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Morphometric Study of Superior Surface of Proximal End of Tibia

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KEYWORDS

Anteroposterior and tranverse diameter of medial and lateral condyle anterior and posterior diameters and transverse diameter of intercondylar region.

ABSTRACT:

Background: The knee joint is one of the largest joint of human body, it not only provides locomotion but also helps in weight bearing of the body. The knee joint is most often affected by osteoarthritis ,fractures or any other traumas. Therefore for the treatment of such conditions frequently adopted procedure are total knee arthroplasty and unicompartmental knee arthroplasty. For the success of such procedures the prosthesis and the resected bone surface should match irreproachably.The aim of the present study was to measure different condylar and intercondylardiametres of superior surface of tibia as it provides the framework for designing prosthesis of accurate size.

Materials and method: The current study was conducted on 81 dry tibial bones in Department of Anatomy, National Institute of Medical Science and Research Jaipur Rajasthan. Various condylar and intercondylar diameter of superior surface of tibia were measured with the help of digital vernier caliper.

Result: In the present study, mediolateral and transverse diameter of medial condyle was found to be greater than the lateral condyle, the anteroposterior diameter was found to be more than that of transverse diameter. These all parameters on comparison with other studies shows that there is a great variation in morphometry of upper end of tibia according to different regions.

Conclusion: The present study will provide morphometric data of superior surface of tibia which will be helpful for reshaping and resizing of prosthesis in total knee arthroplasty and unicompartmental knee arthroplasty and also of great use for orthopaedician.

INTRODUCTION

Osteoarthritis is a degenerative disorder that affects the joint mainly knee joint, hip joint and spine[16].Osteoarthritis of the knee usually affects the medial compartment of the tibio-femoral articulation[16].

The first change observed is an increase in water content and depletion of proteoglycans from the cartilage matrix. Repeated weight bearing on such a cartilage leads to its fibrillation. The cartilage gets abraded by the grinding mechanism that work at the points of contact between the apposing articular surfaces, until the underlying bone is exposed[17]. With

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further rubbing the subchondral bone becomes hard and glossy. Meanwhile the bone at the margins of the joint hypertrophies to form a rim of projecting spurs known as osteophytes. The loose flakes of cartilage incite synovial inflammation and thickening of capsule, leading to deformity and stiffness of joint[17].

Knee Replacement Surgeries(Knee Arthroplasty) are most common surgical procedures done[30] . The morphometric measurement of the proximal tibia plays an important role in determining the clinical outcome of Total Knee Arthroplasty (TKA) due to ethnic and geographical variations in these measurements[21].In both total and partial knee replacements, the prosthesis are shaped to endure dynamic knee loads during bipedal movement[23].

The success of TKA depends on prosthetic selection and accurate sizing and proper placement of the components[31]. In TKA, a tibial component is more highly susceptible to complications than a femoral component[30]. If a tibial component does not fit, an orthopaedic surgeon may have to select either an oversized or undersized prosthesis[32]. Total knee Arthroplasty should not change the joint kinematics so components of total knee arthroplasty should be designed according to geometry and kinematics[5].

TKA is a precision surgery that requires accurate soft tissue balancing and resection of bone thickness equal to thickness of the prosthetic component implanted, so that flexion extension spacing are equal, allowing joint stability throughout the range of motion. The success of TKA depends to a large extent on prosthetic selection and accurate sizing and proper placement of the components[2].

Morphometric measurements of the proximal tibia are essential for designing and manufacturing tibial components[2]. Morphometric parameters of the upper end of the tibia can also be used to guide treatment[5]. An accurate and repeatable tibial measurement system helps in improvement of tibial prosthesis design[5].

Morphometry is a reliable method for the evaluation of structures in this region of the tibia for medical purposes[10]. Knowing age-related morphological variation of the tibia will contribute to the design and development of novel knee implant components[2]. Maximizing the surface area of coverage between the resected surface of the bone and the implant component is one approach to extending the life of knee prosthesis. The mediolateral length and anteroposterior width data are typically used to classify the numbers of tibial component sizing[23].

The aim of the present study was to figure out the morphometric dimensions of the medial condyle and lateral tibial condyle and intercondylar area[4]. The proximal end of tibia consist of medial and lateral condyle[27].The superior surface of both condyles are articular. Both condyles are seperated by an intercondylar region[28]. The medial condyle is larger than lateral condyle. The superior surface of condyles are oval in shape for articulation with the medial condyle of femur. The articular surface extends laterally onto the side of the raised medial intercondylar tubercle[29].

The superior surface of lateral condyle is circular in shape and articulates above with the lateral condyle of femur. The medial edge of this surface extends onto the side of lateral intercondylar tubercle. The superior articular surface of both condyles are concave centrally and the outer margins of the surface are flatter and are in contact with the interarticular disc(menisci) of fibrocartilage in the knee joint. The intercondylar region bears six distinct facets for the attachment of menisci and cruciate ligament[29].

