Bratislava Medical Journal
https://doi.org/10.1007/s44411-026-00582-6

RESEARCH

Morphometric Reappraisal of Gerdy's Tubercle and Proximal Tibia for Total Knee Arthroplasty

Niymet Pelin Cavdar Yilmaz[1] · Ayhan Comert[1] · Yigit Gungor[2] · Ferid Abdulaliyev[3] · Mehmet Yilmaz[1] · Halil Ibrahim Acar[1]

Received: 3 December 2025 / Revised: 3 March 2026 / Accepted: 15 March 2026
© The Author(s) 2026

Abstract

Purpose The shape and size of Gerdy's tubercle (GT) vary among individuals. This study aimed to investigate not only the anatomical differences in GT—particularly its size and shape—on dry tibiae and cadavers, but also its precise localization and distances to the tibial plateau. The findings may assist surgeons in preoperative planning for total knee arthroplasty (TKA). In addition, the morphometric structure of the tibial plateau was examined to provide a detailed description of the tibial plateau.

Methods A total of 100 dry tibiae and 18 formalin-fixed cadaveric knee-leg specimens were examined using a digital caliper. The width, height, and distances between the GT and surrounding structures were recorded. Morphometric parameters of the tibial plateau were also measured. Statistical analyses were performed using SPSS software.

Results GT dimensions and their distances to adjacent structures were proportional to tibial length. The most common GT morphology was triangular, with a smooth surface and the tip at the center. GT height, width, and distances to surrounding structures were greater in cadaveric specimens compared to dry bones. All GT measurements were positively correlated, and tibial plateau parameters demonstrated positive correlations with GT dimensions.

Conclusion This study demonstrates that dimensional variations can influence tibial plateau morphometry and that asymmetry exists between the medial and lateral condyles. These findings emphasize the importance of patient-specific implants in total knee arthroplasty (TKA). Moreover, the detailed morphometric description of Gerdy's tubercle (GT) presented here may serve as a valuable reference for clinical evaluation, surgical planning, and intraoperative decision-making in TKA.

Keywords Gerdy's tubercle · Tibial plateau · Morphometry · Total knee arthroplasty

✉ Ayhan Comert
comertayhan@yahoo.com; comert@medicine.ankara.edu.tr

Niymet Pelin Cavdar Yilmaz
pelincavdar@gmail.com

Yigit Gungor
yigitgungor2@gmail.com

Ferid Abdulaliyev
Feridabduleliyev@gmail.com

Mehmet Yilmaz
md.mehmetyilmaz@gmail.com

Halil Ibrahim Acar
drhalilacar@yahoo.com

[1] Department of Anatomy, Faculty of Dentistry, Ankara University, Ankara, Turkey

[2] Department of Anatomy, Faculty of Medicine, Kirikkale University, Ankara, Turkey

[3] Department of Orthopedics and Traumatology, Yozgat City Hospital, Yozgat, Turkey

1 Introduction

Gerdy's tubercle (GT) was named after the French anatomist and surgeon Pierre Nicholas Gerdy [1]. It is located on the anterolateral aspect of the proximal tibia, approximately 2 cm superior and lateral to the tibial tuberosity and about 1 cm inferior to the joint line. Textbooks typically describe GT as a smooth, triangular facet that serves as the attachment site for the iliotibial tract [2, 3]. In addition, fibrous extensions of the vastus lateralis and biceps femoris muscles also insert into GT along with the iliotibial tract. Clinically, this prominent structure can usually be palpated just below the lateral tibial plateau; however, its identification may be difficult in obese patients or in cases of soft tissue swelling. For this reason, several studies have examined the morphology and localization of GT [4].

When GT is not easily palpable, nearby landmarks such as the fibular head, the inferior pole of the patella and the

Published online: 30 March 2026

tibial tuberosity (TT) may be used for orientation. One previous study reported the direct distance between GT and TT as 35.51 mm, and the distance between the lateral tibial plateau (TP) and GT as 11.50 mm [5]. However, these single values were insufficient for precise localization, as both horizontal and vertical distances to TP and TT are required, particularly in patients with non-palpable GT [5].

The shape and size of GT are also important for its identification. Its morphology varies depending on whether its surface is smooth or rough, and it has been classified into multiple shapes. Kalra et al. described GT as triangular & smooth, circular & smooth, vertically oval & smooth, transversely oval & smooth, irregular & rough, or triangular & rough [6]. Hussein et al. proposed four groups: triangular (Group A), oval (Group B), irregular (Group C), and unidentified (Group D) [7]. Akter et al. offered the broadest classification, dividing GT into six types (A–F) according to figure and texture [8]. Similarly, Akdemir et al. classified GT based on shape and texture, but did not further subdivide the types [9].

Total knee arthroplasty (TKA) is a widely performed operation for knee reconstruction. At the beginning of the procedure, the tibial plateau is resected to accommodate the prosthetic component. In advanced osteoarthritis, classical tibial cuts may be excessive, leading to undesirable outcomes. To avoid this, GT may serve as a useful anatomical landmark if its distance to the tibial plateau is defined and correlated with other osteological markers. [10, 11]. Although GT can often be palpated on the anterior aspect of the lateral tibial plateau, this may be challenging in obese patients [4]. Therefore, precise localization of GT in relation to nearby structures is essential. Beyond arthroplasty, GT has additional surgical relevance. It can serve as a landmark to identify the peroneal nerve's course, providing a safe zone to reduce the risk of iatrogenic injury during surgery [12]. Furthermore, GT has been reported as a potential source of autologous bone graft material for reconstructive procedures [13].

The present study aimed to define the precise localization of GT relative to nearby anatomical landmarks and to evaluate the morphometry of the proximal tibia. In doing so, it seeks not only to contribute to the accuracy and safety of total knee arthroplasty but also to enhance anatomical knowledge of this well-known yet underexplored structure.

2 Material and Methods

This study was conducted at Ankara University School of Medicine, Department of Anatomy. A total of 100 dry human tibiae (50 right and 50 left) and 18 formalin-fixed cadaveric knee specimens (12 right and 6 left) without gross pathology were evaluated. Specimens with deformity or damage of the proximal tibia were excluded. Only cadavers that met the inclusion criteria (i.e., absence of deformity, prior surgery, or damage to the proximal tibia) were included. Furthermore, some cadaver specimens contained only a single tibia or leg. This also affected our count of right- and left-limb pairs.

Measurements were performed with a Mitutoyo digital caliper (500-181-30/150 mm/0.01 mm). The caliper was calibrated before each use. All parameters were measured independently by two observers, and the inter-rater reliability coefficient was > 0.90 for all measurements. To minimize the margin of error in measurements, the tibiae were positioned with a vise (Stanley Multi Angle Vice) so that the long axis of the bone was perpendicular to the ground. Specifically, when measuring the vertical length difference between two structures, the vertical distances of these structures from the ground were measured, and the difference was calculated. For the evaluation of the surface area of GT, the ImageJ software was used to analyse photographs of the tubercle.

The parameters evaluated in this study were as follows:

- GT's height (H), width (W), shape (triangular, oval, circular, irregular; smooth or rough)
- Distance between the tip of GT and the tip of the tibial tuberosity (TT): direct (DTT), vertical (VTT), and horizontal (HTT).
- Distance between the tip of GT and the center of the tibiofibular joint: direct (DFJ) and vertical (VFJ). (This parameter could be evaluated only in dry bones)
- Distance between the tip of GT and the point where a perpendicular line from GT meets the tibial plateau (TP).
- Distance between the tip of TT and the point where a perpendicular line from TT meets the tibial plateau (PTT).
- Vertical distance between the highest point of the intercondylar eminence and the tip of GT (VIE). (This parameter could be evaluated only in dry bones)
- Vertical distance between the tip of GT and the lateral intercondylar tubercle (VLI). (This parameter could be evaluated only in dry bones)
- Tibial length: the distance from the superior surface of the tibial plateau to the tip of the medial malleolus.
- Anteroposterior dimensions of the superior articular surfaces of the tibial condyles (AB, CD): the maximum distance between the posterior and anterior borders.
- Mediolateral dimensions of the superior articular surfaces of the tibial condyles (EF, GH): the maximum distance between the medial and lateral borders.
- Tibial plateau width (IJ): the maximum distance between the medial and lateral borders of the superior articular surface.

