

Upper end of Tibia of Nepalese adults: A Morphometric studyRajeev Mukhia,¹ Dil Islam Mansur,² Krishna Wahekar³¹Department of Anatomy, Manipal College of Medical Sciences, Pokhara, Nepal.²Department of Anatomy, Kathmandu University School of Medical Sciences, Dhulikhel, Nepal³Department of Orthopaedics, Manipal Teaching Hospital, Nepal**ABSTRACT**

Introduction: The tibia bone forms the main skeleton of the leg. It plays an important role in weight bearing and takes part in the formation of knee joint. The knowledge of different dimensions of upper end of tibia will help the orthopaedic surgeons for diagnosis, planning and treatment of disease related to knee. Inappropriate design of knee replacement could affect the outcome of surgery with reported complications. The objective of the study is to find out the morphometric measurements of upper end of tibia in Nepalese Population.

Methods: After ethical approval (MEMG/IRC/211/GA) the study was done on 60 dry tibia bones of Nepalese citizens irrespective of sex and race in the Department of Anatomy, Manipal College of Medical Sciences, Pokhara. The morphometric measurements of medial condyle, lateral condyle, intercondylar area and circumference of upper end of tibia of both sides were measured manually by thread, scale and Vernier calliper. Data were reported as mean \pm SD and analyzed with MS Excel 2007 software.

Results: Average anteroposterior measurements were found to be 46.38 mm and 39.14 mm and average transverse measurements were 28.79 mm and 27.86 mm respectively for medial and lateral condyles of both sides. The anteroposterior and transverse measurements of intercondylar area of tibia were 47.75 mm and 7.11 mm on the right side and 49.81 mm and 7.25 mm respectively on the left side ($p < 0.05$). Similarly mediolateral length and circumference of upper end of tibia of left limb were significantly greater than the right limb ($p < 0.05$).

Conclusion: The knowledge of different dimensions of upper end of tibia may be important in anthropological practice. Morphometric parameters of upper end of tibia will be important to orthopaedic surgeons for diagnosis, planning and treatment of disease related to knee in Nepalese population.

Keywords: *Tibia, Medial condyle, Lateral condyle, Intercondylar area*

INTRODUCTION

In human body, tibia is the second largest and strongest bone also known as shin bone. The proximal end of the tibia is widely expanded, has two condyles – medial and lateral, and intercondylar area between them. Both condyles of tibia are articular and articulate superiorly with corresponding condyles of femur which is the femoro-tibial component of knee joint.¹ It is commonly recognized as the large weight bearing bone of the leg. The upper end of tibia is separated with corresponding femoral condyles by the fibro-cartilaginous menisci.² Anatomical knowledge regarding upper end of the tibia is important as it provides reliable method of assessing knee deformity. Morphometric parameters of upper end of tibia can be used to guide treatment and monitor outcome of total knee replacement surgeries. It also aids in characterization of tibial deformity and improvement of tibial prosthesis design.³ During surgical procedures of knee replacement, the damaged bone and cartilage are resurfaced preferably with metal and plastic components as

substitutes. In unicompartmental knee replacement, only a part of the knee is resurfaced and changed. This procedure is a good alternative method to total knee replacement for people with little damage which is restricted to just small area of the knee.⁴

There have been very few studies on the morphometry of the upper end of tibia in the Nepalese population. The morphometry of upper end of tibia is variable between different individuals with different nationality. Hence, the objectives of the study are to measure the morphometric parameters of condyle and intercondylar areas of the proximal end of the tibia and also to correlate with previous studies. The results obtained from this study might be helpful for designing the optimal tibial components that would be beneficial in unilateral and total knee

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arthroplasty in Nepalese population by orthopaedic surgeons. Detailed anatomical study of upper end of tibia would serve in planning interventions in appropriate surgical field required for numerous pathological and wasting conditions of the knee joint.

METHODS

The cross sectional, descriptive study with convenient sampling was carried out on the availability of 60 adult tibia bones of both extremities (30 were of right side and 30 were of left side) in the Department of Anatomy, Manipal College of Medical Sciences, Pokhara, from January 2020 to March 2020. Ethical clearance (MEMG/IRC/211/GA) was taken from Institutional Review Committee of Manipal College of Medical Sciences, Pokhara, Nepal. After taking permission from the concerned authorities of the Anatomy Department, normal tibias were collected from the Osteology laboratory of Anatomy. The tibia bones were retrieved from cadavers of Nepalese origin aged between 30 to 60 years irrespective of sex. Tibia with any fracture or abnormalities like tumours, deformities and trauma was excluded from the study. The side determination was done for the entire bone and following parameters were measured (Figure 1).

