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Morphometric Study Of Medial And Lateral Condyles Of Tibia In Marathwada Region Of Maharashtra.

Mukta S Pande[1], Pratima Kulkarni[2]

[1]Assistant Professor, Department of Anatomy, GMC Aurangabad, India.
[2]Associate Professor, Department of Anatomy, GMC Aurangabad, India.

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ABSTRACT

Background: Accurate morphometric data of the tibial condyles are essential for designing and selecting population-specific knee prostheses, particularly for unicompartmental and total knee arthroplasty. Variations in tibial dimensions based on sex and population may influence prosthetic fit and surgical outcomes. Objectives: To evaluate the morphometric dimensions of the medial and lateral tibial condyles of the proximal tibia and to compare these parameters between sexes and sides in a population from the Marathwada region of Maharashtra.

Materials and Methods: A cross-sectional study was conducted on 182 dried cadaveric tibiae of known sex obtained from the departmental bone bank, including 128 male tibiae (64 right, 64 left) and 54 female tibiae (27 right, 27 left). Tibiae with fractures or arthritic changes were excluded. Anteroposterior and transverse dimensions of the superior articular surfaces of the medial and lateral condyles were measured using a digital vernier caliper. Data were analyzed using SPSS version 16. Mean and standard deviation were calculated and t-tests were applied to assess differences between sexes and sides. A P value < 0.05 was considered statistically significant.

Results: All measured parameters of the medial and lateral tibial condyles were significantly larger in males compared to females on both right and left sides ($P < 0.001$). No statistically significant differences were observed between right and left sides in either males or females ($P > 0.05$ for all parameters).

Conclusions: Significant sexual dimorphism exists in the morphometric dimensions of the proximal tibial condyles, with females exhibiting smaller measurements than males. These findings emphasize the importance of gender- and population-specific considerations in the design and selection of tibial components for knee arthroplasty in the Marathwada population.

Keywords: *Medial condyle, lateral condyle, morphometry.*

INTRODUCTION

The expanded proximal end of the tibia bears body weight transmitted through the femur. The proximal end includes the medial condyle, lateral condyle, an intercondylar area and the tibial tuberosity.[1] The Asian subpopulation is known to have a smaller build and skeletal structure compared with their Western counterparts.[2] In unicompartmental arthroplasty, only a portion of the knee joint is replaced.[3] The shape of the medial tibial plateau differs from that of the lateral plateau. While attempting optimal anteroposterior coverage during medial unicompartmental knee arthroplasty, this difference can lead to mediolateral overhang.[4] Therefore, it is important to have baseline anthropometric data for a given population. The present work is an elaborate anatomical study of the proximal end of the tibia that provides the range, mean and standard deviation of the study parameters. The parameters were compared between male and female tibiae, as well as between right- and left-sided bones of the same cadavers, as per the departmental bone bank records.

MATERIALS AND METHODS

Prior permission was obtained from the HOD, Department of Anatomy, Government Medical College (GMC), Aurangabad. As all the specimens were cadaveric no consent was possible and permission of ethical commitee was not deemed necessary. A total of 182 dried cadaveric tibiae of known sex (as per departmental bone bank records), including 128 male tibiae (64 right and 64 left) and 54 female tibiae (27 right and 27 left), were studied. Tibiae that were broken or showed arthritic changes were excluded based on gross examination. After determination of the side, measurements were taken

meticulously using a digital vernier caliper with a least count of 0.01 mm. All measurements were recorded by the same observer to reduce interobserver bias.

The following parameters were recorded:

1) Maximum distance between the anterior and posterior borders of the superior articular surface of the medial condyle (AB) (Fig 1). 2) Maximum transverse distance of the superior articular surface of the medial condyle (CD) (Fig 2). 3) Maximum distance between the anterior and posterior borders of the superior articular surface of the lateral condyle (EF) (Fig 3). 4) Maximum transverse distance of the superior articular surface of the lateral condyle (GH) (Fig 4).

