

MORPHOMETRIC STUDY OF MEDIAL AND LATERAL CONDYLE OF THE TIBIA IN NORTH INDIAN POPULATION

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ABSTRACT

SUMMARY: Total and unicompartmental joints replacements have become the main standard for the treatment of degenerative disorders and osteoarthritis of the knee. In total knee arthroplasty less than half an inch (9 mm) of the tibial and femoral articular surfaces are removed from the ends of bones and replace the metal and plastic prosthesis. There by the dimensions of each condyle are requisite for designing prosthesis required for knee arthroplasty. Fifty (25 right & 25 left) adult fully ossified dry tibiae were taken from the Department of Anatomy and morphometric measurements of medial and lateral condyle were taken by using a Vernier caliper. Statistical analysis of the parameters was done. Present study, the mean anteroposterior, the transverse diameter of medial and lateral condyles of tibia were 45.71 ± 3.17 , 29.75 ± 2.95 , and 39.71 ± 3.09 , 30.24 ± 2.45 mm respectively. The mean mediolateral length of total tibia and the mean circumference of the upper tibia were 69.35 ± 5.08 and 191.49 ± 14.85 mm respectively. The results of this study will be helpful for anatomists, anthropologists, and orthopedics in cases of unicompartmental knee arthroplasty, complete knee arthroplasty procedures, and meniscal transplantation.

KEYWORDS : Knee, Tibia, Condyles, Morphometry, Arthroplasty.

INTRODUCTION

The bipedal erect posture of man caused a change in functional and mechanical measurements of skeletal structure so much that the lower limb is primarily adopted for locomotion and weight bearing. Therefore, greater strength and stability is required for the lower limb as compared with the upper limb (1). The proximal end of tibia is an important component of knee joint through the tibiofemoral articulation. The proximal end of the tibia is expanded, having medial and lateral condyle. In man weight bearing is related mainly to extended knee positions. The relationship between the different weight bearing situations and the anteroposterior and mediolateral dimensions of diaphysis and epiphysis of the tibia is well established (2). Morphometric parameters of upper end of tibia can be used to guide treatment and monitor the outcome of total knee replacement surgeries. Knee joint surgeries are technically demanding and rapidly evolving procedures; hence an elaborate anatomical study of this relevant surgical field would serve in planning required interventions in numerous pathological and degenerative conditions of the knee joint (3). Hence, the aim of this study is to measure the dimensions of the medial and lateral condyles of tibia, which can serve as guidelines for designing a suitable tibial component of total knee prosthesis for Indian population.

MATERIALS AND METHODS

The study was carried out on 50 dry tibiae (25 right and 25 left), obtained from the Department of Anatomy of Government Medical College, Amritsar, India. All bones were adult type and without any signs of erosion. Each tibia was assigned a serial number. Data was collected by Vernier caliper. Descriptive statistical methods like Mean \pm SD and percentage was used for depicting and analyzing data.

Following parameters were recorded in a proforma

1. Maximum anteroposterior (AP) diameter of medial condyle (Fig. 1A)
2. Maximum anteroposterior (AP) diameter of lateral condyle (Fig. 1B)

3. Maximum transverse (TS) diameter of medial condyle (Fig. 1C)
4. Maximum transverse (TS) diameter of lateral condyle (Fig. 1D)
5. Mediolateral (ML) length of tibia (Fig. 1E & Fig. 1F)
6. Circumference of the upper end (Fig. 1G & Fig. 1H)



Figure 1: Anteroposterior diameter of superior articular surface of medial and lateral condyle of Tibia showing in Figure 1A & Figure 1B. Transverse diameter of superior articular of medial and lateral condyle of Tibia showing in Figure 1C & Figure 1D. Mediolateral length of Tibia showing in Figure 1E & figure 1F. Circumference of the upper end of Tibia showing in Figure 1G & Figure 1H.

RESULTS

On comparing the anteroposterior and transverse diameters it was seen that the anteroposterior diameter was more than transverse diameter on both the sides. While comparing between two condyles, it was seen that both anteroposterior and transverse diameters were more in medial condyle on both sides.