1. Anteroposterior measurements (AP) of medial condyle: The maximum distance between anterior and posterior borders of superior articular surface of medial condyle.
2. Transverse measurements (T) of medial condyle: The maximum transverse distance of superior articular surface of medial condyle.
3. Anteroposterior measurements (AP) of lateral condyle: The maximum distance between anterior and posterior borders of superior articular surface of lateral condyle.
4. Transverse measurements (T) of lateral condyle: The maximum transverse diameter of superior articular surface of lateral condyle.
5. Anteroposterior measurements (AP) of intercondylar area: The maximum distance between anterior and posterior borders.
6. Transverse measurements (T) of intercondylar area: The maximum transverse diameter at the middle narrow part – (at the level of intercondylar eminence)
7. Mediolateral length (ML): the maximum transverse length across both condyles
8. Circumference (CF) of upper end of tibia: The maximum diameter of superior articular surface.

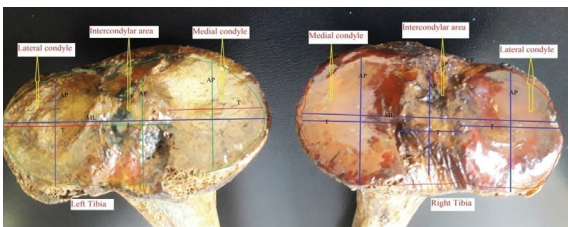


Figure 1: Superior view of upper end of tibia showing measurements of different parameters of right and left tibia

All the measurements were measured manually with the help of measuring scale, thread and Vernier calliper and recorded separately for right and left tibia. The average of three measurements taken as such was calculated. All the data were represented as mean \pm SD then analyzed with MS Excel 2007 software. Independent t-test was used to calculate the differences in the parameters of right and left tibia. P value <0.05 was considered as statistically significant.

RESULTS

The following observations were found and noted in the present study. The mean results and standard deviation (SD) of different parameters of upper end of both right and left tibia is summarized in Table 1.

Table 1: Showing mean and standard deviation of different parameters of upper end of right and left tibia in millimetre (mm).

Parameters	Right side	Left side	p-value
Anteroposterior measurements of medial condyle	45.99 \pm 2.49	46.77 \pm 1.48	0.10
Transverse measurements of medial condyle	29.12 \pm 1.10	28.46 \pm 1.15	0.05
Anteroposterior measurements of lateral condyle	39.32 \pm 1.10	38.97 \pm 0.85	0.10
Transverse measurements of lateral condyle	27.96 \pm 0.58	27.76 \pm 0.82	0.21
Anteroposterior measurements of intercondylar area	47.75 \pm 0.85	49.81 \pm 0.67	0.001
Transverse measurements of intercondylar area	7.11 \pm 0.19	7.25 \pm 0.27	0.01
Mediolateral length	66.56 \pm 0.59	66.88 \pm 0.71	0.01
Circumference of upper end of tibia	191.1 \pm 1.33	194.4 \pm 0.82	0.001

P value <0.05 was considered as statistically significant.

The anteroposterior and transverse measurements of medial condyle of tibia were 45.99 \pm 2.49 mm and 29.12 \pm 1.10 mm respectively on the right side and 46.77 \pm 1.48 mm and 28.46 \pm 1.15 mm respectively on the left side and that of lateral condyle were 39.32 \pm 1.10 mm and 27.96 \pm 0.58 mm respectively on the right side and 38.97 \pm 0.85 and 27.76 \pm 0.82 mm respectively on the left side. Furthermore, both anteroposterior and transverse measurements were found to be more in medial condyle as compared to lateral condyle on both sides. The anteroposterior and transverse measurements of intercondylar area of tibia were 47.75 \pm 0.85 mm and 7.11 \pm 0.19 mm respectively on the right

side and 49.81 ± 0.67 mm and 7.25 ± 0.27 mm respectively on the left side. The anteroposterior and transverse measurements of intercondylar area of left tibia were significantly higher than right tibia (p value 0.001 and 0.01) respectively. The mediolateral length of right and left tibia showed 66.56 ± 0.59 mm and 66.88 ± 0.71 mm respectively with p value of 0.01. Circumference of upper end of left tibia was significantly more as compared to the circumference of right tibia 194.4 ± 0.82 Vs 191.1 ± 1.33 mm, $p=0.001$. The variation in the morphometry of anteroposterior measurements of intercondylar area, mediolateral length and circumference of upper end of tibia in two sides seems to be statistically significant ($p<0.05$).

