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THE STUDY OF MORPHOMETRY OF PROXIMAL END OF TIBIA

Anatomy

Ms. Shraddha Jitendra Suryawanshi M.Sc. Medical Anatomy Student Dr Balasaheb Vikhe Patil Rural Medical College ,Department of Anatomy Loni.

Dr. Mohini Madhukarrao Joshi* Professor, Dr Balasaheb Vikhe Patil Rural Medical College ,Department of Anatomy , Loni*Corresponding Author

Dr. Rajeev R. Desai Professor and Head Dr Balasaheb Vikhe Patil Rural Medical College ,Department of Anatomy , Loni

ABSTRACT

Background: The proximal tibia plays a crucial role in weight transmission and knee joint stability. Accurate morphometric knowledge of this region is essential for prosthetic design and successful knee arthroplasty. Population-specific data on proximal tibial dimensions, particularly in the Indian population, remain limited.**Materials and Methods:** This descriptive cross-sectional study was conducted in the Department of Anatomy, Pravara Institute of Rural Medical College, Loni, on 150 dry adult tibiae (75 right and 75 left). Fully ossified, intact bones were included, while damaged or pathological specimens were excluded. Various morphometric parameters of the proximal tibia were measured and compared between sides.**Results:** Analysis revealed no statistically significant differences between the left and right sides for any measured parameter ($p > 0.05$). Measurements including anteroposterior and mediolateral dimensions of the condyles, intercondylar area, tibial tuberosity, upper-end circumference, and related anatomical landmarks demonstrated marked bilateral symmetry.**Conclusion:** The study provides comprehensive morphometric data of the proximal tibia in a western Indian population, showing generally smaller dimensions compared to other populations. These findings underscore the importance of population-specific prosthetic sizing for optimal load transfer and stability in unicompartmental and total knee arthroplasty. The data may also be useful in forensic and anthropological applications. Further studies using radiological and three-dimensional techniques are recommended.

KEYWORDS

Tibial tuberosity, Gerdy's tubercle, medial and lateral tibial condyles, total knee replacement

INTRODUCTION:

The inferior extremity is specialized for weight transmission and locomotion, enabling erect bipedal posture with lesser strength and stability than the upper branch. The knee joint, a emulsion synovial joint, plays a pivotal part in conforming body mass and posture while allowing multidirectional movement and bearing high loads.[1]

The proximal end of the tibia forms an essential element of the knee joint through the tibiofemoral articulation, transmitting body weight from the femur to the talus. The tibia, a typical long bone and the alternate longest bone after the femur, has a prismoid shaft and expanded ends. Its proximal end includes medium and side condyles, an intercondylar area, and the tibial tuberosity[2] The tibial tuberosity, an apophysis formed from a secondary ossification center, serves as the attachment for the patellar ligament and is susceptible to avulsion injuries, particularly in conditions similar as Osgood – Schlatter complaint.

Long-term weight bearing on the knee joint can lead to pathological conditions such as septic arthritis, post-traumatic arthritis, and age-related osteoarthritis. These conditions are commonly managed by Total Knee Arthroplasty (TKA) or Unicompartmental Knee Arthroplasty (UKA)[3] The basic principle of TKA is resection of the superior surface of the proximal tibia and its replacement with a tibial prosthesis. Surgical success depends not only on proper soft-tissue balancing but also on accurate rotational and sagittal alignment with minimal prosthetic overhang.

Anthropometry is the measurement of the human body and is important in medical and forensic sciences. Proximal tibial morphometry is essential in knee osteoarthritis management, particularly for accurate prosthesis design and successful knee arthroplasty outcomes.

The present study is to provide morphometric data for designing tibial components of prostheses that can be used in patients with knee joint osteoarthritis in the population. As surgeries of knee joint are rapidly evolving and technically demanding too, so a morphometric study of this region will definitely serve in the planning of various interventions needed in degenerative and other pathological conditions of knee.

Materials and Methods:

The morphology of the proximal end of the tibia was measured in all parameters that are present on the proximal end of the tibia.

Study Setting: Department of Anatomy, Pravara Institute of Rural Medical College, Loni.