- Anteroposterior dimension of the intercondylar area (KL): the maximum distance between its posterior and anterior borders.
- Mediolateral dimensions of the intercondylar area at three levels: anterior end (MN), middle narrow part (OP), and posterior end (RS).
- The surface area of Gerdy's tubercle.

The corresponding illustrations are presented as follows: tibial plateau measurements (Figs. 1 and 2), tibial length (Fig. 3), GT measurements (Fig. 4), GT shape classifications (Fig. 5), and cadaveric measurements (Figs. 6 and 7), surface area of GT measurements with ImageJ software (Fig. 8).

2.1 Statistical Analysis

All data were analyzed using SPSS (version 20; SPSS, Chicago, IL, USA). Descriptive data were summarized as means and standard deviations (Std). The G-power analysis was performed before the specimen selection. The results were subjected to descriptive statistics to determine the correlation between the variables using the Spearman-Rho and Pearson's correlation tests. The Mann–Whitney U test was used to determine the difference between the right and left tibia bones and cadaveric knees. The level of significance for all tests was $p < 0.05$.

All data were analyzed using SPSS software (version 20; SPSS Inc., Chicago, IL, USA). Descriptive statistics were presented as mean ± standard deviation (SD). Correlations between variables were assessed using Spearman's rho and Pearson's correlation tests. Differences between right and left tibiae and between cadaveric knees were evaluated using the Mann–Whitney U test. A p-value of < 0.05 was considered statistically significant.

3 Results

The measurements obtained in the present study are summarized in Table 1.

3.1 Gerdy's Tubercle (GT) Dimensions

The mean width of GT was 12.83 ± 1.80 mm on the right side and 13.23 ± 2.27 mm on the left side. In cadaveric samples, these values were 14.00 ± 1.37 mm (right) and 14.57 ± 2.21 mm (left). GT height measured 15.13 ± 2.21 mm on the right and 15.97 ± 2.81 mm on the

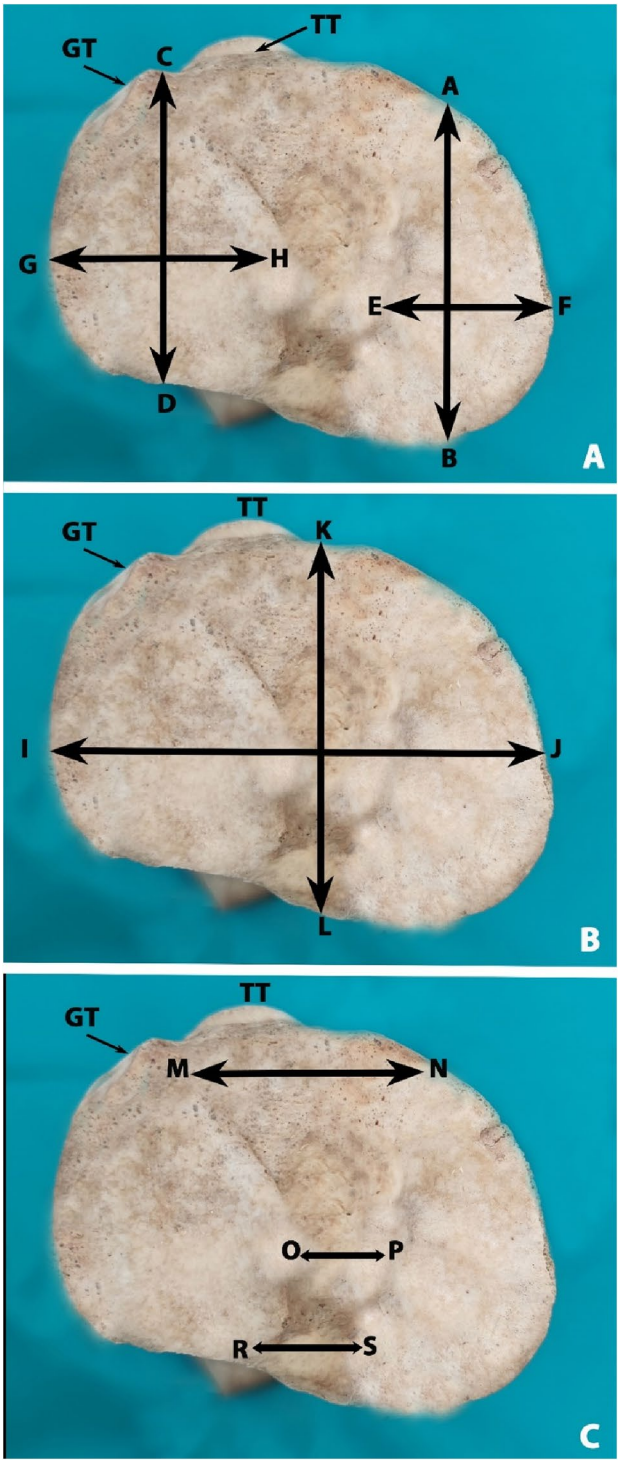


Fig. 1 Tibial plateau measurements are demonstrated on a left dry tibia. GT: Gerdy's tubercle; TT: Tibial tuberosity. **a** Anteroposterior and mediolateral dimensions of tibial condyles. AB: anteroposterior dimension of the medial condyle; EF: mediolateral dimension of the medial condyle; CD: anteroposterior dimension of the lateral condyle; GH: mediolateral dimension of the lateral condyle. **b** Width of the tibial plateau (IJ) and anteroposterior dimension of the intercondylar area (KL). **c** Mediolateral dimensions of the intercondylar area. MN: anterior end; OP: middle narrow part; RS: posterior end