The anterior horn of medial meniscus lies just in front of the medial articular surface. The anterior cruciate ligament lies on smooth area just behind the attachment of anterior horn of medial meniscus. The anterior horn of lateral meniscus lies in front of intercondylar eminence just lateral to the attachment of anterior cruciate ligament. The posterior horn of lateral meniscus lies on the posterior slope of intercondylar eminence. The posterior horn of medial meniscus is attached to the depression behind the base of the medial intercondylar tubercle. The posterior cruciate ligament is attached to the posterior most smooth area of intercondylar region[29].

The proximal end of tibia articulates with distal end of femur to form tibio-femoral articulation that plays a key role in transmission of body weight from the femur above to the talus below. The tibia ossifies from one primary centre and two secondary centres[31]. The primary centre appears in the shaft during the seventh

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week of intrauterine life. A secondary centre for the upper end appears just before birth (at the end of ninth month) and fuses with the shaft at 16th to 18th year. A secondary centre for the lower end appears during 1st year, forms the medial malleolus by the seventh year, and fuses with the shaft by 15th to 17th year[31].

The knee joint is a complex synovial joint which plays an important role in adjusting the centre of the body mass and posture require a great range of movement in three dimension together with the ability to withstand high forces[2].The joint is stabilized by various ligament attached to the condyles of tibia. The capsular ligament of knee joint is attached to the upper border which also provides attachment to the deeper fibres of tibial collateral ligament[29].

In previous studies, on comparison with similar studies in other populations, it was found that the anatomical profile of proximal end of tibia is smaller in Indian population therefore the need for resizing of the already available prosthesis for Total Knee Arthroplasty arose. This study may be of help to the Orthopaedicians for resizing and reshaping of the prosthesis for Indian population[5].

MATERIALS AND METHODS:

The current study was conducted on 81 dry tibial bones in Department of Anatomy, National Institute of Medical Science and Research Jaipur Rajasthan. Various condylar and intercondylar diameter of superior surface of tibia were measured with the help of digital vernier caliper. Broken bones and bones with congenital anamolies were excluded. Statistical analysis was done using SPSS Microsoft Excel Software. Data was updated in Microsoft excel and analysis was done using SPSS software.

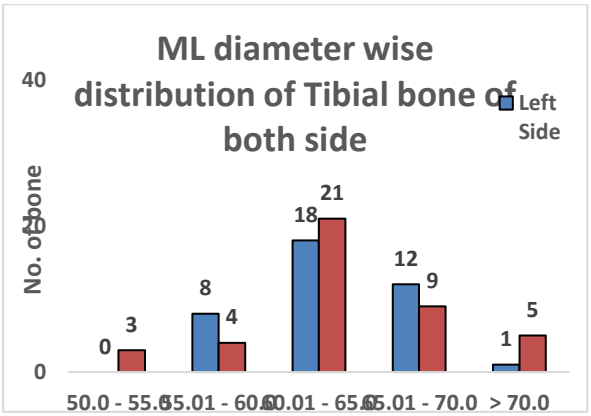
RESULTS AND OBSERVATIONS:

Distribution of ML diameter of tibial bone of both side

The medio-lateral (ML) diameter of the tibial bone shows a similar distribution pattern on both left and right sides with most measurements concentrated between 60.01-65.0mm. On the left side, nearly half of the samples (46.15%) fell within this interval, while the right side displayed on even higher proportion (50%). The second most common ML range was 65.01-70.0mm accounting for 30.77% of left and 21.43% of right tibiae.

Table 1: Frequency distribution of ML diameter of tibial bone of both side

ML Interval (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %
50.0 - 55.0	0	0.00%	3	7.14%
55.01 - 60.0	8	20.51%	4	9.52%
60.01 - 65.0	18	46.15%	21	50.00%
65.01 - 70.0	12	30.77%	9	21.43%
> 70.0	1	2.56%	5	11.90%



Distribution of APIC diameter of tibial bone of both side

The table and corresponding bar chart present the frequency distribution of the APIC (AnteroposteriorIntercondylar) diameter of the tibial bone on both the left and right sides. A total of 39 left tibiae and 42 right tibiae were analyzed across four APIC diameter intervals. For the left side, the majority of tibiae fell within the 35.01–40.0 mm interval (41.03%), followed closely by the 40.01–45.0 mm range (38.46%). Only a small proportion (2.56%) exhibited a diameter between 30.0–35.0 mm, indicating that smaller APIC diameters are uncommon among the sampled bones.