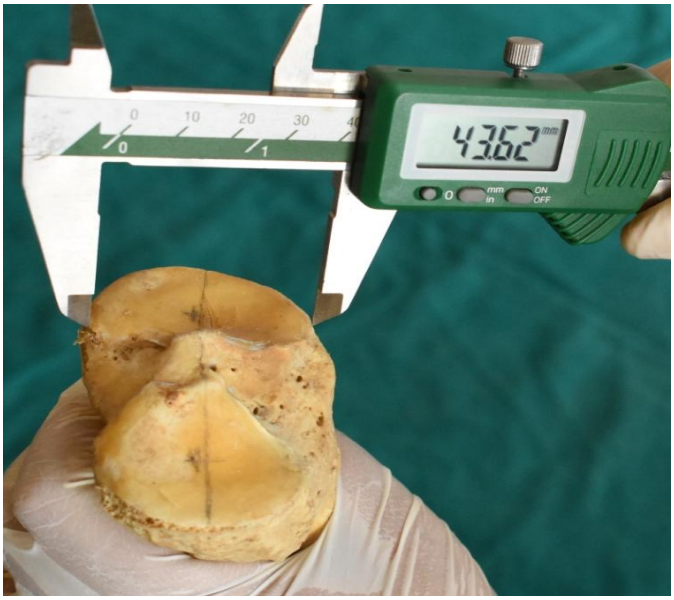

Figure 1: Measurement of anteroposterior dimension of medial condyle of tibia with digital vernier calliper. (AB)

Figure 2: Measurement of transverse diameter of medial condyle of tibia with digital vernier caliper. (CD)

Figure 3: Measurement of anteroposterior dimension of superior surface of lateral condyle. (EF)

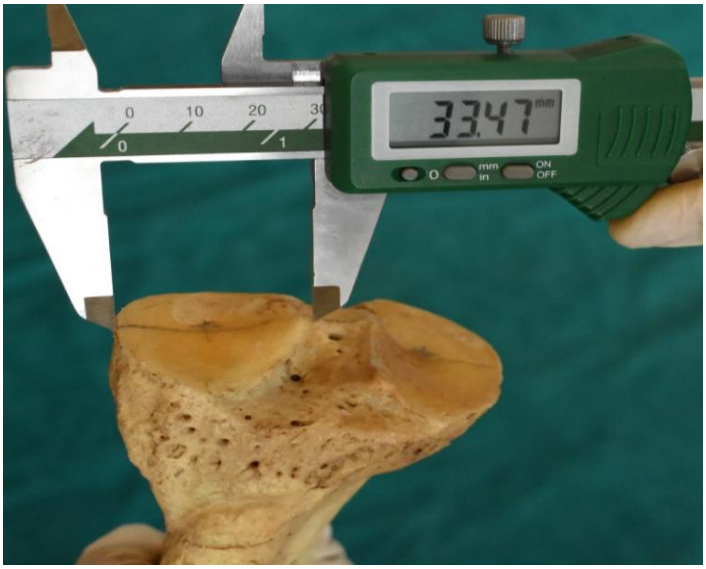

Figure 4: Measurement of transverse dimension of lateral condyle of tibia with digital vernier caliper. (GH)

Statistical Analysis: The data obtained were entered into Microsoft Excel and statistical analysis was performed using SPSS software version 16. Mean and standard deviation were calculated and the t-test was applied to determine the significance of differences between the right and left sides and between males and females. A P value < 0.05 was considered statistically significant.

RESULTS

A total of 182 dried cadaveric tibiae, comprising right- and left-sided bones from 64 male and 27 female skeletons (as per departmental bone bank records), were studied. The study sample was divided into four groups: male right tibia (n = 64), male left tibia (n = 64), female right tibia (n = 27) and female left tibia (n = 27). The range, mean and standard deviation were calculated for each study group. [Table 1]

Comparisons between the right and left sides were made separately for each sex. On comparison between the right male tibia and right female tibia, as well as between the left male tibia and left female tibia, the differences were statistically significant

for all study parameters (P < 0.05). [Table 1]

When comparisons were made between the right and left tibiae in males and between the right and left tibiae in females, the differences were not statistically significant for any of the study parameters (P > 0.05) (Table 2). Thus, no statistically significant difference was observed between the right and left sides in either males or females

Table 1: Range, mean +/- SD for study parameters and comparison between right male and right female tibial condyles as well as between left male and left female tibial condyles