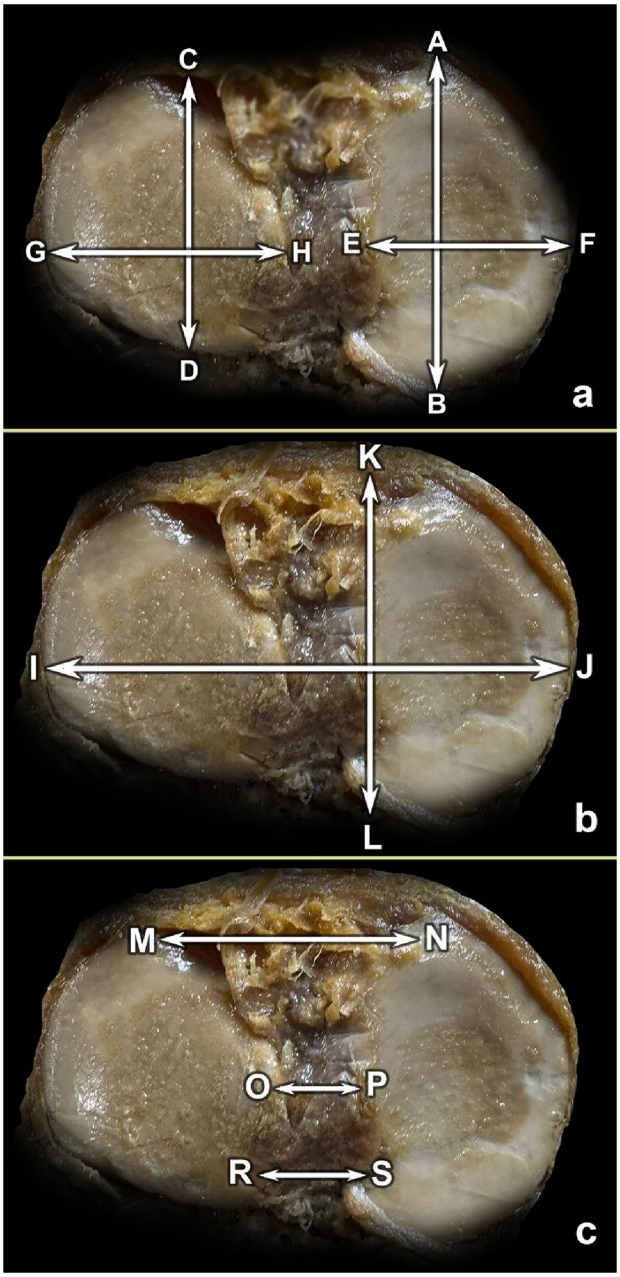


Fig. 2 Tibial plateau measurements are demonstrated on a left tibia. GT: Gerdy's tubercle; TT: Tibial tuberosity **a** Anteroposterior and mediolateral dimensions of tibial condyles. AB: anteroposterior dimension of the medial condyle; EF: mediolateral dimension of the medial condyle; CD: anteroposterior dimension of the lateral condyle; GH: mediolateral dimension of the lateral condyle. **b** Width of the tibial plateau (IJ) and anteroposterior dimension of the intercondylar area (KL). **c** Mediolateral dimensions of the intercondylar area. MN: anterior end; OP: middle narrow part; RS: posterior end.

left, whereas in cadavers it measured 15.51 ± 0.87 mm (right) and 16.35 ± 1.75 mm (left).



Fig. 3 Tibial length. The superior line indicates the superior surface of the tibial plateau; the inferior line suggests the tip of the medial malleolus. The vise used to stabilize the tibia is shown in the photograph

3.2 Distances to the Tibial Tuberosity (TT)

The direct distance between GT and TT was 33.78 ± 3.98 mm (right) and 34.20 ± 4.05 mm (left) on dry bones, and 33.65 ± 4.98 mm (right) and 33.98 ± 4.91 mm (left) on cadavers.

The horizontal distance was 22.99 ± 3.44 mm (right) and 24.08 ± 3.20 mm (left), whereas in cadavers it was 22.18 ± 4.17 mm (right) and 25.13 ± 3.78 mm (left).

The vertical distance between GT and TT was 24.27 ± 3.92 mm (right) and 23.64 ± 3.69 mm (left) in dry bones, and 25.19 ± 4.23 mm (right) and 24.15 ± 3.98 mm (left) in cadavers.

3.3 Distances to the Tibial Plateau

The perpendicular distance between GT and the tibial plateau was 11.51 ± 1.55 mm (right) and 12.78 ± 1.97 mm (left) on dry bones, and 13.64 ± 2.42 mm (right) and 14.97 ± 2.43 mm (left) in cadavers.

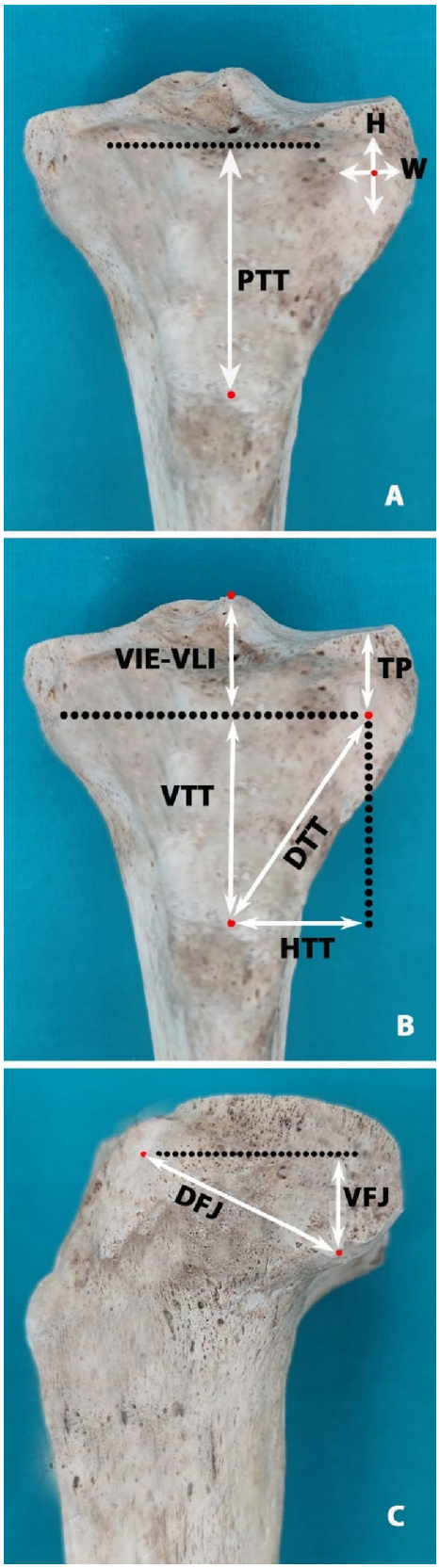


Fig. 4 Measurements of Gerdy's tubercle (GT) on dry bone. **a** PTT: ▸ distance between the tibial tuberosity and tibial plateau; H: GT height; W: GT width. **b.** TP: distance between GT and tibial plateau; VIE: vertical distance between GT and intercondylar eminence; VLI: vertical distance between GT and lateral intercondylar tubercle; DTT: direct distance between GT and TT; HTT: horizontal distance between GT and TT; VTT: vertical distance between GT and TT. **c** DFJ: direct distance between GT and tibiofibular joint; VFJ: vertical distance between GT and tibiofibular joint

For TT, the perpendicular distance to the tibial plateau was 29.29 ± 4.46 mm (right) and 30.67 ± 3.76 mm (left). In cadavers, these values were 30.01 ± 5.03 mm (right) and 30.42 ± 3.89 mm (left).

3.4 Distances to the Tibiofibular Joint

The vertical distance between GT and the center of the tibiofibular joint was 6.12 ± 2.48 mm (right) and 6.41 ± 1.87 mm (left). The direct distance was 30.83 ± 3.34 mm (right) and 30.96 ± 3.49 mm (left) on the bones.

3.5 Tibial Length

The mean tibial length was 351.23 ± 24.30 mm (right) and 343.82 ± 23.95 mm (left). In cadavers, these values were 355.65 ± 43.40 mm (right) and 358.07 ± 20.66 mm (left).

3.6 Intercondylar Relationships

The vertical distance between the highest point of the intercondylar eminence and GT was 15.13 ± 2.85 mm (right) and 16.32 ± 3.06 mm (left).

The vertical distance between GT and the lateral intercondylar tubercle was 14.74 ± 3.03 mm (right) and 16.04 ± 2.93 mm (left).

3.7 GT Morphology

The most common GT shape was triangular smooth (59%), while the rarest was irregular smooth (1%). The GT tip was located centrally in 78.8% of cases, laterally in 15.6%, and medially in 5.6%.

3.8 Surface Area

The footprint surface area of GT measured 270.12 ± 16.12 mm^2 (right) and 280.15 ± 15.16 mm^2 (left) on dry bones, and 250.96 ± 17.56 mm^2 (right) and 270.14 ± 16.85 mm^2 (left) in cadavers.