Table 2: Frequency distribution of APIC diameter of tibial bone of both

APIC Interval (In mm)	Left Side		Right Side	
	n =	In %	n =	In %

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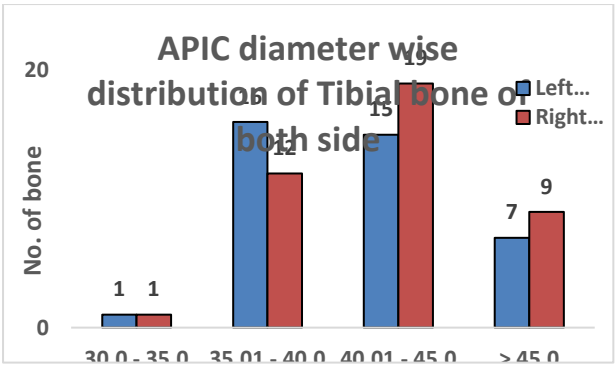
	39		42	
30.0 - 35.0	1	2.56%	1	2.38%
35.01 - 40.0	16	41.03%	12	28.57%
40.01 - 45.0	15	38.46%	19	45.24%
> 45.0	7	17.95%	9	21.43%

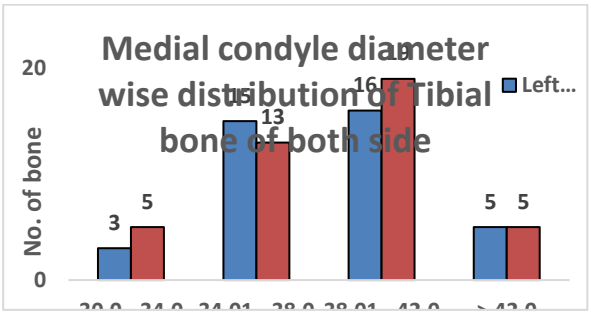


Distribution of medial condyle diameter of tibial bone of both side

The distribution of medial condyle diameter of the tibial bone shows notable variation between the left and right sides. In both sides, the majority of tibiae fall within the **38.01**–42.0 mm range, with 41.03% on the left and a slightly higher 45.24% on the right. The second most frequent range is **34.01–38.0 mm**, accounting for 38.46% of left tibiae and 30.95% of right tibiae. The smallest diameter group (30.0–34.0 mm) shows relatively low representation on both sides, although the right side (11.90%) exhibits a slightly higher frequency than the left (7.69%). Notably, the proportion of tibiae with diameters **greater than 42.0 mm** is the same on both sides (12.82% left and 11.90% right), suggesting a symmetrical occurrence of extremely large medial condyles.

Table 3: Frequency distribution of medial condyle diameter of tibial bone of both side

Medial Condyle Diameter (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %
30.0 - 34.0	3	7.69%	5	11.90%
34.01 - 38.0	15	38.46%	13	30.95%
38.01 - 42.0	16	41.03%	19	45.24%
> 42.0	5	12.82%	5	11.90%

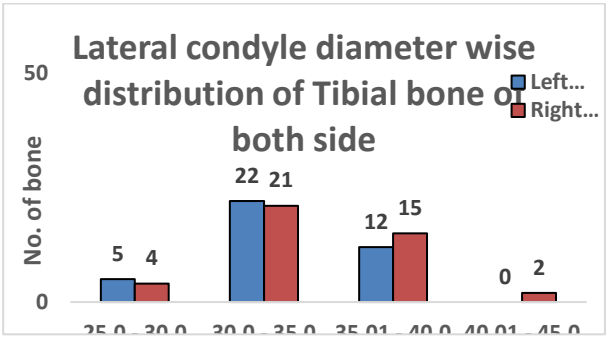


Distribution of lateral condyle diameter of tibial bone of both side

The corresponding bar chart illustrate the frequency distribution of the lateral condyle diameter of the tibial bone on both sides. The majority of specimens on both left (56.41%) and right (50%) sides fall within the 30.0–35.0 mm range, indicating this as the most common diameter category. A considerable proportion also lies within the 35.01–40.0 mm range, accounting for 30.77% on the left and 35.71% on the right side.

Table 4: Frequency distribution of lateral condyle diameter of tibial bone of both side

Lateral Condyle Diameter (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %
25.0 - 30.0	5	12.82%	4	9.52%
30.0 - 35.0	22	56.41%	21	50.00%
35.01 - 40.0	12	30.77%	15	35.71%
40.01 - 45.0	0	0.00%	2	4.76%



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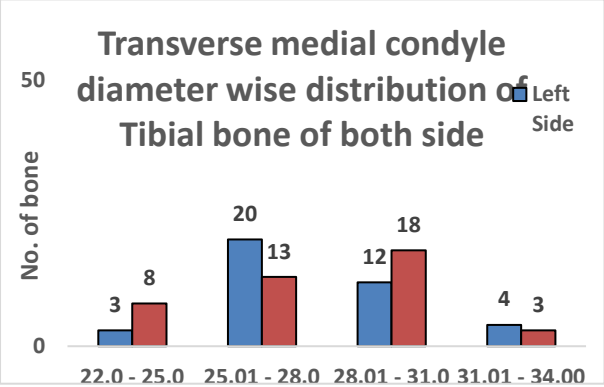
Distribution of transverse medial condyle diameter of tibial bone of both side

The associated bar chart show the distribution of the transverse medial condyle diameter of the tibial bone on both sides. The most frequently observed diameter range is 25.01–28.0 mm on the left side (51.28%), while on the right side the majority of bones fall within the 28.01–31.0 mm range (42.86%). Smaller diameters (22.0–25.0 mm) and (31.01–34.0 mm) are seen infrequently.