Table-1: Showing Mean, Range and p- value of all parameters of right, left and total tibia

Parameters	Mean ± SD			Range			p value
	Right	Left	Total	Right	Left	Total	
AP diameter of medial condyle	46.03 ± 2.94	45.38 ± 3.41	45.71 ± 3.17	39.7-51	38.3-51.5	38.3-51.5	0.214
TS diameter of medial condyle	28.96 ± 3.16	30.54 ± 2.55	29.75 ± 2.95	24.4-39.3	25.1-34.6	24.4-39.3	0.933
AP diameter of lateral condyle	39.7 ± 3.50	39.73 ± 2.69	39.71 ± 3.09	32.2-46.7	34.1-45.2	32.2-46.7	0.967
TS diameter of lateral condyle	28.74 ± 3.23	30.24 ± 2.45	29.49 ± 2.49	21.3-31.9	26.1-33.4	21.3-33.4	0.564
ML length of proximal tibia	68.93 ± 5.50	69.77 ± 4.69	69.35 ± 5.08	56-79.5	62.7-77	56-79.5	0.507
Circumference of upper end tibia	189.80 ± 16.08	193.18 ± 13.64	191.49 ± 14.85	147.5-215.3	162.8-212.6	147.5-215.3	0.037

DISCUSSION

Various studies have been carried out on morphometry of medial and lateral condyles of tibia. Following tables present

the comparison of means of the various previous studies with that of the present study.

Table-2: Comparison of Anteroposterior diameter and Transverse diameter of condyles of tibia with previous studies (mm)

Study	Year	Population Range	Anteroposterior diameter of Medial condyle	Anteroposterior diameter of Lateral condyle	Transverse diameter of Medial condyle	Transverse diameter of Lateral condyle
			Mean ±SD	Mean ± SD	Mean ± SD	Mean ± SD
Bae DK, Park JY (4)	2000	Korean	48.0 ± 3.1	39.8 ± 2.9	-	-
Servien et al (5)	2008	French	50.8 ± 3.3	47.2 ± 3.3	-	-
Ankit Srivastav (6)	2014	North Indian	R: 38.63 L: 39.94	R: 36.47 L: 36.94	R: 29.73 L: 27.5	R: 29.21 L: 29.77
Ivan AS (7)	2014	South Indian	R: 40.86 ± 4.23 L: 41.33 ± 4.28	R: 36.72 ± 4.10 L: 35.48 ± 3.94	-	-
Gupta C et al (8)	2015	South Indian	R: 45.5 ± 2.9 L: 40.19 ± 3.35	R: 40.8 ± 2.7 L: 40.6 ± 3.6	R:27.0 ± 2.4 L: 27.6 ± 2.7	R: 26.6 ± 2.4 L: 29.2 ± 3.2
Murlimamju BV (9)	2016	South Indian	R: 40.6 ± 3.9 L: 39.2 ± 3.6	R: 34.8 ± 3.7 L: 32.6 ± 3.4	R: 26.9 ± 2.9 L: 26.6 ± 2.7	R: 26.5 ± 3.4 L: 25.7 ± 2.5
Vasanthi A (10)	2017	North costal AP	R: 45.48 ± 0.52 L: 47.67 ± 1.39	R: 40.05 ± 0.42 L: 41.54 ± 0.42	R: 24.27 ± 1.01 L: 22.50 ± 1.04	R: 23.26 ± 1.02 L: 22.38 ± 1.04
Shital Shah (11)	2018	Gujarat (India)	42.7 ± 3.8	40.0 ± 3.3	26.7 ± 3.0	25.0 ± 3.0
Juned Labbi (12)	2019	Mumbai (India)	R: 41.10 ± 3.75 L: 40.19 ± 3.35	R: 37.16 ± 3.38 L: 36.57 ± 2.97	R: 28.35 ± 2.49 L: 28.11 ± 2.26	R: 27.83 ± 2.77 L: 27.88 ± 2.55
Nayak G et al (13)	2019	Odisha (India)	R: 41.7 ± 5.0 L: 41.2 ± 4.2	R: 36.6 ± 3.1 L: 39.2 ± 3.0	R: 27.8 ± 3.4 L: 28.1 ± 5.9	R: 29.5 ± 2.9 L: 29.6 ± 2.8
Ahmad et al (14)	2019	Uttrakhand (India)	R: 40.18 ± 4.7 L: 40.21 ± 5.64	R: 35.94 ± 4.59 L: 37.02 ± 3.87	R: 28.46 ± 3.63 L: 28.27 ± 2.95	R: 27.89 ± 4.26 L: 27.92 ± 3.06
Present study	2021	North Indian	R: 46.03 ± 2.94 L: 45.38 ± 3.14	R: 39.7 ± 3.5 L: 39.73 ± 2.69	R: 28.96 ± 3.16 L: 30.54 ± 2.55	R: 28.74 ± 3.23 L: 30.24 ± 2.94