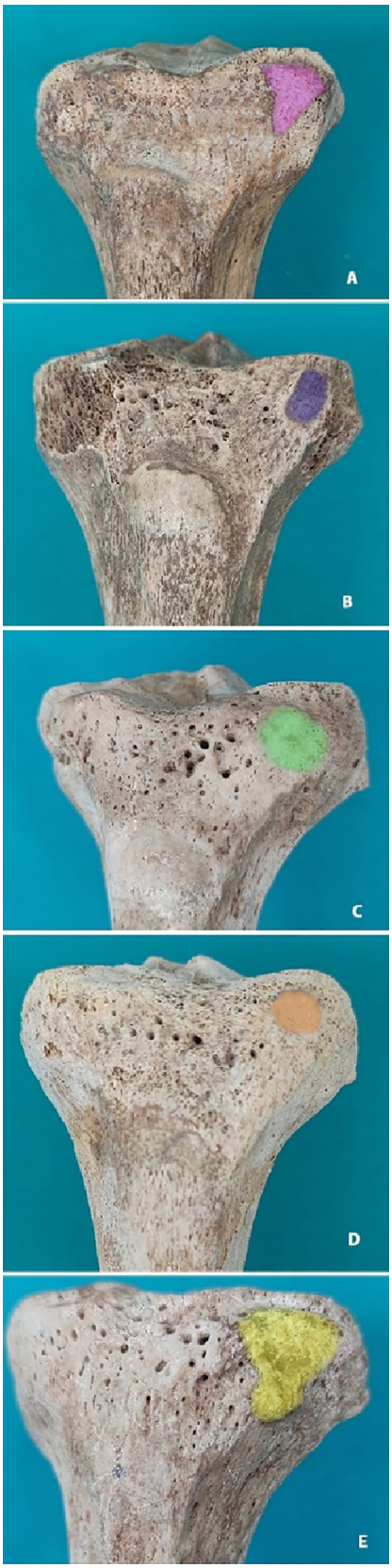


Fig. 5 Morphological types of GT: **a**.Triangular **b**.Vertically oval **c**. Horizontally oval **d.** Circular **e**. Irregular

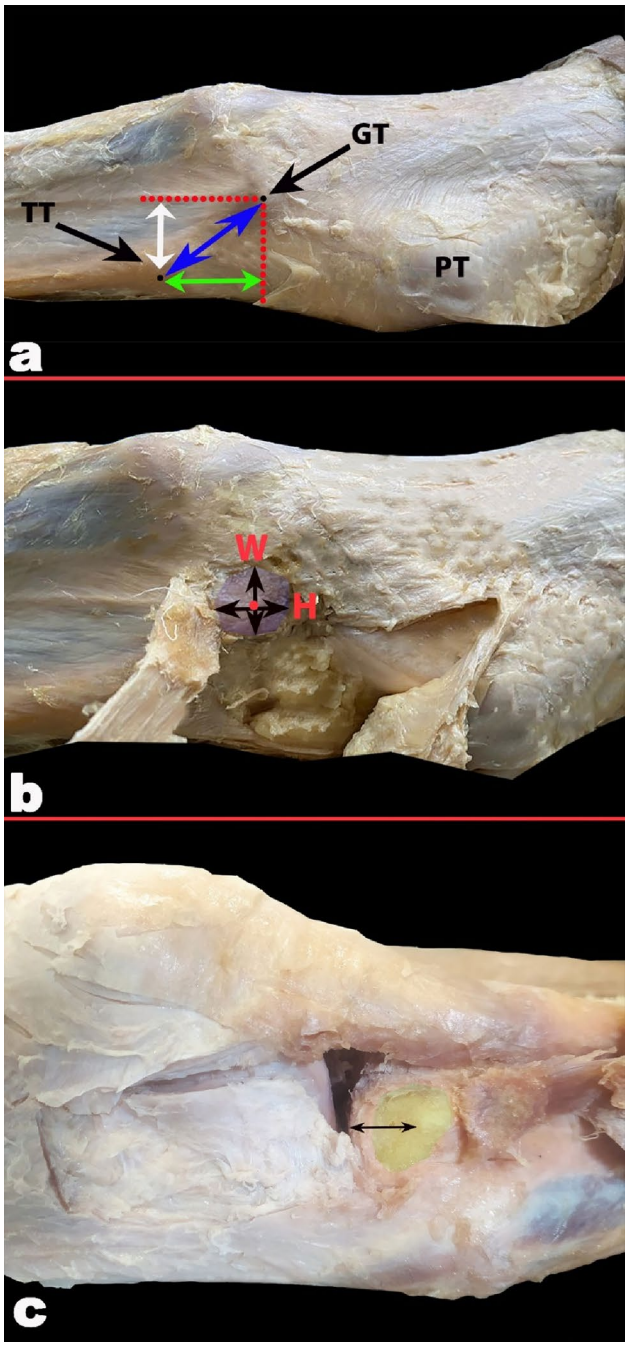


Fig. 6 **a** Distances between the tibial tuberosity and Gerdy's tubercle. White arrow: Horizontal distance, Blue arrow: Direct distance, Green arrow: Vertical distance. TT: tibial tuberosity, GT: Gerdy's tubercle, PT: Patella. **b** Dimensions of GT. H: Height, W: Weight. **c** Surface area of GT footprint and the distance between GT and tibial plateau. Green area: Surface area of GT, Black arrow: The distance between GT and the tibial plateau

3.9 Tibial Plateau Dimensions

- Superior articular surface: Mediolateral diameter was 65.22 ± 2.49 mm (right) and 65.37 ± 2.97 mm (left).

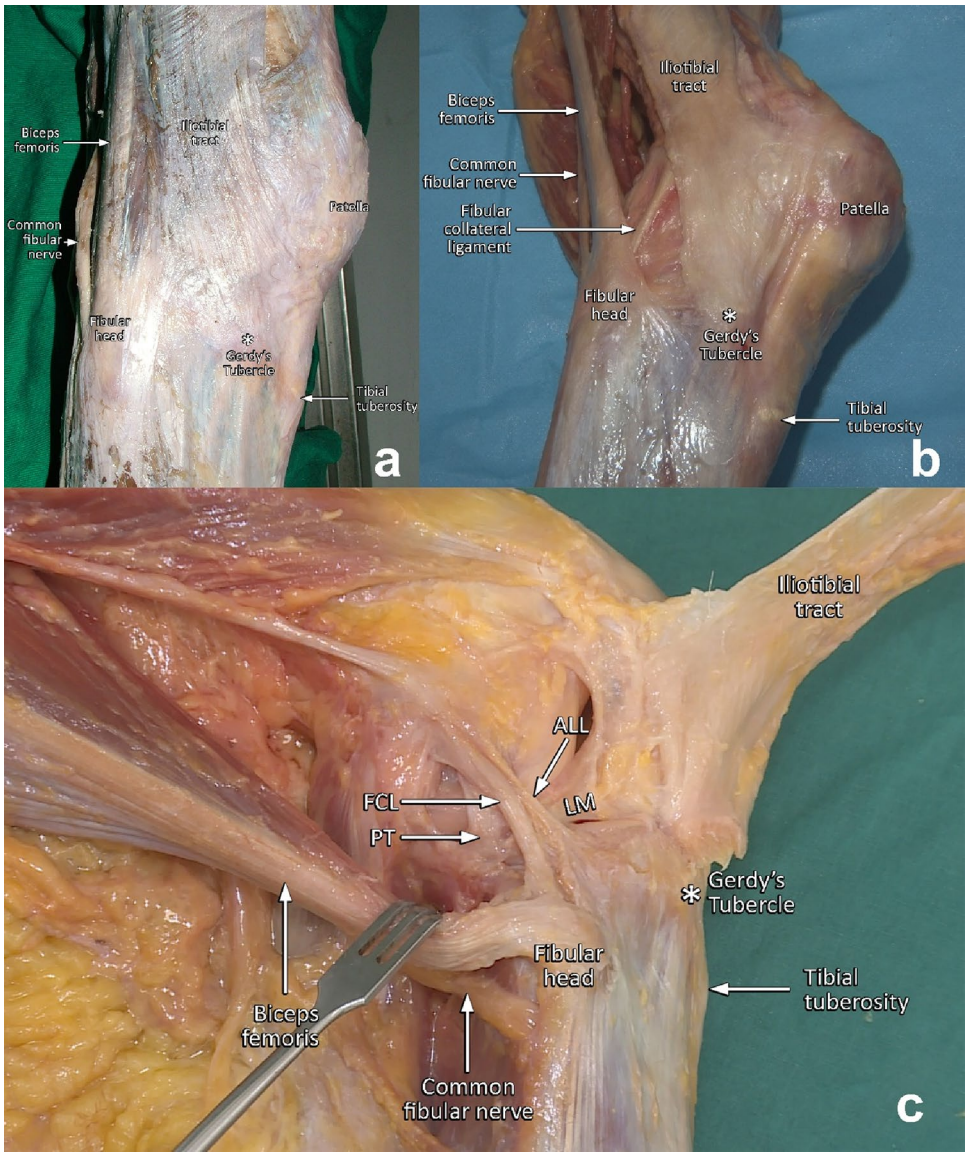


Fig. 7 The cadaveric examination of Gerdy's tubercle and the surrounding structures. **a** The superficial examination. **b** The fascia removed. **c** The iliotibial tract is removed, and its attachment to Gerdy's tubercle is shown. PT: Popliteus tendon, FCL: Fibular Collateral Ligament, ALL: Anterolateral ligament, LM: Lateral Meniscus