Table 5: Frequency distribution of transverse medial condyle diameter of tibial bone of both side

Transverse Medial Condyle Diameter	Left Side		Right Side	
	n = 39	In %	n = 42	In %
22.0 - 25.0	3	7.69%	8	19.05%
25.01 - 28.0	20	51.28%	13	30.95%
28.01 - 31.0	12	30.77%	18	42.86%
31.01 - 34.00	4	10.26%	3	7.14%

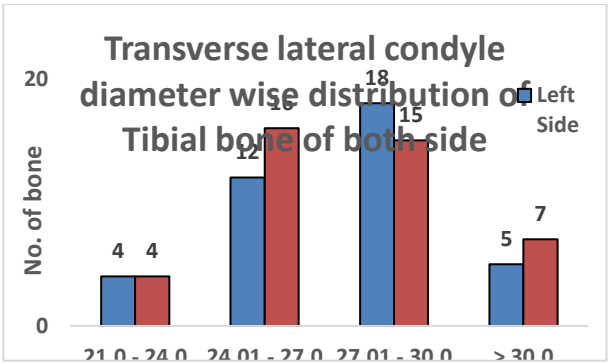


Distribution of transverse lateral condyle diameter of tibial bone of both side

The corresponding bar diagram depict the distribution of the transverse lateral condyle diameter of the tibial bone on both sides. The majority of tibiae on both the left (46.15%) and right (35.71%) sides fall within the 27.01–30.0 mm range, indicating this as the most common diameter group. This is followed by the 24.01–27.0 mm category, which also shows a considerable proportion on both sides. Only a small number of bones are observed at the lower (21.0–24.0 mm) or higher (>30.0 mm) diameter extremes.

Table 6: Frequency distribution of transverse lateral condyle diameter of tibial bone of both side

Transverse Lateral Condyle Diameter	Left Side		Right Side	
	n = 39	In %	n = 42	In %
21.0 - 24.0	4	10.26%	4	9.52%
24.01 - 27.0	12	30.77%	16	38.10%
27.01 - 30.0	18	46.15%	15	35.71%
> 30.0	5	12.82%	7	16.67%



Distribution of A-P anterior intercondylar region diameter of tibial bone of both side

The accompanying bar chart show the distribution of the A-P anterior intercondylar region diameter of the tibial bone on both sides. The majority of specimens lie within the 27.01–30.0 mm range on both left (35.90%) and right (45.24%) sides, making it the most common diameter group in this region. This is followed by the 24.01–27.0 mm category, which also shows a substantial proportion on each side. Very few bones show measurements below 24 mm or above 33 mm.

Table 7: Frequency distribution of A-P anterior intercondylar region diameter of tibial bone of both side

A-P Anterior Diameter (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %

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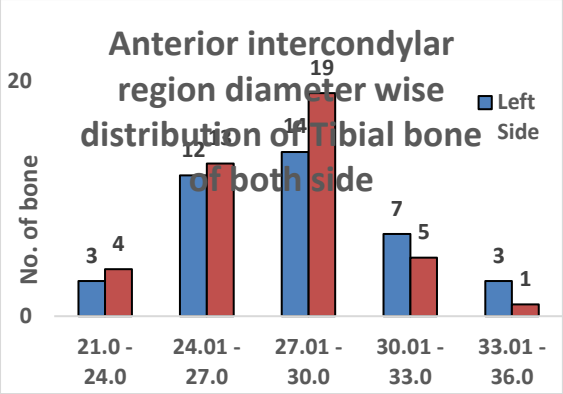
21.0 - 24.0	3	7.69%	4	9.52%
24.01 - 27.0	12	30.77%	13	30.95%
27.01 - 30.0	14	35.90%	19	45.24%
30.01 - 33.0	7	17.95%	5	11.90%
33.01 - 36.0	3	7.69%	1	2.38%

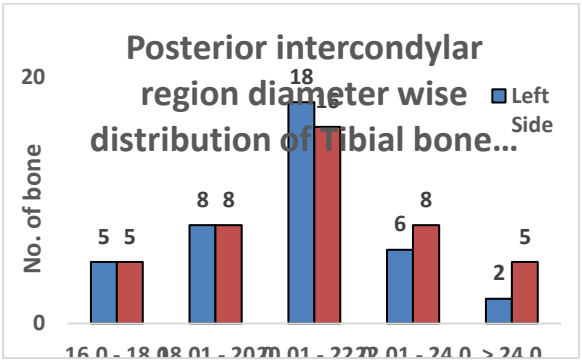


Distribution of A-P posterior intercondylar region diameter of tibial bone of both side

The corresponding bar chart represent the distribution of the A-P posterior intercondylar region diameter of the tibial bone on both sides. The majority of bones fall within the 20.01–22.0 mm range, contributing 46.15% on the left side and 38.10% on the right side, making it the most common diameter group observed. This is followed by the 18.01–20.0 mm range, while larger diameters greater than 24.0 mm are relatively uncommon on both sides.

