condyle is $33.29 \pm 0.9\text{mm}$ and $60.27 \pm 1.0\text{mm}$ respectively. The intercondylar width of right femur

is $21.00 \pm 0.7\text{mm}$ and left side is $23.21 \pm 0.5\text{mm}$ (Table 1).

The mean value of transverse and antero-posterior diameter of right side of medial condyle of tibia is $33.91 \pm 10.3\text{mm}$ and $40.15 \pm 6.6\text{mm}$ respectively and transverse and antero-posterior diameter of lateral condyle is $33.08 \pm 3.4\text{mm}$ and $38.47 \pm 2.7\text{mm}$ respectively. The transverse and anteroposterior diameter of left medial condyle of tibia is $35.07 \pm 5.05\text{mm}$ and $40.77 \pm 2.1\text{mm}$ respectively and that of transverse and antero-posterior diameter of left lateral condyle of tibia is $34.23 \pm 0.03\text{mm}$ and $38.88 \pm 1.7\text{mm}$ respectively.

The difference between the right transverse diameter of lateral femoral and lateral tibial condyle was statistically significant ($r=0.11$ & $p\text{-value}=0.01$). The transverse diameter of right tibial medial condyle is greater than that of right femoral medial condyle and the difference being statistically significant ($r=0.33$ & $p\text{-value}=0.003$) and that of antero-posterior diameter of right medial femoral condyle and right medial tibia condyle is also statistically significant when compared ($r=0.36$ & $p\text{-value}=0.002$).

On comparing the two condyles of the tibia it was observed that both antero-posterior and transverse measurements were greater in medial condyle on both sides, whereas antero-posterior and transverse measurements of lateral femoral condyles of both the sides were greater (Table 1,2).

The combined mean of antero-posterior and transverse diameter of lateral femoral condyle is 58.69mm and 32.09mm respectively and medial femoral condyle is 57.46mm and 28.39mm respectively. The mean of combined bicondylar width and intercondylar width right and left is 76.06mm and 22.10mm respectively.

On combining both sides of tibia, mean of antero-posterior and transverse diameter of lateral tibial condyle is 38.67mm and 33.65mm respectively and medial tibial condyle is 40.46 and 34.49mm respectively whereas, mean of intercondylar diameter is 17.08mm , anterior-posterior anterior intercondylar diameter is 20.83mm and that of anterior-posterior posterior intercondylar diameter is 17.83mm .

This study concluded that lateral condyles of both right and left tibia and femur are greater than that of medial condyles of the same.

Table 1: Showing various parameters of femur where, right side of femur (n=24), left side of femur (n=33)

Parameters	Right		Left	
	Range (mm)	Mean \pm Std.Dev	Range(mm)	Mean \pm Std. Dev
Femoral Lateral Condyle AP Dia. in mm	46.45- 67.88	57.12 ± 2.2	49.02- 64.4	60.27 ± 1.0
Femoral Medial Condyle AP Dia. in mm	46.33- 65.72	56.22 ± 3.5	47.09- 65.74	58.70 ± 2.0
Femoral Lateral Condyle Trans. Dia. in mm	25.27- 38.57	30.90 ± 1.0	26.15- 36.76	33.29 ± 0.9
Femoral Medial Condyle Trans. Dia. in mm	22.85- 35.32	28.32 ± 5.8	22.85- 33.79	28.47 ± 1.3
Intercondylar Width in mm	15.27- 26.98	21.00 ± 0.7	14.84- 26.74	23.21 ± 0.5
Bicondylar Width in mm	64.55- 87.56	74.26 ± 6.3	64.48- 81.72	77.86 ± 0.5

Table 2: Showing various parameters of tibia where, right and left side of tibia (n=28) each

Parameters	Right		Left	
	Range (mm)	Mean \pm Std.Dev	Range(mm)	Mean \pm Std.Dev
Tibial Lateral Condyle AP Dia. in mm	35.68- 41.27	38.47 ± 2.7	35.68- 40.67	38.88 ± 1.7
Tibial Medial Condyle AP Dia. in mm	33.53- 46.78	40.15 ± 6.6	33.53- 42.9	40.77 ± 2.1

Tibial Lateral Condyle Trans. Dia. in mm	29.63- 36.54	33.08±3.4	29.63- 34.26	34.23±0.03
Tibial Medial Condyle Trans. Dia. in mm	23.57- 44.26	33.91±10.3	23.57- 40.12	35.07±5.05
Tibial Intercondylar Trans. Dia. in mm	11.12 20.16	15.64±4.5	11.12- 21.74	18.52±3.2
Anterior-Posterior Anterior Intercondylar Dia. in mm	14- 21.02	17.51±3.5	15.82- 30.11	24.16±5.9
Anterior-Posterior Posterior Intercondylar Dia. in mm	11.28- 17.95	14.61±3.3	14- 22.45	21.06±1.3

DISCUSSION

Table 3: Showing comparison of different parameters of femur with the other study

S.No.	Year	Authors	(FLAP)	(FMAP)	(FLT)	(FMT)	(IW)	(BW)
1	2023	Present study	58.69±1.6	57.46±2.75	32.09±0.95	28.39±3.55	22.10±0.6	76.06±3.4
2	2022	Mithlesh Ranjan et al ⁸	57.8 ± 4.2	54.6 ± 4.3	-	-	-	-
3	2021	Xiang-hui Dong et al ²	67.3±3.3	64.7±2.7	-	-	-	76.3±3.2
4	2009	F.B. Cheng et al ¹²	50.7± 4.0	51.3± 3.3	-	-	-	71.0± 3.0

