



## Original Research Article

## A study on morphometric dimensions of tibial condyles in Indian population

Avantika Bamne<sup>1</sup>, Uma Pandalai Gayathri<sup>1,\*</sup><sup>1</sup>Dept. of Anatomy, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, India

## ARTICLE INFO

## Article history:

Received 19-06-2020

Accepted 09-07-2020

Available online 17-10-2020

## Keywords:

Tibia

Medial condyle

Lateral condyle

Knee prosthesis

Arthroplasty

## ABSTRACT

**Background and Aim:** Knee joint is the largest and complex joint in the body which helps in weight bearing and locomotion. It is subjected to degenerative changes like osteoarthritis, Knee injuries and trauma. Present study is proposed to access measurements of upper end of tibia. These morphometric parameters can be useful to guide the treatment in procedures of unicompartmental knee arthroplasty and total knee arthroplasty.

**Material and Methods:** Present study was conducted in Index Medical College, Department of anatomy, Indore, Madhya Pradesh. Different parameters of 62 human dried tibiae [31 right and 31 left] measured are anteroposterior [AP] and transverse diameter [TD] of medial condyle, lateral condyle and total tibial condyle.

**Results:** In present study, mean values of anteroposterior and transverse diameters of medial condyle, lateral condyle and total tibial condyle were found to be slightly greater on left side than that of right side. Furthermore AP diameter of medial condyle were found to be greater than that of lateral condyle on both sides and TD of medial found to be lesser than that of lateral on both sides.

**Conclusion:** Results of this study will be helpful for orthopedicians to design appropriate size of knee prosthesis in knee arthroplasty also useful for forensic experts, anthropologist and anatomist.

© 2020 Published by Innovative Publication. This is an open access article under the CC BY-NC license (<https://creativecommons.org/licenses/by-nc/4.0/>)

## 1. Introduction

Knee joint is the largest joint in the human body. It is a compound synovial joint, performs a significant role in adjusting the centre of body mass and posture which requires a great range of movements in three dimensions together with the capability to bear high forces.<sup>1</sup>

Knee joint is a modified hinge joint, composing of tibiofemoral and patellofemoral components. The main articular surface of femur and tibia are its medial and lateral condyles in its lower and upper end respectively. The pair of tibial condyles are separated by the intercondylar eminence. The articular surface of lateral condyle is circular while medial condyle is oval. Through the tibiofemoral articulation, the upper end of tibia plays a crucial role in conducting the body weight from femur above to talus

below, thus being unique in performing day to day activities and sports.<sup>2</sup> Therefore knee joint is commonly affected by osteoarthritis which is the most common pathological disorder of knee. Osteoarthritis is usually treated by Total Knee Arthroplasty [TKA] or Unicompartmental Knee Arthroplasty<sup>3</sup> [UKA]. In TKA precise soft tissue balancing is required along with resection of bone thickness equal to the thickness of prosthetic component implanted which helps in equal spacing for flexion & extension and permits joint stability throughout the range of motion. The success of TKA depends on the prosthetic selection, accurate sizing and proper placement. In order to sustain the flexion & extension spacing, Anteroposterior measurements [AP] of prosthetics is essential. The mediolateral measurements decide essential coverage of resected bone surface and wound closure.<sup>4</sup> In UKA, damaged knee parts are replaced only in a single compartment. UKA is designed to cause less trauma and damage by replacing only

\* Corresponding author.

E-mail address: [umapandalai07@gmail.com](mailto:umapandalai07@gmail.com) (U. P. Gayathri).

less bone and maintaining most of the individuals own bone.<sup>5</sup> At present UKA is a satisfying treatment for unicompartmental knee arthritis. The prosthetics are made with the measurements available from western population studies. Hardly few Indian studies are available on the anthropometric measurements of upper end of tibia. Hence this study aims to measure the dimensions of upper end of tibia which can be a useful guide for designing knee prostheses for Indians.