DISCUSSION

Many previous studies on adult tibia have been carried out in different countries using different materials and techniques such as cadaveric specimens, dry bones, Computed Tomography (CT) scans, Magnetic Resonance Imaging (MRI) scans and plain radiographs. However few studies have been carried out regarding the morphometry of upper end of tibia in recent years.⁵⁻⁸ The present study was done on dry bones which establish the morphometric parameters of upper end of tibia in adult Nepalese population. The different parameter of upper end of tibia of present study being compared with previous studies is shown in Table 2.

Table 2. Comparison of different parameters of upper end of tibia in present study with previous studies.

Previous studies	Year	Population	AP measurement of medial condyle (mm)	AP measurement of lateral condyle (mm)	AP measurement of Intercondylar area (mm)	Mediolateral measurement (mm)
Bae DK & Park JY ⁹	2000	Korean	48.0 ± 3.1	39.8 ± 2.9	-	-
Kwak DS et al ¹⁰	2007	Korean	-	-	47.3 ± 3.8	73.5 ± 5.6
Yan JH et al ¹¹	2010	Chinese	48.0 ± 3.1	39.8 ± 2.9	49.87 ± 3.9	73.5 ± 5.6
Chaichankul C et al ¹²	2011	Thai	-	-	46.04 ± 4.4	68.8 ± 5.8
Ivan et al ¹³	2014	Indian	41.0 ± 4.2	36.1 ± 4.0	42.0 ± 4.3	66.4 ± 5.3
Vasanti et al ¹⁴	2017	Indian	46.57 ± 0.95	40.80 ± 0.42	51.2 ± 0.65	-
Ahmad et al ¹⁵	2019	Indian	40.19 ± 5.11	36.41 ± 4.29	42.52 ± 4.79	66.33 ± 5.9
Present Study	2020	Nepalese	46.38 ± 1.98	39.14 ± 0.97	48.79 ± 0.76	66.72 ± 0.65

The study in Chinese population had measured anteroposterior measurements of medial and lateral condyle of tibia and found it to be 48.0 ± 3.1 mm and 39.8 ± 2.9 mm respectively.¹¹ Furthermore, the study had measured anteroposterior measurements of medial and lateral condyle of tibia in Indian population and found it to be 46.57 ± 0.95 mm and 40.80 ± 0.42 mm respectively.¹⁴ The data obtained from these populations coincided with the data obtained from the present study which was conducted in Nepalese population. However, the results of the studies done on Indian population¹⁵ were lower than that was reported in our study. The study in Korean population¹⁰ revealed the dimension of anteroposterior measurement of intercondylar area of tibia to be 47.3 ± 3.8 mm as compared to 48.79 ± 0.76 mm in the present study. However, the results of the studies done on Indian population^{13,15} were lower than the present study. The mediolateral measurement across both tibial condyles in the present study corroborate with the studies done on Thai population¹² and Indian population¹⁵ However, higher values were reported in Korean population¹⁰ and Chinese population.¹¹

Designing the prosthesis of knee, considering the gender difference has been advocated in Chinese population.¹⁶ The research on 100 total knee arthroplasty specimen, suggested that asymmetrical

smaller lateral condyle surface of tibia produces better outcome compared to the symmetrically constructed prosthesis.¹⁷ A study on the knees operated with unicompartmental knee arthroplasty stated that the metric parameters of medial and lateral plateau symmetrically differs with reference to each other, it may complicate the medial unicompartmental knee arthroplasty owing to unrequired mediolateral overhanging while attempting optimal anteroposterior coverage of articular surface.¹⁸

The morphometry of upper end of tibia in Nepalese population are different as compared to other countries populations. The difference may be due to racial differences or different measuring technique. The purpose of this study was to completely investigate the morphometry of upper end of tibia bone and also to compare the morphometric data of the present study in Nepalese population with other studies in different populations.

CONCLUSION

Parameters of intercondylar area and circumference are higher in left tibia as compared to right tibia in adult Nepalese. The dimensions of upper end of tibia in Nepalese population are different as compared to Chinese, Korean, Thai and Indian populations. The knowledge on morphometry of upper end of

tibia will be important to orthopaedic surgeons for diagnosis, planning and treatment of disease related to knee and also for unicompartmental knee arthroplasty and total knee arthroplasty for preventing the loosening of knee prosthesis in Nepalese population.

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