Anteroposterior diameter was 42.90 ± 2.30 mm (right) and 42.91 ± 1.66 mm (left). In cadavers, the mediolateral diameter was 59.96 ± 1.98 mm (right) and 62.35 ± 2.59 mm (left). Anteroposterior diameter was 40.29 ± 3.01 mm (right) and 36.98 ± 2.02 mm (left).

- Lateral plateau: Mediolateral diameter was 23.40 ± 2.90 mm (right) and 22.91 ± 0.84 mm (left). Anteroposterior diameter was 37.15 ± 2.95 mm (right) and 36.45 ± 1.00 mm (left). In cadavers, the Mediolateral diameter was 20.98 ± 2.48 mm (right) and 25.01 ± 1.28 mm (left). Anteroposterior diameter was 38.27 ± 2.85 mm (right) and 34.98 ± 1.23 mm (left)
- Medial plateau: Mediolateral diameter was 23.54 ± 2.42 mm (right) and 23.34 ± 1.63 mm (left). Anteroposterior diameter was 39.11 ± 2.35 mm (right) and 39.68 ± 2.37 mm (left). In cadavers, the Mediolateral diameter was 21.98 ± 1.09 mm (right) and 20.98 ± 2.14 mm (left). Anteroposterior diameter was 35.29 ± 2.98 mm (right) and 35.45 ± 2.15 mm (left).

3.10 Intercondylar Area

The anteroposterior length was 41.32 ± 4.17 mm (right) and 40.89 ± 3.59 mm (left).

Mediolateral diameters measured 19.56 ± 4.14 mm (anterior end, right) and 20.14 ± 4.82 mm (anterior end, left), 14.28 ± 2.53 mm (middle, right) and 14.28 ± 2.74 mm (middle, left), and 16.98 ± 3.06 mm (posterior end, right)

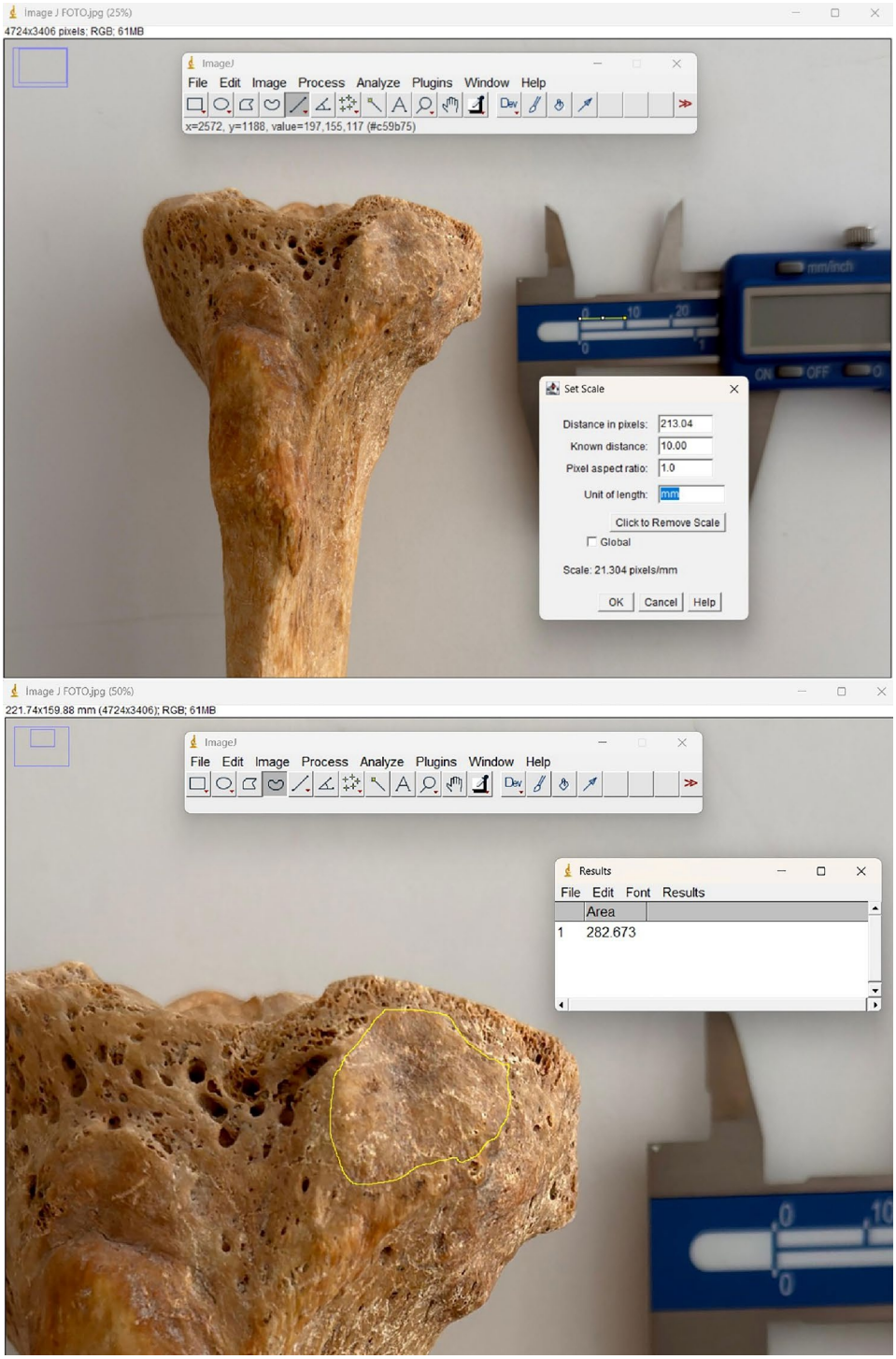


Fig. 8 The steps for using ImageJ to measure area are demonstrated

and 16.73 ± 3.15 mm (posterior end, left). In cadavers, the anteroposterior length was 39.28 ± 3.56 mm (right) and 41.25 ± 3.22 mm (left). Mediolateral diameters measured 18.95 ± 5.01 mm (anterior end, right) and 22.14 ± 3.98 mm (anterior end, left), 12.51 ± 2.09 mm (middle, right) and 12.75 ± 3.21 mm (middle, left), and 15.98 ± 2.85 mm (posterior end, right) and 17.01 ± 2.97 mm (posterior end, left).

3.11 Correlation Analysis

Spearman Rho correlation showed a moderate positive relationship between:

- The vertical distance between GT and the distance from TT to the tibial plateau ($\rho = 0.454$, $p < 0.01$).