Researchers also use Maximum Tibial Length [MTL] for estimating human stature. Estimating human stature with MTL is of great use in forensic medicine and physical anthropology.<sup>6</sup>

## 2. Materials and Methods

The present study was conducted in Department of Anatomy, Index Medical College and Research Centre, Indore, Madhya Pradesh. 62 dried human tibiae bones [31 right & 31 left] of unknown age and sex were analysed. Samples were obtained from Index medical college and Sri Aurobindo Institute of Medical Sciences, Indore, Madhya Pradesh. Damaged, fractured and unossified bones were excluded from the study. Using standard digital vernier caliper dimension values were measured in millimeter (mm). The dimensions to be measured for conducting present study are Medical Condyle Anteroposterior diameter [MCAP], Lateral condyle Anteroposterior diameter [LCAP], Medical Condyle Transverse diameter [MCTD], Lateral Condyle Transverse diameter [LCTD], Total tibial condyle Anteroposterior [TTC-AP] and total tibial condyle Transverse diameter [TTC-TD]. MCAP was measured from the most anterior point to most posterior point as a single line. MCTD is measured from the medial tubercle to medial margin of medial condyle as a straight line perpendicular to AP diameter. LCAP was measured from the most anterior point to most posterior point as a single line. LCTD is measured from the lateral tubercle to lateral margin of lateral condyle as a straight line perpendicular to AP diameter. AP diameter of TTC is measured as straight line from the middle of medial and lateral tubercle of intercondylar eminence from the most anterior to posterior point. Transverse diameter of TTC is measured as a straight line from the medial margin of medial condyle to lateral margin of lateral condyle. The measurements were performed by same person to avoid inter observer errors. Data obtained were tabulated and statistically analyzed using SPSS software (version 12.0). Values between right and left sides tibiae were statistically analyzed using unpaired t- test, whereas values between the medial and lateral condyle statistical analyzed by using paired t test. p value less than 0.05 is considered statistically significant.



Fig. 1: Measurement of medial condyle A-P diameter



Fig. 2: Measurement of lateral condyle A-P diameter

## 3. Results

The morphometric study is conducted on 62 human dried tibiae, all measured values of different parameters are tabulated, analyzed and subjected to statistical analysis by using SPSS software (version 12.0). The results are as follows:

Tables 1 and 2, the Total Tibial Condyle (TTC) area is calculated as:  $TTC = AP \times TD$ ,<sup>7</sup> So TTC area of right side is 2784.33 mm and TTC area of left side is 3120.28 mm.

As shown in the Table 1, the mean values of TTC- AP are  $43.58 \pm 3.89$  mm on right side while on the left it was  $45.03 \pm 3.71$  mm and the mean values of TTC -TD was  $63.89 \pm 7.29$  mm on right side while on the left side it was  $66.22$

**Table 1:** Measurements of parameters of tibial condyles

Side of tibia	Medial condyle		Lateral condyle		Total tibial condyle	
	MCAP	MCTD	LCAP	LCTD	TTC-AP	TTC-TD
Right	39.38 ± 4.08	27.64 ± 2.64	34.81 ± 3.76	28.52 ± 3.28	43.58 ± 3.89	63.89 ± 7.29
Left	40.08 ± 3.44	29.11 ± 3.14	35.42 ± 3.33	29.47 ± 3.01	45.03 ± 3.71	66.22 ± 4.38

All parameters are recorded in mm. and represented as Mean ± Standard Deviation.

**Table 2:** Comparison of measurements between right and left tibia

Parameter	RangeRight(Mean ±SD)	Range left (Mean ±SD)
Medial condyle AP length	39.38 ± 4.08	40.08 ± 3.44
Lateral condyle AP length	34.81 ± 3.76	35.41 ± 3.33
Medial condyle TD length	27.64 ± 2.64	29.11 ± 3.14
Lateral condyle TD length	28.52 ± 3.28	29.54 ± 3.06
Total tibial condyle AP Length	43.58 ± 3.89	45.12 ± 3.66
Total tibial condyle TD length	63.89 ± 7.29	66.22 ± 4.38

All parameters are recorded in mm. and represented as Mean ± Standard Deviation

**Fig. 3:** Measurement of medial condyle T-D diameter**Fig. 4:** Measurement of lateral condyle T-D diameter

± 4.38 mm; so the difference is considered as statistically not significant [p value = 0.13]. The mean values of medial condylar AP length on right side comes to be 39.38 ± 4.08 mm and on left side it was 40.08 ± 3.44 mm. The mean values of medial condylar TD length on right side comes to be 27.64 ± 2.64 mm and on left side it was 29.11 ± 3.14 mm which is considered to be not statistically significant.