Table 4: Showing comparison of different parameters of tibia with the other study

S.No.	Year	Authors	(TLAP)	(TMAP)	(TLT)	(TMT)	(TIT)	(AP-AICA)	(AP-PICA)
1	2023	Present study	38.65±2.2	40.46±4.35	33.65±1.71	34.49±7.67	17.08±3.85	20.83±4.7	17.83±2.3
2	2022	Mithlesh Ranjan et al ⁸	42.9 ± 4.0	46.0 ± 4.2	-	-	-	-	-
3	2021	Xiang-hui Dong et al ²	50.1±3.3	53.7±2.1	-	-	-	-	-
4	2019	Elham Karim et al ¹³	48.70±5.3	50.12±4.88	17.09±6.83	13.40±6.17	-	-	-
5	2017	Bansal et al ⁴	44.48 ±4.08	46.36± 5.2	33.94 ±2.69	36.30±4.30	-	-	-
6	2009	F.B. Cheng et al ¹²	45.3± 2.5	50.7± 2.4	-	-	-	-	-
7	2008	E. Servien et al ¹⁴	47.2 ±3.3	50.8 ±3.3	29.3±2.4	28.8 ±2.5	-	-	-

Table 5: Showing comparison of different parameters of right and left femur with the other study

S. No.	Year	AUTHORS	(FLAP)		(FMAP)		(FLT)		(FMT)		(IW)		(BW)	
			Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
1	2023	Present study	57.12 ±3.2	60.27 ±4.5	56.22 ±5.0	58.70 ±4.9	30.90 ±1.4	33.29 ±2.9	28.32 ±8.2	28.47 ±2.8	21.00 ±0.9	23.21 ±3.0	74.26 ±8.9	77.86 ±5.8
2	2020	Rajan and Ramachandran ³	58.52 ±3.44	56.92 ±3.41	56.62 ±4.19	57.14 ±4.82	22.86 ±3.12	23.1± 2.34	22.64 ±3.96	23.12 ±2.17	21.66 ±2.69	21.5± 4.64	72.82 ±3.89	71.62 ±5.67
3	2019	Chavda et al. ¹⁵	54.7± 4.01	55.0± 4.31	52.9± 4.99	53.5± 4.15	30.3± 3.05	29.6 ± 2.03	26.7± 2.03	26.9± 2.23	20.4± 3.17	18.7± 2.52	69.6± 5.04	69.8± 4.96
4	2017	Biswas et al ¹⁶	56.20 ± 3.36	56.05 ±4.29	52.97 ± 3.77	54.74 ± 3.85	27.80 ± 2.91	28.0 ± 2.56	25.48 ± 2.05	27.28 ± 2.29	20.86 ± 2.52	19.45 ± 2.57	71.71 ± 4.50	70.71 ± 5.25
5	2017	Shweta et al ¹⁷	-	-	-	-	-	-	-	-	20.82 ± 2.57	21.0± 3.13	73.1± 6.14	72.16 ± 6.58

Table 6: Showing comparison of different parameters of right and left tibia with the other study

S. No.	Year	Auth ors	(TLAP)		(TMAP)		(TLT)		(TMT)		(TIT)		(AP-AICA)		(AP-PICA)	
			Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
1	2023	Present study	38.47±2.7	38.88±1.7	40.15±6.6	40.71±13	33.08±4	34.20±03	33.91±1	35.07±5	15.64±4	18.52±3	17.51±3	24.16±5	14.61±3	21.06±39
2	2018	Zala wadi a and Patel	MALE													
			38.26±2.43	38.51±2.35	44.27±1.93	44.57±2.18	27.13±1.86	27.38±1.97	28.31±1.66	28.32±1.35						
			FEMALE													

			35.3 6±2. 27	35. 64± 2.4 6	39.5 3±1. 97	39.8 7±2. 10	25.8 6±1. 32	25.9 1±1. 42	26.4 7±1. 33	25.9 1±1. 52						
3	2016	Murl iman ju et al	34.8 ± 3.7	32. 6 ± 3.4	40.6 ± 3.9	39.2 ± 3.6	26.5 ± 3.4	25.7 ± 2.5	26.9 ± 2.9	26.6 ± 2.7						
4	2014	Swat i Gand hi et al	MALE													
			40.8 6+3. 79	40. 69+ 4.1 3	48.4 5+4. 14	47.7 3+4. 37	28.6 2+3. 10	28.8 2+3. 12	30.1 8+2. 83	29.3 8+3. 14			23.8 4+2. 90	21.9 6+6. 76	17.8 6+2. 98	23.2 2+2. 55
			FEMALE													
			36.7 8+3. 03	37. 30+ 3.8 1	42.3 9+4. 19	42.3 6+4. 65	26.1 4+2. 51	26.0 0+3. 06	27.2 5+3. 05	26.9 6+2. 18			25.4 8+2. 38	25.0 4+3. 48	21.8 4+2. 64	22.3 8+2. 84

In this study we have selected six morphometric parameters of lower end of dry femur bone and seven parameters of upper dry tibia bone. Our findings are similar to study of Mithlesh Ranjan et al in respect to femoral lateral and medial antero-posterior diameter.

CONCLUSION

The obtained anthropometric data of femoral and tibial condyles are useful for designing of TKA implants which will be more suitable for Indian patients and for better long-term outcome.

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