Table 1 Measurement results on dry bone and cadavers

Group Statistics for Dry Bone and Cadavers								
N: 118	Dry Bone (n:100)				Cadaver (n: 18)			
	Right (n: 50)		Left (n: 50)		Right (n: 12)		Left (n: 6)	
	Mean	Std. D	Mean	Std. D	Mean	Std. D	Mean	Std. D
Direct Distance between GT and tip of tibial tuberosity (TT) (mm)	33.78	3.98	34.20	4.05	33.65	4.98	33.98	4.91
Horizontal Distance between GT and tip of tibial tuberosity (TT) (mm)	22.99	3.44	24.08	3.20	22.18	4.17	25.13	3.78
Vertical Distance between GT and tip of tibial tuberosity (TT) (mm)	24.27	3.92	23.64	3.69	25.19	4.23	24.15	3.98
Distance between the merging point of the perpendicular line from GT to tibial plateau and tip of GT (mm)	11.51	1.55	12.78	1.97	13.64	2.42	14.97	2.43
Distance between the merging point of perpendicular line from TT to tibial plateau and tip of TT (mm)	29.29	4.46	30.67	3.76	30.01	5.03	30.42	3.89
Vertical Distance between GT and center of tibiofibular joint (mm)	6.12	2.48	6.41	1.87	–	–	–	–
Direct Distance between GT and center of tibiofibular joint (mm)	30.83	3.34	30.96	3.49	–	–	–	–
Tibia Lenght (mm)	343.82	23.95	351.23	24.30	355.65	43.40	358.07	20.66
Vertical distance between the highest point of intercondylar eminence and tip of GT (mm)	15.13	2.85	16.32	3.06	–	–	–	–
Vertical distance between GT and lateral intercondylar tubercle (mm)	14.74	3.03	16.04	2.93	–	–	–	–
Width (mm)	12.83	1.80	13.23	2.28	14.00	1.38	14.57	2.22
Height (mm)	15.13	2.21	15.97	2.81	15.51	0.87	16.35	1.75
Mediolateral dimension of superior articular surfaces of tibial plateau (mm)	65.22	2.49	65.37	2.97	59.96	1.98	62.35	2.59
Anteroposterior dimension of superior articular surfaces of Intercondylar Area (mm)	42.90	2.30	42.91	1.66	40.29	3.01	36.98	2.02
Mediolateral Dimension of Lateral Plateau (mm)	23.40	2.90	22.91	0.84	20.98	2.48	25.01	1.28
Anteroposterior Dimension of Lateral Plateau (mm)	37.15	2.95	36.45	1.00	38.27	2.85	34.98	1.23
Mediolateral Dimension of Medial Plateau (mm)	23.54	2.42	23.34	1.63	21.98	1.09	20.98	2.14
Anteroposterior Dimension of medial Plateau (mm)	39.11	2.35	39.68	2.37	35.29	2.98	35.45	2.15
Anteroposterior Distance of the Intercondylar Area (mm)	41.32	4.17	40.89	3.59	39.28	3.56	41.25	3.22
Intercondylar Area, Anterior End (mm)	19.56	4.14	20.14	4.82	18.95	5.01	22.14	3.98
Intercondylar Area, Middle Narrow part (mm)	14.28	2.53	14.28	2.74	12.51	2.09	12.75	3.21
Intercondylar Area, Posterior End (mm)	16.98	3.06	16.73	3.15	15.98	2.85	17.01	2.97
Surface Area of the GT's Footprint (mm^2)	270.12	16.12	280.15	15.16	250.96	17.56	270.14	16.85

- The vertical distance between GT and the direct distance between GT and the tibiofibular joint ($\rho = 0.403$, $p < 0.01$).

Further correlations were identified between DTT and:

- HTT ($\rho = 0.562$, $p < 0.01$)
- VTT ($\rho = 0.583$, $p < 0.01$)
- PTT ($\rho = 0.563$, $p < 0.01$)
- DFJ ($\rho = 0.480$, $p < 0.01$)
- Tibial length ($\rho = 0.554$, $p < 0.01$)
- GT width ($\rho = 0.360$, $p < 0.01$)
- H ($\rho = 0.380$, $p < 0.01$)
- EF ($\rho = 0.296$–0.380, $p < 0.01$)
- GH ($\rho = 0.527$, $p < 0.01$)
- AB ($\rho = 0.425$, $p < 0.01$)
- MN ($\rho = 0.489$, $p < 0.01$)
- OP ($\rho = 0.417$, $p < 0.01$)
- RS ($\rho = 0.487$, $p < 0.01$).

4 Discussion

Total knee arthroplasty requires precise bone resection and accurate surface coverage [14]. Inappropriate or excessive tibial cuts may lead to malalignment, which is associated

with poor clinical outcomes [15]. For this reason, tibial plateau morphometry plays a critical role in both surgical planning and the design of tibial implants. Current component sizes, however, do not always fit every patient, since morphometric parameters vary significantly across populations [12, 14–19].

Gerdy's tubercle (GT) is a prominent bony eminence that can be easily palpated on the anterolateral surface of the lateral tibial condyle. Because of its accessibility, GT serves as a valuable surgical landmark. It is used to guide incision placement in tibial plateau fracture surgeries [20], to protect the common peroneal nerve during surgical approaches [1], and to provide bone grafts, with or without the iliotibial tract, in reconstructive procedures [13, 21]. Moreover, GT is included in the classification of tibial fractures and belongs to the so-called "fragile hot zones," which exhibit a higher fracture line density [3]. In anterolateral ligament reconstruction, the graft is commonly inserted between GT and the fibular head [5]. Given its surgical relevance, defining the precise localization and morphometry of GT is of great importance [22].

Gerdy's tubercle's intraoperative identification may be challenging in certain surgical approaches, particularly in minimally invasive or anteromedial approaches used in total knee arthroplasty. In the context of TKA, the medial parapatellar approach entails the palpation of the Gerdy tubercle subsequent to the dislocation of the patella and the excision of the infrapatellar fat pad. In clinical practice, this reference point is considered during the tibial cut. Moreover, the detailed morphometric characterization of GT may still provide valuable anatomical reference data, especially for preoperative planning, orientation, and procedures in which the anterolateral tibia is exposed. In this context, the present findings should be interpreted primarily as contributing to the anatomical understanding of this region rather than as a standalone surgical guide. Furthermore, even when GT is not used intraoperatively, understanding its spatial relationship with adjacent anatomical structures may enhance the surgeon's orientation and, by extension, contribute to safer surgical practice.

In anatomical textbooks, GT is described as a smooth, triangular facet located approximately 2 cm lateral to the tibial tuberosity and 1 cm below the joint line [16, 23]. Akter et al. evaluated GT in 200 dry bones and classified it into types A–F based on shape, reporting that the triangular and smooth type (Type A) was the most common [8]. Similarly, Kalra et al. found that GT was predominantly triangular and smooth [13]. Hussain et al. also classified GT according to its shape and texture, identifying triangular shape (Group A) and smooth texture (Group A) as the most frequent types [1]. In our study, GT was triangular and smooth in 59% of cases, consistent with these previous reports.

The vertical distance between GT and the tibial tuberosity is especially important, as it determines the cut level of the tibial plateau during arthroplasty. GT can serve as a reliable landmark to prevent excessive cuts, but if GT is absent or non-palpable, the tibial tuberosity may be used to locate GT for surgical guidance. [11] The present study is the first to examine the vertical distance between GT and the tibial tuberosity. Additionally, distances between GT and both the intercondylar eminence and the tibiofibular joint were assessed for the first time, providing information relevant for radiological and arthroscopic evaluations of fractures, such as Segond fractures. Comparisons of dry bone measurements with previous studies are presented in Table 2.