Diameter	Side	Sex	Range	Mean +/- SD	p value
Medial Condyle Superior Articular Surface Anteroposterior Measurements	Right	Male	36.75 to 50.63	44.25 +/- 2.72	< 0.001
		Female	34.57 to 46.25	39.60 +/- 2.87	
	Left	Male	36.75 to 49.83	44.04+/- 2.73	< 0.001
		Female	34.79 to 44.54	39.39+/-2.74	
Medial Condyle Superior Articular Surface Transverse Measurements	Right	Male	24.24 to 32.79	29.04+/-1.82	< 0.001
		Female	22.18to 29.46	26.47+/-1.92	
	Left	Male	26.49 to 35.29	30.03+/-2.03	< 0.001
		Female	23.55 to 34.16	27.58 +/- 2.27	
Lateral Condyle Superior Articular Surface Anteroposterior Measurements	Right	Male	29.04 to 44.34	38.52+/-2.85	< 0.001
		Female	30.48 to 41.58	34.66 +/-2.81	
	Left	Male	33.84 to 46.86	38.64+/-2.62	< 0.001
		Female	30.41 to 40.06	34.25+/-2.59	
Lateral Condyle Superior Articular Surface Transverse Measurements	Right	Male	24.48 to 35.45	30.11+/-2.27	< 0.001
		Female	22.4 to 32.89	26.81 +/- 2.50	
	Left	Male	25.65 to 38.22	30.10+/-2.45	< 0.001
		Female	21.8 to 31.77	26.07 +/-2.43	

Level of significance: P < 0.05

Table 2: Comparison of Tibial Condylar Dimensions Between Right and Left Sides

Parameter	Sex	Right Side Mean ± SD (mm)	Left Side Mean ± SD (mm)	P value
Medial condyle – Anteroposterior (AB)	Male (n=64)	44.25 ± 2.72	44.04 ± 2.73	**0.667**
	Female (n=27)	39.60 ± 2.87	39.39 ± 2.74	**0.781**
Medial condyle – Transverse (CD)	Male (n=64)	29.04 ± 1.82	30.03 ± 2.03	**0.055**
	Female (n=27)	26.47 ± 1.92	27.58 ± 2.27	**0.060**
Lateral condyle – Anteroposterior (EF)	Male (n=64)	38.52 ± 2.85	38.64 ± 2.62	**0.793**
	Female (n=27)	34.66 ± 2.81	34.25 ± 2.59	**0.578**
Lateral condyle – Transverse (GH)	Male (n=64)	30.11 ± 2.27	30.10 ± 2.45	**0.981**
	Female (n=27)	26.81 ± 2.50	26.07 ± 2.43	**0.281**

Statistical test: Independent samples t-test (Welch correction), Level of significance: P < 0.05

DISCUSSION

With altered lifestyle and increased life expectancy, the knee joint, which plays a crucial role in locomotion, commonly suffers from ailments such as arthritis, trauma and infections. The biomechanics of the knee are largely governed by the shape of the distal femur and proximal tibia and the relationship that exists between their articulating surfaces. A normal knee, defined as having neutral alignment, has a limb angle of 180° ± 3°.[5] Inadequate tibial coverage can lead to tibial implant collapse due to the load being shifted to cancellous bone instead of cortical bone.[4] Therefore, precision in surgery and appropriate selection of prosthesis are essential for achieving optimal postoperative outcomes. In a study by E. Servien et al,[4] the anteroposterior dimension was greater for the medial tibial plateau (mean 50.8 mm, SD 3.3) than for the lateral

plateau (mean 47.2 mm, SD 3.3). This difference was statistically significant, indicating asymmetry of the proximal tibia.

The results of the present study were compared with those of previous studies, as shown in Table 3. Kwak D S et al,[6] performed an anthropometric analysis using three-dimensional computed tomographic measurements of the cut surface of 200 proximal tibiae from Korean cadavers. On comparison, the results of the present study were slightly smaller than those reported by Kwak D S et al.[6] Differences in study population and measurement methodology may account for this variation.