Table 8: Frequency distribution of A-P posterior intercondylar region diameter of tibial bone of both side

A-P Posterior Diameter (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %
16.0 - 18.0	5	12.82%	5	11.90%
18.01 - 20.0	8	20.51%	8	19.05%
20.01 - 22.0	18	46.15%	16	38.10%
22.01 - 24.0	6	15.38%	8	19.05%
> 24.0	2	5.13%	5	11.90%



Distribution of transverse anterior intercondylar region diameter of tibial bone of both side

The corresponding bar chart present the distribution of the transverse anterior intercondylar region diameter of the tibial bone on both sides. The most common diameter class in both left (38.46%) and right (38.10%) sides is 16.01–20.0 mm, followed by the 20.01–24.0 mm range, which is more frequent on the right side (30.95%). A higher percentage of specimens on the left side (28.21%) demonstrate measurements greater than 24.0 mm, compared to only 9.52% on the right.

Table 9: Frequency distribution of transverse anterior intercondylar region diameter of tibial bone of both side

Transverse Anterior Diameter (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %
12.0 - 16.0	7	17.95%	9	21.43%
16.01 - 20.0	15	38.46%	16	38.10%
20.01 - 24.0	6	15.38%	13	30.95%
> 24.0	11	28.21%	4	9.52%

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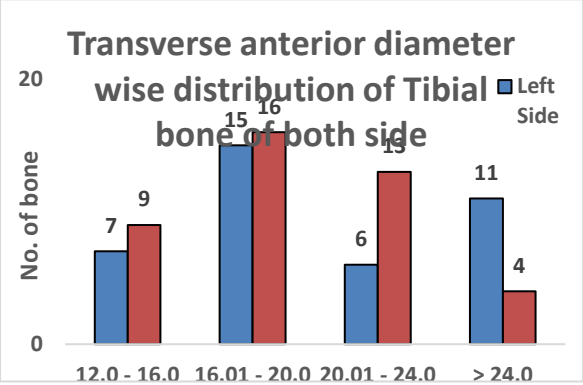
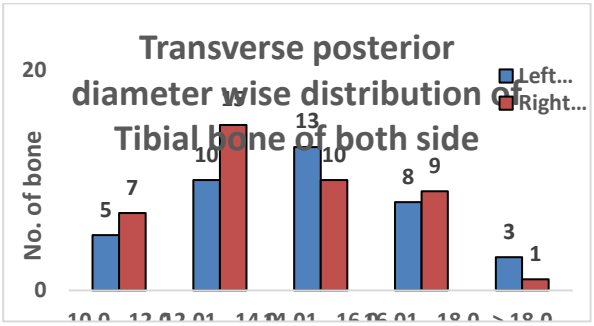


Distribution of transverse posterior intercondylar region diameter of tibial bone of both side

The accompanying bar chart present the distribution of transverse posterior intercondylar region diameter of the tibial bone on both sides. The results show that the most common diameter range on the left side is 14.01–16.0 mm (33.33%), whereas on the right side, the majority of bones fall within the 12.01–14.0 mm range (35.71%). Smaller diameters (10.0–12.0 mm) and larger diameters (>18.0 mm) are observed less frequently on both sides.

Table 10: Frequency distribution of transverse posterior intercondylar region diameter of tibial bone of both side

Transverse Posterior Diameter (In mm)	Left Side		Right Side	
	n = 39	In %	n = 42	In %
10.0 - 12.0	5	12.82%	7	16.67%
12.01 - 14.0	10	25.64%	15	35.71%
14.01 - 16.0	13	33.33%	10	23.81%
16.01 - 18.0	8	20.51%	9	21.43%
> 18.0	3	7.69%	1	2.38%



Descriptive statistics of different diameters of tibial bone of both side

The measurements show a high degree of symmetry between both sides, with only minor variations. The mediolateral (ML) diameter demonstrates the greatest values among all parameters, with similar minimum and maximum ranges on both sides and comparable mean values (Left: 62.85 ± 3.84 mm; Right: 63.62 ± 4.89 mm). The anteroposterior measurements—including the APIC, A-P medial condyle, and A-P lateral condyle—also exhibit closely aligned distributions between the left and right tibia.

Table 11: Descriptive statistics of different diameters of tibial bone of both side

Variables		Minimum	Maximum	Median (IQR)	Mean ± SD
Left Side	**ML**	55.51	70.36	63.56 (60.35-65.3)	62.85 ± 3.84
	APIC	32.96	48.75	41.58 (39.07-44.65)	41.58 ± 3.75
	A-P Medial Condyle	31.72	46.2	38.06 (36.69-40.24)	38.18 ± 3.13
	A-P Lateral Condyle	25.87	37.36	33.58 (32.37-35.50)	33.43 ± 2.76
Right Side	**ML**	53.75	75.19	63.51 (60.91-66.94)	63.62 ± 4.89
	APIC	32.94	50.4	41.27 (39.16-	42.04 ±