We also evaluated tibial length, which correlated with GT dimensions. This indicates that in patients with longer tibiae, the distance between GT and the tibial plateau is expected to be greater, a finding that can inform surgical planning and anthropometric studies. Some cadaveric measurements were

Table 2 Comparison of the previous study's dry bone GT evaluations and present study

SH	H	W	DTT	TP	PTT	HTT	VTT	VFJ	DFJ	VIE	VLI
Kalra et al. [13] (*N*: 103)	Tri.s	–	–	–	–	–	–	–	–		
Hussain et al. [1] (*N*: 72)	Tri.s	–	–	–	–	–	–	–	–		
Akter et al. [8] (*N*: 200)	Tri.s	–	–	–	–	–	–	–	–		
Akdemir et al. [9] (*N*: 57)	Ov.s	12	9.55	34.49	11.7	–	–	–	–		
Present study (*N*: 100)	Tri.s	15.12	12.82	34.20	11.5	30.66	24.08	24.27	6.11	16.31	14.74

Tri.s: Triangular and smooth, Ov.s: Oval and smooth, H: GT's Height, W: GT's widht, DTT: Direct distance between GT and tibial tuberosity (TT), TP: Distance between GT and tibial plateau (TP), PTT: Distance between TT and TP, HTT: Horizontal distance between GT and TT, VTT: Vertical distance between GT and TT, VFJ: Vertical distance between GT and tibiofibular joint (TFJ), DFJ: Direct distance between GT and TFJ, VIE: Vertical distance between GT and intercondylar eminence, VLI: Vertical distance between GT and lateral intercondylar tubercle.

performed for the first time in the literature, allowing evaluation of GT's real dimensions, location, and shape by tensioning the iliotibial band over GT. These cadaveric results were consistent with dry bone measurements, validating our measurement methods. However, cadaveric assessment limited the evaluation of GT texture because the overlying iliotibial band was slightly displaced. Cartilage on the tibial plateau contributed to greater distances between GT and the plateau in cadavers compared to dry bones, suggesting that cartilage may provide additional space for tibial cuts during surgery. GT size and distances to surrounding structures were proportional to tibial length, and the direct distance between GT and the tibial tuberosity (DTT) correlated with several measurements of GT and the tibial plateau. This suggests that even in cases of tibial plateau destruction, DTT can be used to estimate implant size.

Previous studies of tibial plateau morphometry show variable results. Gandhi et al. measured 100 tibiae and found AB (anteroposterior medial condyle) 45.23 ± 4.34 mm, EF (mediolateral medial condyle) 28.44 ± 2.8 mm, CD (anteroposterior lateral condyle) 39.41 ± 3.69 mm, and GH (mediolateral lateral condyle) 27.4 ± 2.95 mm [3]. Murlimanju et al. reported AB 39.8 ± 3.8 mm, EF 26.7 ± 2.8 mm, CD 33.6 ± 3.7 mm, and GH 26.1 ± 2.9 mm [15, 27]. Nayak et al. measured AB at 41.4 ± 4.5 mm, EF at 28.0 ± 5.0 mm, CD at 38.2 ± 3.3 mm, and GH at 29.6 ± 2.8 mm [7]. Santos et al. reported AB 45.21 ± 3.62 mm, EF 28.63 ± 3.03 mm, CD 37.86 ± 3.98 mm, and GH 31.98 ± 3.02 mm [25]. Akdemir et al. found AB 39.76 ± 4.10 mm, EF 23.27 ± 2.63 mm, CD 34.72 ± 3.51 mm, and GH 21.83 ± 2.52 mm [9]. Our tibial condyle measurements were lower than most previous studies but similar to Akdemir et al., possibly due to ethnic differences.

In our study, mediolateral and anteroposterior dimensions of the lateral tibial plateau were greater on the right side, whereas medial plateau measurements did not differ by side. Previous studies reported similar findings: Murlimanju et al. observed greater anteroposterior size of the lateral plateau on the right [27], while other studies found no side differences [3, 9]. Overall, lateral condyle dimensions were significantly smaller than those of the medial condyle ($p < 0.05$), consistent with previous reports [3, 4, 6, 7, 9, 15, 27]. These results suggest that medial and lateral knee prostheses should be designed individually rather than symmetrically [6].

The tibial plateau width (IJ) was reported as 68.3 ± 5.1 mm by Gupta et al. [26], 70.78 ± 2.40 mm by Zalawadia and Patel [28], and 65.14 ± 4.70 mm by Akdemir et al. [9]. Our measurements were similar to those of Akdemir et al. but lower than those of the other studies. Anteroposterior tibial plateau dimensions were measured in our study, providing valuable data for preoperative planning of tibial implants.

Intercondylar area dimensions were also compared with those reported in the literature. Santos et al. reported KL (anteroposterior) of 48.68 ± 3.4 mm [25]; Nayak et al. reported 42.6 ± 4.2 mm [7]; Gupta et al. reported 45.7 ± 3.9 mm [26]; Akdemir et al. reported 41.62 ± 4.27 mm [9]; and Gandhi et al. reported 46.01 ± 3.62 mm [3]. Our study found 41.32 ± 4.17 mm, consistent with Akdemir et al. but lower than most others, likely reflecting ethnic variation. Mediolateral dimensions at the anterior end (MN) measured 19.56 ± 4.14 mm in our study, lower than those of Gandhi et al. and Akdemir et al. [3, 9]. The middle intercondylar mediolateral distance (OP) was 14.28 ± 2.53 mm in our study, differing from previous reports [2, 3, 7, 16, 25]. Posterior intercondylar mediolateral dimensions (RS) measured 16.98 ± 3.06 mm, higher than Gandhi et al. [3], lower than Akdemir et al. [9] and Nayak et al. [7], but similar to Santos et al. [25]. A comparison of tibial plateau morphometry is summarized in Table 3**.**

Limitations of our study include the inability to determine the gender and age of dry bones, as well as the small number of cadavers (n = 18), which prevented evaluation of some parameters measured on dry bones. Previous studies suggest that gender- and age-specific differences may affect tibial morphometry [28]. Future research using imaging techniques and larger cadaveric samples is recommended to better assess these variables.

5 Conclusion

Total knee arthroplasty procedures are increasing worldwide. Accurate knowledge of population-specific tibial plateau dimensions is essential for selecting appropriately sized implants and performing precise tibial cuts. Gerdy's tubercle (GT), located inferior to the tibial plateau, is easily palpable and can be a useful surgical landmark. However, in obese patients or those with soft-tissue swelling, GT may be difficult to identify, making precise localization relative to surrounding anatomical structures essential. This study contributes to the anatomical literature by not only defining GT's precise location but also presenting detailed measurements of the tibial plateau. Our findings underscore the importance of patient-specific implants. Notably, this is the first study to measure the vertical distances between GT and the tibial tuberosity and the lateral intercondylar tubercle, and to report cadaveric measurements of GT dimensions.

Table 3 Comparison of the previous study's tibial plateau measurements and present study

	AB	CD	EF	GH	IJ	KL	MN	OP	RS
Gandhi et al. [3] (*N*: 100)	45.23	39.41	28.44	27.4	–	46.01	23.79	6.92	6.92
Gupta et al. [26] (*N*: 50)	44.5	40.7	27.3	27.9	68.3	45.7	–	–	–
Bilkay et al. [20] (*N*: 44)	41.9	36.5	–	–	70.2	–	–	–	–
Murlimanju et al. [27] (*N*: 73)	39.8	33.6	26.7	26.1	–	–	–	–	–
Santos et al. [25] (*N*: 120)	45.21	37.86	28.63	31.98	–	48.68	30.92	11.11	16.72
Zalawadia et al. [28] (*N*: 120)	42.07	36.94	27.26	28.07	70.78	–	–	–	–
Nayak et al. [7] (*N*: 46)	41.4	38.2	28.0	29.6	–	42.6	30.2	12.7	18.5
Akdemir et al. [9] (*N*: 57)	39.76	34.72	23.27	21.83	65.14	41.62	24.86	21.27	21.36
Present study (*N*: 100)	39.11	36.45	23.4	22.91	65.21	41.32	20.13	14.28	16.98

AB anteroposterior dimension of medial condyle, *CD* anteroposterior dimension of lateral condyle, *EF* mediolateral dimension of medial condyle, *GH* mediolateral dimension of lateral condyle, *IJ* the width of tibial plateau, *KL* anteroposterior dimension of the intercondylar area, *MN* mediolateral dimension of intercondylar area at anterior end, *OP* mediolateral dimension of intercondylar area at middle narrow part, *RS* mediolateral dimension of intercondylar area at posterior end.