Study Type: Descriptive type of Cross Sectional Study

Sample Size: The study was carried out on 150 dry tibia (75right and 75 left).

Inclusion criteria: Fully ossified, dried, macerated and thoroughly cleaned tibia which were complete in all respects in order to give correct observation.

Exclusion criteria: Unossified bones with diseased and Injuries.
Study Period: 2 years

Materials:

1. 1.Digital Vernier Caliper
2. Thread
3. Scale
4. Measuring Tape

RESULTS:

Table 1: Showing Measurements of Right Tibia

Parameter	Range	Mean	S.D.	S.E.	P-Value
Mediolateral Length	32.80	64.51	6.40	0.74	0.34
Anteroposterior length of Medial Condyle	32.61	41.08	6.05	0.70	0.07
Anteroposterior length of Lateral Condyle	29.48	36.02	5.47	0.63	0.63
Anteroposterior Intercondylar Area	31.74	40.81	5.52	0.64	0.32
Length of Upper Smooth Part of Tibial Tuberosity	14.72	17.87	3.12	0.36	0.31
Length of Lower Rough Part of Tibial Tuberosity	15.72	18.83	2.77	0.32	0.62

Breadth of Upper Smooth Part of Tibial Tuberosity	11.2	16.58	2.25	0.26	0.26
Breadth of Lower Rough Part of Tibial Tuberosity	11.3	16.64	2.06	0.24	1.00
Vertical diameter of Gerdy's Tubercle	12.76	13.24	3.21	0.37	0.53
Transverse diameter of Gerdy's Tubercle	12.40	11.36	1.93	0.22	0.52

Table 2: Showing Measurements of Left Tibia :

Parameter	Range	Mean	S.D.	S.E.	P-Value
Mediolateral Length	27.92	63.55	6.29	0.73	0.34
Anteroposterior length of Medial Condyle	21.87	39.42	5.38	0.62	0.07
Anteroposterior length of Lateral Condyle	26.5	35.61	5.79	0.67	0.64
Anteroposterior Intercondylar Area	23.88	39.93	5.55	0.64	0.32
Length of Upper Smooth Part of Tibial Tuberosity	16.4	17.49	3.18	0.37	0.31
Length of Lower Rough Part of Tibial Tuberosity	20.5	18.64	3.91	0.45	0.62
Breadth of Upper Smooth Part of Tibial Tuberosity	12.43	16.96	2.37	0.27	0.26
Breadth of Lower Rough Part of Tibial Tuberosity	11.95	16.64	2.48	0.29	1.00
Vertical diameter of Gerdy's Tubercle	11.36	12.90	2.54	0.29	0.53
Transverse diameter of Gerdy's Tubercle	13.67	11.60	2.42	0.28	0.52

DISCUSSION

In the present study (Fig-1), the mean mediolateral (ML) length of the proximal tibia was 63.55 ± 6.29 mm on the left side and 64.51 ± 6.40 mm on the right side, with an overall mean of 64.03 ± 6.34 mm. A slightly higher value on the right side indicated minimal bilateral asymmetry, possibly due to functional dominance and mechanical loading.

Compared to other studies, the present values were lower. Rashmi Rani P et al.[4] reported a higher mean ML length of 67.91 ± 5.76 mm, while Chaichankul C et al.[5] found a mean of 68.8 ± 5.8 mm in the Thai population, with significant sexual dimorphism. These differences suggest the influence of anthropometric and genetic factors on proximal tibial morphology.

In the present study, (Fig.2) the anteroposterior (AP) length of the medial tibial condyle showed a mean value of 39.42 ± 5.38 mm on the left side and 41.08 ± 6.05 mm on the right side, with an overall mean of 40.25 ± 5.76 mm. A slightly higher AP dimension was observed on the right side, suggesting minimal bilateral asymmetry, which may be related to differences in functional loading. These findings are comparable to those reported by Ahmad et al[6]., who observed a mean AP length of the medial condyle of 40.18 ± 4.75 mm on the right side and 40.21 ± 5.64 mm on the left side, with a total mean of 40.19 ± 5.11 mm.. The anteroposterior (AP) length of the medial tibial condyle reported by Servian et al. [7]50.8± 3.3mm and Bae DK [8]et al 48.0± 3.1 mm. was found to be higher when compared to the values observed in the present study.

