Original Research Article Journal of College of Medical Sciences-Nepal, Vol-15, No 4, Oct-Dec 2019

ISSN: 2091-0657 (Print); 2091-0673 (Online) **Open Access**
DOI: 10.3126/jcmsn.v15i4.24207

Morphometric Analysis of Superior Articular Surface of Tibia in Dry Cadaveric Bones

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ABSTRACT

Background: Total knee arthroplasty is the most cost effective and rapidly evolving technique. The success of procedure relies on appropriate sizing of tibial component, for which elaborate information of various dimensions of upper surface of tibia is mandatory. Hence, this study is aiming to generate baseline data on antero-posterior and transverse measurements of medial and lateral condyles and intercondylar area of upper surface of tibia. **Methods**: The study was conducted in 42 dry human cadaveric tibia with unidentified age and sex, in the Department of Anatomy, College of Medical Sciences and Teaching Hospital, Chitwan. The antero-posterior and transverse measurements of medial and lateral condyles and intercondylar area of tibia were recorded in millimeter (mm) with digital Vernier calipers. The data was analysed using SPSS version 16.0. **Results**: The antero-posterior and transverse measurements of medial condyle of tibia were 43.00±5.95 mm and 25.21±8.08 mm respectively on the right side and 45.33±5.36 mm and 27.43±8.57 mm respectively on the left side and that of lateral condyle were 37.94±5.64 mm and 25.21±8.71 mm respectively on the right side and 41.03±3.65 mm and 27.06±8.83 mm respectively on the left side. The antero-posterior and transverse measurements of intercondylar area of tibia were 47.49±6.31 mm and 15.71±3.93 mm respectively on the right side and 49.24±6.91 mm and 15.02±3.88 mm respectively on the left side. The variation in the measurements between right and left tibia showed significant difference only for antero-posterior measurement of lateral condyle ($p<0.05$). **Conclusions**: The study generates baseline data regarding various anthropometric measurements of upper surface of tibia, which will assist the orthopedic surgeon to create a resected bony surface identical to the tibial component of an implant in unilateral and total knee arthroplasty.

Keywords: measurement; morphometric; superior articular surface; tibial condyles.

INTRODUCTION

Human being unique among primates had adopted an upright posture and bipedal locomotion. The upright posture in mankind has resulted in variation in functional as well as mechanical requirements of all skeletal components in such a way that the lower limbs is principally acclimatized for weight bearing and propulsion.[1] In human weight bearing is associated to closed packed knee position. Ljunggren has highlighted the relationship between the different weight bearing situations and the antero-posterior and medio-lateral dimensions of upper and lower ends and shaft of the tibia.[2] Information concerning morphometry of superior end of the tibia is essential in assessing various internal derangement of knee and monitoring the treatment and outcome of total knee replacement surgeries. Knee joint surgeries are rapidly evolving procedures; hence an extensive anatomical knowledge of this relevant surgical field is vital in planning necessary interventions in various degenerative and pathological conditions of the knee joints. Keeping the above factors in limelight, this study is undertaken aiming to generate the baseline data on morphometric dimensions of proximal tibial surface as no such literature is available in Nepal in this regard.

METHODS

The present study was conducted in the Department of Anatomy, College of Medical Sciences and Teaching Hospital, Chitwan from February 2019 to April 2019. The study material comprised of 42 dry human cadaveric tibia with unidentified age and sex. The tibia with gross deformities and pathological changes were excluded. Ethical approval from Institutional Review Committee of College of Medical Sciences was obtained (Ref. No: 2019-015). The parameters measured were as shown in (Figure 1).

Antero-posterior measurements of superior articular surface of medial condyle: The maximum distance between anterior [point A] and posterior [point B] borders of superior articular surface of medial condyle.

Transverse measurements of superior articular sur ace of medial condyle: The maximum

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Article received: 2019-05-24. **Article accepted:** 2019-11-22.