Acknowledgements The authors express their sincere gratitude to the individuals who donated their bodies to science, thereby enabling the advancement of anatomical research. These invaluable contributions enhance medical knowledge and ultimately improve patient care. We extend our highest respect and appreciation to the donors and their families for their selfless and enduring legacy. These donors and their families deserve our highest gratitude.

Author Contributions N.P. Cavdar Yilmaz: Writing original draft, Review & Editing, Cadaveric dissections, Project development, Data analysis, Data collection A. Comert: Manuscript Writing, Review & Editing, Data collection, Supervision, Project development, Conceptualization Y. Gungor: Cadaveric dissections, Data collection F. Abdulaliyev: Cadaveric dissections, Data analysis M. Yilmaz: Data collection, Data analysis HI Açar: Data collection.

Funding Open access funding provided by the Scientific and Technological Research Council of Türkiye (TÜBİTAK). This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article**.**

Ethic Approval Conducting scientific studies on cadavers or cadaveric body parts does not require ethical approval in our university.

Consent to Participate Consent to participate is not applicable for this study.

Consent for Publication Not applicable.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

1. Hussain A, Mughal IA, Hanif M. Anatomical study of Gerdy's tubercle, its shape, texture and clinical application. Prof Med J. 2020. https://doi.org/10.29309/tpmj/2020.27.05.3931.
2. Yang B, Song C, Yu J, Yang Y, Gong X, Chen L, et al. Intraoperative anthropometric measurements of tibial morphology: comparisons with the dimensions of current tibial implants. Knee Surg Sports Traumatol Arthrosc. 2014. https://doi.org/10.1007/s00167-014-3258-0.
3. Gandhi S, Kumar Singla R, Mehta V, Kumar SR. Morphometric analysis of upper end of tibia. J Clin Diagn Res. 2010. https://doi.org/10.7860/JCDR/2014/8973.4736.
4. Greene KA. Gender-specific design in total knee arthroplasty. J Arthroplasty. 2007. https://doi.org/10.1016/j.arth.2007.05.019.
5. Kim MS, Koh IJ, In Y. Isometric anterolateral ligament reconstruction using the semitendinosus tendon with suspensory tibial

fixation. Arthrosc Tech. 2020. https://doi.org/10.1016/j.eats.2020.03.017.
6. Yao X, Zhou K, Lv B, Wang L, Xie J, Fu X, et al. 3D mapping and classification of tibial plateau fractures. Bone Joint Res. 2020. https://doi.org/10.1302/2046-3758.96.BJR-2019-0382.R2.
7. Nayak G, Panda SK, Chinara PK. Morphometric analysis of tibial plateau. Int J Res Med Sci. 2019. https://doi.org/10.18203/2320-6012.ijrms20191336.
8. Akter M, Ara JG, Zaman F, Any OH, Afreen KN, Jamil K. Observational study of Gerdy's tubercle on fully ossified dry human left tibia. Int J Psychiatr. 2021. https://doi.org/10.33425/2641-4317.1102.
9. Akdemir Aktaş H, Ülkir M, Günenç Beşer C, Demiryürek D. Reappraisal of the proximal tibia anatomy in Turkish population. Surg Radiol Anat. 2023. https://doi.org/10.1007/s00276-023-03094-y.
10. Atik OŞ, Hatipoğlu MY. Does the use of robotic technology in knee arthroplasty provide superior clinical outcomes? Jt Dis Relat Surg. 2025. https://doi.org/10.52312/jdrs.2025.57927.
11. Özer H, Abdulaliyev F, Cavdar Yilmaz NP, et al. Gerdy's tubercle as a novel anatomical landmark for the proximal tibial cut in total knee arthroplasty. Jt Dis Relat Surg. 2024. https://doi.org/10.52312/jdrs.2024.1531.
12. Hitt K, Shurman JR, Greene K, McCarthy J, Moskal J, Hoeman T, et al. Anthropometric measurements of the human knee: correlation to the sizing of current knee arthroplasty systems. J Bone Joint Surg Am. 2003. https://doi.org/10.2106/00004623-200300004-00015.
13. Kalra S, Chauhan P, Khandelwal A, Rani P. Variations of Gerdy's tubercle, proposal of a morphological classification: anatomical study and its clinical importance. J Morphol Sci. 2014. https://doi.org/10.4322/jms.068014.
14. Zhuo H, Zhu F, Pan L, Li J. The use of autologous iliotibial band with Gerdy's tubercle for irreparable rotator cuff tears. Orthop Surg. 2020. https://doi.org/10.1111/os.12799.
15. Delcogliano M, Marin R, Deabate L, Previtali D, Filardo G, Surace MF, et al. Arthroscopically assisted and three-dimensionally modeled minimally invasive rim plate osteosynthesis via modified anterolateral approach for posterolateral tibial plateau fractures. Knee. 2020. https://doi.org/10.1016/j.knee.2020.02.011.
16. Moore, K. L., Dalley, A. F., & Agur, A. Clinically oriented anatomy (8th ed.). Lippincott Williams and Wilkins; 2017. pp 691.
17. Koh YG, Nam JH, Chung HS, Chun HJ, Kim HJ, Kang KT. Morphometric study of gender difference in osteoarthritis posterior tibial slope using three-dimensional magnetic resonance imaging. Surg Radiol Anat. 2020. https://doi.org/10.1007/s00276-020-02429-3.
18. Erkocak OF, Kucukdurmaz F, Sayar S, Erdil ME, Ceylan HH, Tuncay I. Anthropometric measurements of tibial plateau and correlation with the current tibial implants. Knee Surg Sports Traumatol Arthrosc. 2016. https://doi.org/10.1007/s00167-015-3609-5.
19. Ho WP, Cheng CK, Liau JJ. Morphometrical measurements of resected surface of femurs in Chinese knees: correlation to the sizing of current femoral implants. Knee. 2006. https://doi.org/10.1016/j.knee.2005.05.002.
20. Bilkay C et al. Türk Toplumunda Tibia Proksimalinin Morfometrik Özellikleri ve Klinik Önemi. Int J of Basic and Clinic Med. 2016.
21. Kwak DS, Surendran S, Pengatteeri YH, Park SE, Choi KN, Gopinathan P, et al. Morphometry of the proximal tibia to design the tibial component of total knee arthroplasty for the Korean population. Knee. 2007. https://doi.org/10.1016/j.knee.2007.05.004.
22. Donegan DJ, Seigerman DA, Yoon RS, Liporace FA. Gerdy's tubercle: the lighthouse to the knee. J Orthop Trauma. 2015. https://doi.org/10.1097/BOT.0000000000000196.
23. Standring S. Gray's Anatomy The Anatomical Basis of Clinical Practice. 41st ed. Edinburgh: Elsevier Churchill Livingstone; 2016.
24. Uehara K, Kadoya Y, Kobayashi A, Ohashi H, Yamano Y. Anthropometry of the proximal tibia to design a total knee prosthesis for the Japanese population. J Arthroplasty. 2002. https://doi.org/10.1054/arth.2002.35790.
25. Lucena dos Santos, Elizabete Regina Silva, et al. Determination of sex based on the morphometric evaluation of the proximal tibia. Int. j. morphol; 2018.
26. Gupta C, Kumar J, Kalthur S, D′souza A. A morphometric study of the proximal end of the tibia in South Indian population with its clinical implications. Saudi J Sports Med. 2015. https://doi.org/10.4103/1319-6308.156354.
27. Murlimanju BV, Purushothama C, Srivastava A, Kumar CG, Krishnamurthy A, Blossom V, et al. Anatomical morphometry of the tibial plateau in South Indian population. Ital J Anat Embryol. 2016. https://doi.org/10.13128/IJAE-20275.
28. Zalawadia AZ, Patel M, S. Morphometrıc study of upper end of tıbıa ın gujarat regıon and ıts clınıcal ımplıcatıon ın knee arthroplasty. Int J Anat Res. 2018. https://doi.org/10.16965/ijar.2017.493.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.