The mean values of lateral condylar AP length on right side comes to be 34.81 ± 3.76 mm and on left side it was 35.42 ± 3.33 mm. The mean values of lateral condylar TD length on right side comes to be 28.52 ± 3.28 mm and on left side it was 29.47 ± 3.01 mm which is considered to be not statistically significant.

According to Table 2, it was observed that mean value of MCAP was 39.38 ± 4.08 mm and LCAP was 34.81 ± 3.76 mm on right side. The p value is less than 0.0001, this difference is considered to be extremely statistically significant. Similarly the mean value of MCTD was 27.64

**Fig. 5:** Measurement of total tibial condyle A-P diameter



**Fig. 6:** Measurement of total tibial condyle T-D diameter

$\pm 2.64$  while LCTD was  $28.52 \pm 3.28$  mm [ $p = 0.0229$ ] this difference is considered to be statistically significant.

It was observed that mean value of MCAP was  $40.08 \pm 3.44$  mm and LCAP was  $35.41 \pm 3.33$  mm on left side. The  $p$  value is less than 0.0001, this difference is considered to be extremely statistically significant. But it was seen that the mean value of MCTD on left side was  $29.11 \pm 3.14$  mm while LCTD was  $29.54 \pm 3.06$  mm.

As per table no. 2, mean values of TTC TD was 63.89 mm which is greater than TTC- AP= 43.58 mm. that is on right side, while mean values of TTC- TD was  $66.22 \pm 4.38$  mm which is greater than TTC AP =  $45.12 \pm 3.66$  mm. that is on left side,  $P$  value is less than 0.0001 and this difference is considered to be statistically significant.

#### 4. Discussion

From past, studies done by various authors on different populations across India and abroad it was recorded that Indians need smaller size knee prosthesis as compared to Caucasian and western population. Even though in past, many studies conducted by CT and MRI, has been reported inaccurate. So direct measurements taken from dry bones have significant advantage in designing knee prosthesis.

The study from P Chaitanya Shree et al<sup>7</sup> which was based on Tamil Nadu population showed that the medial condylar AP length was 37.91mm was greater than the lateral one which was 36.89mm. From another study done by Ankur Zalawadia<sup>8</sup> it was seen that the Medial condylar AP length  $44.27 \pm 1.93$  mm greater than that of lateral condylar AP  $38.26 \pm 2.43$  mm. This study was based on Gujarat population. The present study was highly correlated with the aforementioned studies. The mean values of medial condylar AP length were  $39.38 \pm 4.08$ mm was greater than the lateral one which was  $34.81 \pm 3.76$  mm.

The study done by Swati Gandhi<sup>9</sup> who had measured 100 adult human dry tibiae, 50 male and 50 female, in Indian population. AP measurements of intercondylar area were  $47.19 \pm 2.93$  mm on right side and  $49.11 \pm 3.97$  mm on left. Our measurements correlated with this study as TTC AP was  $43.58 \pm 3.89$  mm on right and on left it was  $45.03 \pm 3.71$  mm. our study also compared with Chandni Gupta et al,<sup>2</sup> in Karnataka population, AP length of intercondylar region was found as 46.6 mm on right side and 44.9 mm on left side and Transverse diameter of tibial condyle were  $67.7 \pm 0.31$  mm on right side and left side  $68.8 \pm 0.65$  mm, our study almost correlated with aforesaid study, as TTC TD on right side  $63.89 \pm 7.29$  mm and on left side  $66.22 \pm 4.38$  mm.

Bukkumbuddhi Virupakshamurthy Murlimanju<sup>10</sup> et al. studied 73 cadaveric tibiae on South Indian Population. Breadth of medial tibial plateau was 26.7 mm and of lateral tibial plateau 26.1 mm. In our study, MCTD were 27.64mm and LCTD 28.52 mm, which was highly correlated.