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				44.36)	3.83
	A-P Medial Condyle	30.39	44.44	39.14 (35.27-40.90)	38.35 ± 3.65
	A-P Lateral Condyle	26.14	42.33	34.68 (32.62-36.20)	34.18 ± 3.36

Descriptive statistics of transverse medial & lateral condyle diameters of tibial bone of both side

The transverse diameters of the tibial condyles demonstrated comparable measurements on both left and right sides. For the left tibia, the medial condyle ranged from 22.71 mm to 31.78 mm with a median of 27.31 mm and a mean of 27.52 ± 2.21 mm, while the lateral condyle showed a slightly broader range (22.92–31.85 mm) and a mean of 27.5 ± 2.26 mm. On the right side, the medial condyle measured between 23.81 mm and 33.27 mm with a mean of 27.73 ± 2.55 mm, and the lateral condyle ranged from 21.45 mm to 37.85 mm with a mean of 27.38 ± 3.01 mm.

Table 12: Descriptive statistics of transverse medial & lateral condyle diameters of tibial bone of both side

Variables		**Minimum**	**Maximum**	**Median (IQR)**	**Mean ± SD**
Left Side	**Transverse Medial Condyle**	22.71	31.78	27.31 (25.78-29.15)	27.52 ± 2.21
	Transverse Lateral Condyle	22.92	31.85	27.64 (26.06-29.20)	27.5 ± 2.26
Right Side	**Transverse Medial Condyle**	23.81	33.27	28.02 (25.48-29.70)	27.73 ± 2.55
	Transverse Lateral Condyle	21.45	37.85	27.26 (25.68-29.08)	27.38 ± 3.01

Descriptive statistics of different diameter of intercondylar region of tibial bone of both side

The intercondylar region of the tibial bone shows consistent dimensional patterns between the left and right sides. On both sides, the anterior A-P diameter is markedly larger than the posterior portion, with mean values around 28 mm anteriorly and 21 mm posteriorly, indicating a naturally wider anterior intercondylar area. Similarly, the transverse measurements reveal greater anterior than posterior dimensions, with mean values of approximately 20 mm anteriorly and 14–15 mm posteriorly.

Table 13: Descriptive statistics of different diameter of intercondylar region of tibial bone of both side

Variables			**Minimum**	**Maximum**	**Median (IQR)**	**Mean ± SD**
Left Side	**A-P Diameter**	**Anterior**	21.98	35.7	27.93 (25.98-30.11)	28.18 ± 3.12
		Posterior	16.49	32.98	20.58 (19.51-21.74)	20.76 ± 2.76
	Transverse	**Anterior**	13.22	30.05	18.86 (17.41-24.43)	20.25 ± 4.53
		Posterior	10.63	20.14	14.52 (13.14-16.32)	14.73 ± 2.27
Right Side	**A-P Diameter**	**Anterior**	21.2	35.39	27.82 (25.89-28.86)	27.6 ± 2.79

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		Posterior	16.52	26.94	20.69 (19.52-22.72)	21.03 ± 2.43
	Transverse	**Anterior**	12.47	26.08	19.35 (16.58-21.52)	19.23 ± 3.57
		Posterior	10.11	18.07	13.79 (12.69-15.48)	14.21 ± 2.05

Comparing different diameters between right and left side of tibial bone by using t-test

The comparison of tibial dimensions between the right and left sides using independent t-tests showed no statistically significant differences across all measured variables, including the mediolateral (ML) diameter, the anteroposteriorintercondylar (APIC) diameter, and the anteroposterior diameters of both the medial and lateral condyles. All p-values were greater than 0.05, indicating that the observed variations between sides fall within normal anatomical variability rather than representing true side-related differences.

Table 14: Comparing different diameters between right and left side of tibial bone by using t-test

Variables	Left Side	Right Side	t-test	P - Value	Significance
ML	62.85 ± 3.84	63.62 ± 4.89	-0.980	0.33015	All are not significant
APIC	41.58 ± 3.75	42.04 ± 3.83	-0.745	0.45835	
A-P Medial Condyle	38.18 ± 3.13	38.35 ± 3.65	-0.287	0.77508	
A-P Lateral Condyle	33.43 ± 2.76	34.18 ± 3.36	-1.390	0.16855	

Comparing medial & lateral diameters between right and left side of tibial bone by using t-test

The comparison of medial and lateral condylar diameters between the left and right tibial bones showed no statistically significant differences. The mean values for both medial and lateral condyles were closely similar on each side, and the corresponding p-values (0.62448 for the medial condyle and 0.80381 for the lateral condyle) were well above the 0.05 threshold. These findings indicate strong bilateral symmetry in condylar morphology, suggesting that variations between sides are minimal and not statistically meaningful.