The present study also showed smaller values compared to those reported by Gandhi et al,[7] who studied a North Indian population. Gandhi et al,[7] reported statistically significant differences in all proximal tibial measurements between the two sexes on both sides. Similar statistically significant differences between males and females were observed in the present study.

The findings of the present study are comparable with those reported by Murlimanju et al,[8] in a South Indian population, Shah et al,[9] in a Gujarat population and Sinha et al,[10] in a Bihar population.

Considering the importance of gender-specific data, the parameters in the present study were recorded and compared separately for male and female populations. Females demonstrated smaller values compared to their male counterparts and these differences were statistically significant. This observation is in agreement with previous studies.[6,7,10] Therefore, gender differences should be taken into account while selecting and designing suitable prostheses for female patients.

Knowledge of the anthropometric dimensions of the proximal tibia is essential for the design and selection of appropriate tibial components for a given population. The present study provides morphometric data for the Maharashtra population from the Marathwada region

Table 3: Comparison of present study with previous studies

Study		Medial condyle		Lateral condyle	
		AP Diameter in mm (Mean +/- SD)	Transverse Diameter in mm (Mean +/- SD)	AP Diameter in mm (Mean +/- SD)	Transverse Diameter in mm (Mean +/- SD)
Present Study (2020) *Marathwada population*	Male (R)	44.25+/-2.72	29.04+/-1.82	38.52+/-2.85	30.11+/-2.27
	Male (L)	44.04+/-2.73	30.03+/-2.03	38.64+/-2.62	30.10+/-2.45
	Female (R)	39.60+/-2.87	26.47+/-1.92	34.66+/-2.81	26.81+/-2.50
	Female (L)	39.39+/-2.74	27.58+/-2.27	34.25+/-2.59	26.07+/-2.43
Kwak et al [6] (3D CT scan)	Male	48.5+/- 3.7	_	44.6+/-3.2	_
	Female	43.5+/- 2.9	_	39.8+/- 2.5	_
Gandhi et al[7] North Indians	Male (R)	48.45+/-4.14	30.18+/-2.83	40.86+/-3.79	28.62+/-3.10
	Male (L)	47.73+/-4.37	29.38+/-3.14	40.69+/-4.13	28.82+/-3.12
	Female (R)	42.39+/-4.19	27.25+/-3.05	36.78+/-3.03	26.14+/-2.51
	Female (L)	42.36+/-4.65	26.96+/-2.18	37.30+/-3.81	26.00+/-3.06
Murlimanju et al [8] South Indians	Right tibia	40.6+/-3.9	26.9+/-2.9	34.8+/-3.7	26.5+/-3.4
	Left tibia	39.2+/-3.6	26.6+/-2.7	32.6+/-3.4	25.7+/-2.5
	Combined (Right+Left	39.8+/-3.8	26.7+/-2.8	33.6+/-3.7	26.1+/-2.9
Shah et al [9] Gujarat	_	42.7+/-3.8	26.7+/-3.00	40.0+/-3.3	25.0+/-3.0
Sinha et al [10] Bihar	Male (R)	43.4+/-2.1	28.5+/-1.2	39.1+/-2.5	26.9+/-1.5
	Male (L)	45.2+/-2.6	28.6+/-1.4	38.9+/-2.7	27.6+/-1.8
	Female (R)	38.9+/-1.5	25.9+/-1.4	35.7+/-2.1	25.5+/-1.3
	Female (L)	38.5+/-2.3	25.7+/-1.5	35.6+/-2.6	25.7+/-1.5

(R-Right, L-Left)

Limitations

The present study was carried out on dry bones. Therefore, minor shrinkage in the morphology of dry bones by a few millimeters compared to live specimens cannot be excluded.

CONCLUSION

The present study provides gender-wise morphometric data of the proximal end of the tibia for the right and left sides separately. Females demonstrated statistically significantly smaller values compared to their male counterparts; this finding should be considered while selecting and designing prostheses for the female population. The study reports the range, mean and standard deviation of the measured parameters. Given the paucity of morphometric data on the tibia from the Marathwada region of Maharashtra, the findings of this study may be useful for selecting and designing appropriate prostheses for this population. The present study may also be beneficial for orthopedic surgeons, anthropologists and forensic personnel.

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Conflict of interest: None.

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