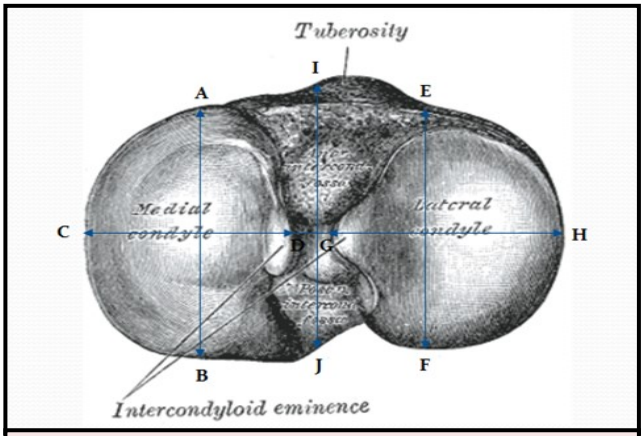

Figure 1. Showing the landmarks and linear measurements on superior surface of medial and lateral condyles of tibia.

transverse diameter of superior articular surface of medial condyle, i.e. distance between points C and D.

Antero-posterior measurements of superior articular surface of lateral condyle: The maximum distance between anterior [point E] and posterior [point F] borders of superior articular surface of lateral condyle.

Transverse measurements of superior articular surface of lateral condyle: The maximum transverse diameter of superior articular surface of lateral condyle, i.e. distance between points G and H.

Antero-posterior measurements of intercondylar area: The maximum distance between anterior [point I] and posterior [point J] borders.

Transverse measurements of intercondylar area: The maximum transverse diameter at the level of intercondylar eminence, i.e. distance between points D and G.

The data were recorded with digital Vernier calipers with a least count of 0.01 mm. The measurements were taken by principle author in order to minimize bias and error of identification of the landmarks involved in measurement. The measurements were taken thrice, and an average of the three readings was calculated. Data obtained were first entered in Epidata 20.1 and analysed with Statistical Package for Social Sciences (SPSS) version 16.0. Kolmogorov-Smirnov test (Normality of distribution) showed normal distribution for all anthropometric variables. Means and standard deviations (SD) of all parameters were calculated. An Independent t test was carried out to determine the disparity in measurements of all parameters between right and left tibia. P-value less than 0.05 was considered as statistically significant.

RESULTS

The current study was conducted in 42 dry human cadaveric tibia, out of which 22 tibia belonged to right side and 20 to the left. Mean and standard deviation of antero-posterior and transverse measurements of superior surface of medial condyle of tibia are depicted in (Table 1).

Table 1. Comparison of antero-posterior and transverse measurements of medial condyle.

Measurement	Mean±SD (mm)	p
Antero-posterior		
Right side	43.00±5.95	0.19
Left side	45.33±5.36	
Transverse		
Right side	25.21±8.08	0.39
Left side	27.43±8.57	

When compared between the two sides, an Independent t-test showed statistically insignificant differences in antero-posterior and transverse measurements of superior surface of medial condyle of right and left tibia, however, the dimensions are more on left side that on the right. Mean and standard deviation of antero-posterior and transverse measurements of superior surface of lateral condyle of tibia are illustrated in (Table 2).

Table 2. Comparison of antero-posterior and transverse measurements of lateral condyle.

Measurement	Mean±SD (mm)	p
Antero-posterior		
Right side	37.94±5.64	0.04
Left side	41.03±3.65	
Transverse		
Right side	25.21±8.71	0.5
Left side	27.06±8.83	

An Independent t-Test revealed that antero-posterior measurement of superior surface of lateral condyle of left tibia is significantly higher than the right, $p<0.05$. Conversely, no statistical difference is observed between the transverse measurement of superior surface of lateral condyle of right and left tibia. Mean and standard deviation of antero-posterior and transverse measurements of intercondylar area of tibia are demonstrated in (Table 3).

Table 3. Comparison of antero-posterior and transverse measurements of intercondylar area

Measurement	Mean±SD (mm)	p
Antero-posterior		
Right side	47.49±6.31	0.57
Left side	49.24±6.91	
Transverse		
Right side	15.71±3.93	0.39
Left side	15.02±3.88	

An Independent t-test confirmed that the differences of antero-posterior and transverse

measurements of intercondylar area between right and left tibia are not statistically significant ($p<0.05$).