Table 15: Comparing medial & lateral diameters between right and left side of tibial bone by using t-test

Variables	Left Side	Right Side	t-test	P - Value	Significance
Medial Condyle	27.52 ± 2.21	27.73 ± 2.55	-0.491	0.62448	Both are not significant
Lateral Condyle	27.5 ± 2.26	27.38 ± 3.01	0.249	0.80381	

Comparing different diameters of intercondylar region of tibial bone between right and left side by using t-test

The comparison of intercondylar region dimensions between the right and left tibial bones revealed no statistically significant differences across all measured parameters. Both the anterior and posterior A-P diameters, as well as the anterior and posterior transverse diameters, showed closely comparable mean values between sides, with p-values ranging from 0.08944 to 0.50445—all above the 0.05 significance threshold.

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Table 16: Comparing different diameters of intercondylar region of tibial bone between right and left side by using t-test

Variables		Left Side	Right Side	t-test	P - Value	Significance
A-P Diameter	Anterior	28.18 ± 3.12	27.6 ± 2.79	1.269	0.20823	All are not significant
	Posterior	20.76 ± 2.76	21.03 ± 2.43	-0.671	0.50445	
Transverse	Anterior	20.25 ± 4.53	19.23 ± 3.57	1.719	0.08944	
	Posterior	14.73 ± 2.27	14.21 ± 2.05	1.563	0.12210	

DISCUSSION:

In the present study entitled –"MORPHOMETRIC STUDY OF SUPERIOR SURFACE OF TIBIA" which has been conducted with aim to measure the various diameters of condylar and intercondylar areas of superior surface of proximal end of tibia among the Indian population.

Total 81 dry tibialbone were studied in the Department of Anatomy at National Institute of Medical Science & Research Jaipur, Rajasthan were enrolled after consideration of the inclusion and exclusion criteria. The Observations and Results are discussed in this section in the light of available data, information, and observations made by other researchers in a similar region or elsewhere.

Present study was done on 81 dry tibial bone and anteroposterior and transverse diameter of medial condyle and lateral condyle was measured. For the medial condyle it was found to be 38.35±3.65 and 27.73±2.55 (Right tibia) and 38.18±3.13 and 27.52±2.21(Left tibia) and for the lateral condyle it was 34.18±3.36 and27.38±3.01(Right side) and 33.43±2.76 and 27.5±2.26(Left side). It was found that the anteroposterior diameter of both the condyles was greater than the transverse diameter and overall the diameters of medial condyle was greater than the lateral condyle.

Zalawadia et al.(2018) in his study conducted on 120 tibial bone in Gujrat population and observed the anteroposterior and transverse diameter of medial as well as the lateral condyle of both right and left side tibia. For the medial condyle it was found to be 38.26±2.43 and 27.13±1.86 (Right tibia) and 38.51±2.35 and 27.38±1.97 (Left side) which was nearer to the diametres obtained in present study, and that of lateral condyle it was 38.26±2.43 and 27.13±1.86(Right side) and 38.51±2.35 and 27.38±1.97(Left side) which was greater than the diameter obtained in the present study.

Muralimanju et al.(2016) conducted the study on 73 tibia in South Indian population and observed anteroposterior and transverse diameter of medial and lateral condyle of both right and left side tibia. It was found to be 34.80±3.90 and 26.50±3.40 (Right tibia) and 32.60±3.40 and 25.70±2.50 (Left tibia) for the medial condyle which is lesser than the diameter obtained in present study. For the lateral condyle it was 34.80±3.90 and 26.50±3.40 (Right side) and 32.60±3.40 and 25.70±2.50 (Left side) which is closer to the diameters obtained in present study.

Sinha B et al.(2018) conducted the study on 50 tibial bone in Bihar population measured the diameters of medial and lateral condyles of both right and left side and it was found to be 39.1±2.5 and 26.9±1.5 (Right tibia) and 38.9±2.7 and 27.6±1.8 (Left tibia) for the medial condyle which is close to the present study, and for the lateral condyle it was39.1±2.5 and 26.9±1.5(Right side) and 38.9±2.7 and 27.6±1.8(Left side) which is greater than the diameter obtained in present study. Khursid et al.(2019) in their study on 30 dry tibial bones in Srinagar population and observed AP diameter of medial condyle 39.1±3.9 and transverse diameter to be 26.1±2.7 which is greater than the diameter obtained in present study while the AP

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diameter of lateral condyle of both sides was observed as 35.1±3.2mm and 25.4±3.1mm which is not that close to the present study.

Ahmad N et al.(2019) in their study on 60 adult human dry tibial bone in Uttarakhand population and observed the mean AP diameter of medial condyle of both right and left side was 40.18mm and 40.21mm and the mean transverse diameter of the medial condyle of both side 28.46mm and 28.27mm which is greater than the diameter observed in present study and for the lateral condyle it was was 35.94±4.59 and 27.89±4.26(Right side) and 37.02±3.87 and 27.92±3.06(Left side) which is greater than the present study.

In present study the transverse diameter for both anterior and posterior part of intercondylar region of both side of tibia was measured. For the anterior part of both right and left was 19.23±3.57(Right) and 20.25±4.53(Left) and for the posterior part it was found to be 14.21±2.05(Right) and 14.73±2.27(Left). It was observed that the transverse diameter was greater on left side than right side tibia.