Ankit Srivastava et al.<sup>11</sup> measured 150 dry tibiae. The mean area of TTC was 2988.73 on right and on left 2951.44 mm. In present study, Total Tibial Condylar areas were 2784.33mm on right side and on the left side were 3120.28mm. Our values were found to be greater than above mentioned study.

#### 5. Conclusion

Tibial condylar shape gains an importance because it provides attachment to medial and lateral menisci. As per study reports, menisci occupies 55–66.7% of the corresponding tibial condyles.<sup>11</sup> Up to 14<sup>th</sup> week of intrauterine life tibial condyles and menisci are of same size on both sides. During later stage of development the size of menisci increases. However the medial condylar area increases more rapidly because of the smaller coverage area of the medial menisci.<sup>12</sup> So the measured parametric values could be helpful for meniscal transplantation.<sup>13</sup> Osteoarthritis of knee joint is very common degenerative disease in adults. It is mainly due to more mechanical stress and genetic factors.<sup>14</sup>

This study will be highly beneficial for orthopaedic surgeons for designing appropriate sizes of knee prosthesis in unicompartmental and also in total knee arthroplasty. Study is also helpful forensic experts, anthropologist and anatomist.

#### 6. Source of Funding

None.

#### 7. Conflict of Interest

None.

## References

1. Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 39th ed. London: Elsevier Churchill Livingstone; 2005.
2. Gupta C, Kumar J, Kalthur SG, D'souza AS. A morphometric study of the proximal end of the tibia in South Indian population with its clinical implications. *Saudi J Sports Med.* 2015;15(2):166.
3. Ivan AS. Morphometric Study of Proximal End of Tibia; 2014. Available from: [http://www.rguhs.ac.in/cdc/onlinecdc/uploads/01\\_M010\\_25888.doc](http://www.rguhs.ac.in/cdc/onlinecdc/uploads/01_M010_25888.doc).
4. Vaidya SV, Ranawat CS, Aroojis A, Laud NS. Anthropometric measurements to design total knee prostheses for the Indian population. *J Arthroplast.* 2000;15(1):79–85.
5. Borus T, Thornhill T. Unicompartmental Knee Arthroplasty. *J Am Acad Orthop Surg.* 2008;16(1):9–18.
6. Attada K, Veera P, Ravindranadh G, Kumari U, Deena K. Anthropometric Measurement of Maximum Tibia Length in South Indian Population. *Anat Sci J.* 2017;14(2):47–54.
7. Shree PC, Babu KY, Mohanraj KG. Morphological and morphometric study of tibial condylar area and its clinical significance. *Drug Invention Today.* 2018;10:10.
8. Morphometric study of upper end. *Int J Anat Res.* 2018;6(1):4836–9.
9. Gandhi S, Singla RK, Kullar JS, Suri RK, Mehta V. Morphometric analysis of upper end of tibia. *J Clin Diagnostic Res.* 2014;8(8):10.
10. Murlimanju BV, Purushothama C, Srivastava A, Kumar CG, Krishnamurthy A, Blossom V, et al. Anatomical morphometry of the tibial plateau in South Indian population. *Italian J Anat Embryol.* 2016;121(3):258–64.
11. Srivastava A, Yadav A, Thomas RJ, Gupta N. Morphometric study of tibial condylar area in the North Indian population. *J Med Sci Clin Res.* 2014;2:515–24.
12. Fukazawa I, Hatta T, Uchio Y, Otani H. Development of the meniscus of the knee joint in human fetuses. *Congenital Anomalies.* 2009;49(1):27–32.
13. Malegaonkar SS, Malegaonkar DB, Naik S, Shireen S. A Morphometric Study of the Proximal End of Tibia in North East Karnataka Population with Its Clinical Implication. *Indian J Anat.* 2017;6(1):81–5.
14. Nayak G, Panda SK, Chinara PK. Morphometric analysis of tibial plateau. *Int J Res Med Sci.* 2019;7(4):1261.

## Author biography

**Avantika Bamne** Associate Professor

**Uma Pandalai Gayathri** Assistant Professor

**Cite this article:** Bamne A, Gayathri UP. A study on morphometric dimensions of tibial condyles in Indian population. *Indian J Clin Anat Physiol* 2020;7(3):280-284.