It was evident from the above table that the findings of [AP diameter of medial condyle] present study were in consonance with the findings of the Bae DK and Park JY (4), Gupta C et al (8), Vasanthi A (10) and also with Shital shah (11) studies but results were different from Servien et al (5), Ankit Srivastav (6), Ivan AS (7), Murlimanju BV (9), Juned Labbi (12), Nayak G et al (13) and Ahmad et al (14).

studies but result were different from Murlimanju BV (9), Vasanthi A (10) and Shital Shah (11).

Table-3: Comparison of ML length and Circumference of proximal tibia (mm)

Study	Year	Population Range	Mediolateral length	Circumference of upper end
			Mean ± SD	Mean ± SD
Bae DK, Park JY (4)	2000	Korean	72.7 ± 4.0	-
Uehara et al (15)	2002	Japanese	65-75	-
Kwak et al (16)	2007	Korean	73.5 ± 5.6	-
HU Yan-jun et al (17)	2010	Chinese	73.50 ± 5.6	-
Chaichankul C (18)	2011	Thai	68.8 ± 5.8	-
Ivan AS (7)	2014	South Indian	R: 66.29 ± 5.15 L: 66.68 ± 5.68	R: 193.3 ± 14.5 L: 193.3 ± 15.8
Gupta C et al (8)	2015	South Indian	R: 67.7 ± 3.1 L: 68.8 ± 5.68	R: 189.5 ± 6.8 L: 190.7 ± 16.5

It was evident from the above table that the findings of [AP diameter of lateral condyle] present study were in consonance with the findings of Bae DK and Park JY (4), Gupta C et al (8), Murlimamju BV (9), Vasanthi A (10), Shital Shah (11) and also with Juned Labbi (12) studies but results were different from Servien et al (5), Ankit Srivastav (6), Ivan AS (7), Nayak G et al (13) and Ahmad et al (14).

It was evident from the above table that the findings of [TS diameter of medial condyle] present study were in consonance with the findings of Ankit Srivastav (6), Gupta C et al (8), Juned Labbi (12), Nayak G et al (13) and also with Ahmad et al (14) studies but result were different from Murlimanju BV (9), Vasanthi A (10) and Shital Shah (11).

It was evident from the above table that the findings of [TS diameter of lateral condyle] present study were in consonance with the findings of Ankit Srivastav (6), Gupta C et al (8), Juned Labbi (12), Nayak G et al (13) and also with Ahmad et al

Vasanthi A (10)	2017	North costal AP	-	R: 127.0 ± 1.27 L: 131.6 ± 1.13
Ahmad et al (14)	2019	North Indian	R: 66.03 ± 6.60 L: 66.72 ± 5.13	-
Present Study	2021	North Indian	R: 68.93 ± 5.50 L: 69.77 ± 4.69	R: 189.8 ± 16.08 L: 193.18 ± 13.64

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It was evident from the above table that the findings of [ML length] present study were in consonance with the findings of Uehara et al (15), Chaichankul C (18), Ivan AS (7) and also with Gupta C et al (8) studies but results were different from the findings of Bae DK, Park JY (4), Kwark et al (16), HU Yan-jun et al (17) and with Ahmad et al (14). It was evident from the above table that the findings of [Circumference of upper end] present study were in consonance with the findings of Ivan AS (7) and Gupta C et al (8) studies but results were different from the findings of Vasanthi A (10).

CONCLUSION

The anatomic data collected in this study provides a comprehensive data about the morphometry of dry adult tibiae, which will provide the basis for designing the optimal tibial prosthesis in total knee arthroplasty for Indian population into consideration as a small sized prosthesis may show mediolateral under sizing and larger sized prosthesis may show mediolateral overhang. The purpose of this study is to analyze the dimensions of each tibial condyle for planning of unicompartmental knee arthroplasty and to compare the morphometric data with other studies in different populations. We as anatomists humbly submit that the results of this study will be extremely valuable in designing appropriate size matched components of knee prosthesis for Indian population.

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