Khursid et al.(2019) in their study on 30 dry tibial bones in Srinagar population and measured the transverse diameter (anterior and posterior) of Intercondylar region of both right and left side. For the anterior part of of both right and left was found to be 24.8±0.37 and for the posterior it was 17.6±0.27 which is greater than the diameter obtained in present study. Nayak G et al. conducted their study in Orissa on 46 tibial bone and measured transverse diameter (anterior and posterior) of Intercondylar region of both right and left side. For the anterior part of of both right and left was found to be 28.7±0.55 and 31.2±0.68 and for the posterior part 18.5±0.42 and 12.8±0.39 which was found to be greater than the present study.

In present study, measured the anteroposterior diameter for both anterior and posterior part of intercondylar region of both side of tibia was measured. For the anterior part of both right and left was 27.6±2.79 and 28.18±3.12 and posterior AP diameter was 21.03±2.43 and 20.76±2.76.Ahmad N et al.(2019) in their study on 60 adult human dry tibial bone and measured the anteroposterior diameter for both anterior and posterior part of intercondylar region of both side of tibia was measured. For the anterior part of both right and left was 26.09±3.55 and 27.29±3.40 and posterior AP diameter was 20.83±2.88 and 20.73±2.64 which were found to be close to the present study.

Lal N et al.(2023) conducted the study in 41 dry tibial bones and measured the anteroposterior diameter for both anterior and posterior part of intercondylar region of both side of tibia was measured. For the anterior part of both right and left was 25.72±2.59 and 26.36±1.78 and post AP diameter was 17.78±1.55 and 18.27±1.57 which were found to be lesser than the diameter obtained in present study.

In present study, the anteroposterior diameter of intercondylar region was measured for both side of tibia and was found to be 42.04±3.83(Right) and 41.58±3.75 (Left).Ahmad N et al.(2019) in their study on 60 adult human dry tibial bone and measured the anteroposterior diameter of intercondylar region of both side of tibia and was found to be 42.24±5.12(Right) which is close to the obtained in present study and 42.89±4.38(Left) which is higher than the present study.

Reeti R et al.(2021) conducted the study on 50 tibia of unknown gender and measured the anteroposterior diameter of Intercondylar region of both right and left side. It was found to be 47.29±0.06(Right) and 49.06±0.07(Left) which is higher than the data obtained in present study. Nayak G et al. conducted their study in Orissa on 46 tibialbone and measured the anteroposterior diameter of Intercondylar region of both right and left side. It was found to be 41.8±0.44 that is observed to be closer to the present study and 43.1±0.40 found to be greater than the present study.

In present study the mediolateral length across both condyles was measured for both sides of tibia and it was found to be 63.62±4.89(Right) and 62.85±3.84(Left).Ahmad N et al.(2019) in their study on 60 adult human dry tibial bone measured the mediolateral length across both condyles and measured as 66.03±6.60(Right) and 66.72±5.13(Left) .Pradhan R R et al.(2023) in their study on 200 adult dry tibial bone measured the mediolateral length which was found to be 68.30±5.86(Right) and 67.37±5.65(Left) which was found to be greater than the present study.

Above studies suggests that there is a variation in morphometry of upper end of tibia according to different regions. The need for accurate morphometric data is crucial for designing prosthesis that fits well and

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provide better outcomes in knee arthroplasty. Most commercially available knee implants are designed based on western anatomical profile which is larger than the profile obtained in indian population which leads to the oversizing of prosthesis in indian population which is a significant concern as excessive overhanging may lead to soft tissue irritation and pain while undercoverage can compromise implant stability.

Limitation of this study is that it was performed on dry bones which may have undergone shrinkage in its morphology as compared with live specimens. This may lead to inaccuracy in the morphometric measurement by a few millimeters and sex differentiation is also not considered.

CONCLUSION:

In the present study, morphometric measurement of proximal end of tibia were taken. Various diameter such as anteroposterior, transverse diameter and various diameter of intercondylar region were measured on dry tibial bone. Comparing this study with other similar studies conducted on different population shows that there is a variation in anatomical profile of proximal end of tibia and hence highlighting the need of resizing and reshaping of prosthesis according to the population, as it is essential for the geometry of the tibial component to match the resected surface as closely as possible to achieve greater stability and load transfer following knee replacement surgery.These morphometric measurements helps the orthopaedic surgeon to select the appropriate size for prosthesis.It will also help anthropologists and forensic experts.

Fig 1(A): Medio-lateral length (ML)

Fig 1(B): Antero-posterior Intercondylar Diameter (APIC)

Fig1(C): Antero-posterior diameter of medial condyle

Fig1(E): Antero-posterior diameter of lateral condyle

Fig 1(D): Transverse diameter of medial condyle

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Fig1(F): Transverse diameter of lateral condyle

Fig1(J): Transverse diameter of posterior intercondylar region

Fig1(I): Anteroposterior diameter of posterior intercondylar region

Fig1(H): Transverse diameter of anterior intercondylar region

Fig 1(G): Anteroposterior diameter of anterior intercondylar region

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