DISCUSSION

Few studies have been carried out regarding the morphometry of upper end of tibia in recent years.[3-7] Data concerning measurements of proximal surface of tibia will indubitably help orthopedic surgeon to clinch the exact etiological diagnosis and to contemplate the most rational therapy in numerous degenerative and pathological disorders of knee joints. Vasanti et al conducted a study in 100 dry human tibia in Rangaraya Medical College, Visakhapatnam and noted that antero-posterior measurement of superior surface of medial condyle of tibia was 45.489±0.52 mm and 47.67±1.39 mm on right and left sides respectively, the measurement being significantly greater on the left tibia, $p<0.05$.[8] In a similar study by Servien et al, the antero-posterior measurement of medial tibial condyle in French population was 50.8±3.3 mm irrespective of sides.[9] The findings of present study was not similar to other study where the measurement was 43.00±5.95 mm on the right tibia and 45.33±5.36 mm on the left tibia, the difference being statistically not significant, $p>0.05$. Furthermore, the difference between the transverse measurement of superior surface of medial condyle of right and left tibia in the current study was insignificant, $p>0.05$ (Mean and SD: right-25.21±8.08 mm; left-27.43±8.57 mm) which is in concurrence with the result of study carried by Vasanti et al (Mean and SD: right-24.27±1.01 mm; left-22.509±1 mm).[8] The antero-posterior measurement of superior surface of lateral condyle of left tibia was more that the right, $p<0.05$ (Mean and SD: right-37.94±5.64 mm; left-41.03±3.65 mm). Conversely, no statistical difference was observed between the transverse measurement of superior surface of lateral condyle of right and left tibia (Mean and SD: right-25.21±8.71 mm; left-27.06±8.83 mm). On the contrary, Vasanti et al found that even though the measurements (both antero-posterior and transverse) of right tibial condyle were slightly greater than that of left, the differences were statistically insignificant.[8] The antero-posterior measurement of intercondylar area in Korean population was 47.3±3.8mm, regardless of side.[10] In a similar study, the antero-posterior and transverse measurements of intercondylar area of tibia were 51.32±0.72 mm and 17.70±0.34 mm respectively on the right side and 51.08±0.63 mm and 18.66±0.62 mm respectively on the left side, the difference being statistically insignificant, $p>0.05$.[8] Similar findings were observed in the current study, in which antero-posterior and transverse measurements of intercondylar area of tibia were 47.49±6.31 mm and 15.71±3.93 mm respectively on the right side and 49.24±6.91 mm and 15.02±3.88 mm respectively on the left side. There was inconsistency in the values of tibial measurements between our study and other authors. Osteoarthritis is one of the most common cause of disability in older adults and is characterized by the deterioration of cartilage in joints, which results in bones rubbing together and creating stiffness, pain, and impaired movement.[11] Total knee arthroplasty is the most cost effective and rapidly evolving technique for the treatment of osteoarthritis and other degenerative disease.[12,13] Total knee replacement is a surgical procedure to resurface knee damaged by arthritis, and ensure painless stable knee with improved mobility and a better quality of life. During the procedure, less than half an inch of the tibial and femoral articular surfaces are removed and replaced with metal and plastic caps. The optimum function and longevity of an implant in total knee arthroplasty depends on appropriate sizing of tibial component ensuring maximum proximal tibial bone coverage and weight transmission.[14-17] Implants with insufficient tibial coverage may result in its failure.[18,19] Cheng et al brought into limelight the three dimensional morphometry of knee and designed the prosthesis considering sexual dimorphism.[20] A study in Turkish population showed that the tibial components designed for Western and Asian populations according to their anthropometric measurements do not perfectly fit the requirements of Turkish population. As such, designing of uni-compartmental knee arthroplasty prosthesis for each population is needed for better accuracy and best result.[4] Hopefully, the morphometric analysis of the proximal articular surface of tibia performed in the current study should prove to be beneficial for accessing the deformities of knee joints and designing the optimal tibial component for unilateral and total knee arthroplasty.

CONCLUSIONS

The study provides a baseline data regarding various anthropometric measurements of upper surface of tibia, which will aid orthopedic surgeon to create a resected bony surface identical to tibial component of an implant in unilateral and total knee arthroplasty.

Limitations of the study

As the present study was done on the dry cadaveric tibia available in the Department of Anatomy, College of Medical Sciences, Chitwan, the study comprised of small sample. Further, the racial and gender difference could not be considered.

ACKNOWLEDGEMENTS

I would like to express my gratitude to all the faculty members and staffs of Department of Anatomy, College of Medical Sciences and for their cooperation in data collection.

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Citation: Pandit R, Sharma N. Morphometric Analysis of Superior Articular Surface of Tibia in Dry Cadaveric Bones. JCMS Nepal. 2019; 15(4):287-90.