The present study (Fig-3) demonstrated minimal side-to-side variation in the anteroposterior length of the lateral tibial condyle, with a mean value of 35.61 ± 5.79 mm on the left side and 36.02 ± 5.47 mm on the right side. The overall mean anteroposterior length of the lateral condyle was 35.82 ± 5.62 mm. These findings are comparable with those reported by Ahmad et al.[6]

In the present study, the anteroposterior (AP) intercondylar length (Fig-4) was found to be smaller in comparison to the South Indian population and was also lower than the values reported in Thai,[8] Korean,[27] and Chinese population[9]

In the present study, the mean length of the upper smooth part of the tibial tuberosity was 17.68 ± 3.14 mm overall, with no significant side difference ($p > 0.05$). These findings are comparable to those of Farooq R. et al., who also reported no significant bilateral variation. The mean length of the lower rough part was 18.74 ± 3.38 mm, again showing no significant side difference, though lower than the values reported by Farooq R. et al.[11]

Similarly, the mean breadth of the upper smooth part (16.77 ± 2.31 mm) and lower rough part (16.64 ± 2.27 mm) showed no statistically significant bilateral differences. While Farooq R. et al. reported comparable bilateral symmetry, their measurements were generally higher. The smaller dimensions observed in the present study may be due to racial, ethnic, or methodological variations. These morphometric data are clinically important for procedures involving the tibial tuberosity, as they assist in accurate implant placement and surgical planning.

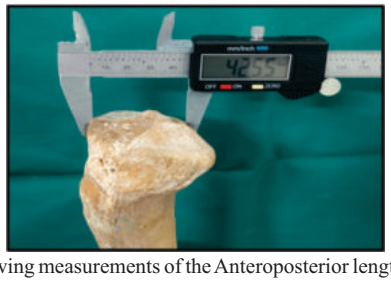
In the present study, the transverse diameter of Gerdy's tubercle (Fig: 5 and 6) measured 11.48 ± 2.19 mm overall, while the vertical diameter was slightly greater at 13.07 ± 2.89 mm, showing mild bilateral variation.

In comparison, Asma Siddiqui et al.[10] reported a mean diameter of 12.5 ± 2.85 mm. These findings indicate variability in the dimensions of Gerdy's tubercle, which is clinically important for surgical landmark identification and orthopaedic procedures involving the proximal tibia

CONCLUSION:

This study assessed key morphometric parameters of the proximal tibia on dry bones, including ML and AP dimensions measured separately for left and right sides. Additional measurements, such as distances to the tibial tuberosity and Gerdy's tubercle, were also recorded. The findings indicate that the Indian population has smaller tibial dimensions compared to other populations, highlighting the need for population-specific prosthesis design.[5]

Fig (1): Showing measurements of the Mediolateral length of Tibia



Fig(2) Showing measurements of the Anteroposterior length of medial condyle

Fig(3): Showing measurements of the Anteroposterior length of lateral condyle

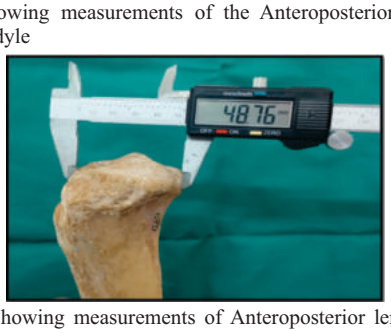
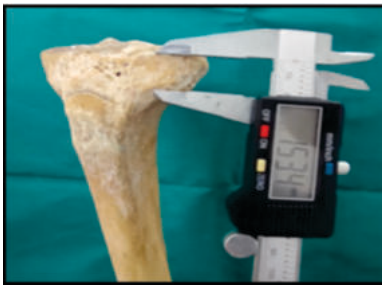


Fig (4) : Showing measurements of Anteroposterior length of the intercondylar area

Fig(5): Showing measurements of the Transverse diameter of Gerdy's tubercle



Fig(6): Showing measurements of the Vertical diameter of Gerdy's tubercle

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