

# Tibial Plateau Morphometry in South Indian Population

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## ABSTRACT

**Introduction:** The knee transplant has become a common surgery nowadays. Hence, there has arisen the need for accurate tibial plateau morphometry which is population specific. The data of which will be helpful in designing tibial prosthesis which is population specific.

**Aim:** The study of tibial plateau morphometry in South Indian population which will add to the existing knowledge and would help in designing tibia prosthesis to suit the local population.

**Materials and Methods:** The study is done on 36 dry tibia obtained from our Anatomy Department. The length and breadth of the articulating surfaces of medial and lateral tibial condyles are measured. The data of the medial and lateral compartments of the tibial plateau and the data of right and left sides are statistically analysed and compared.

**Results:** The mean length and breadth of medial tibial plateau ( $\pm$  standard deviation) is  $42.7 \pm 4.1$  mm and  $30.8 \pm 2.8$  mm and that of lateral tibial plateau is  $37.5 \pm 3.9$

mm and  $30.61 \pm 3.6$  mm. The length as well as the breadth dimensions of lateral tibial plateau is less than that of medial. The two-tailed p-value is less than 0.0001 for length and breadth and this difference is considered to be extremely statistically significant.

The length of medial tibial plateau is longer on the left side. The two-tailed p-value is less than 0.5 for length of medial tibial plateau for right and left sides and this difference is considered to be statistically significant. The differences are not statistically significant between right and left sides in respect of other parameters.

**Conclusion:** The study of morphometry of tibial plateau provides additional information in respect of south Indian population. In the present study it is observed that medial tibial plateau is larger than the lateral and in left sided tibiae the average length of medial tibial plateau is greater than the left lateral tibial plateau. These findings in our study may assist the concerned medical persons in designing meniscal implants and tibial prostheses suitable for local population.

**Keywords:** Lateral condyle, Medial condyle, Total knee replacement

## INTRODUCTION

The tibial plateau is the superior surface of the upper end of the tibia. The intercondylar eminence is the middle elevated area of the tibial plateau. The intercondylar area gives attachment to the anterior and posterior attachments of the medial and lateral menisci and the cruciate ligaments. It separates the medial and lateral articulating surfaces of the tibia. These articulating surfaces of tibial plateau articulate with the articulating surfaces of the femoral condyles and in addition patellar articular surface joins them to form the knee joint.

The total or partial knee replacement surgery involves resecting the superior surface of the tibia up to nearly one centimetre and replacing the resected part with the tibial prosthesis and its implantation. The knee replacement surgery is the treatment of choice in severe osteoarthritis. The disease of osteoarthritis

is the painful complication of ageing and obesity.

Currently, the population of ageing people is on the increase. Obesity has become a common occurrence in recent days irrespective of age. Because of these twin factors the incidences of severe osteoarthritis are on the rise, requiring partial and total knee replacement.

Moghtadaei M et al., opines that, the knee replacement surgery is the complex and the accurate method considered as beneficial for removing pain and in improving the lifestyle of patients suffering from severe case of osteoarthritis [1].

The medial and lateral condylar surfaces of tibia are not similar. The medial condylar plateau is oval in shape and is longer whereas lateral condylar plateau is circular [2].

Hence, tibial plateau morphometry is required for performing knee transplantation surgery. Servien E et al., opines that,

in vivo dimension of each tibial plateau is the key factor in planning unicompartmental knee arthroplasty and optimal coverage of resected tibial plateau is the important factor in the total knee arthroplasty [3,4].

The anatomical studies on tibial plateau are infrequent and very few are available in respect of South Indian population.

The tibial plateau morphometric data as well as sex differences are important in the designing tibial prosthesis suitable for a local population. A mismatch can result in severe complications like cruciate ligament rupture, soft tissue misbalancing, less movements of knee joint after surgery and even prosthesis loosening [4,5]. The knee prosthesis made according to morphometric data of femur and tibia and according to the gender parameters will give excellent results and early mobility of patients as well as lesser complications after surgery [6,7].

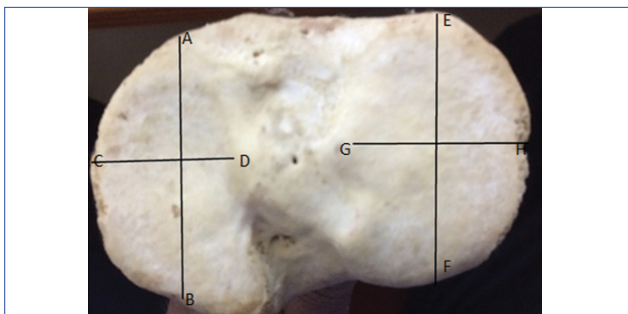
## MATERIALS AND METHODS

The observational study was conducted in the Department of Anatomy, at NRI institute of Medical Sciences, Sangivalasa, Visakhapatnam, India, for the duration of our study is six months between November 2017- April 2018.

The study is specific to South Indian population as the dry tibiae we have in the department belong to the local population. The tibia with the normal structure is numbered to avoid re-measurement.

As our study is not related with any animals and patients, there is no need for ethical approval from the Ethics committee of our Institute, yet we took approval for our study in the month of November 2017.

Total 36 (18 right sided and 18 left sided) dry adult tibia were considered in the study. The tibia with gross deformities and bone damage are excluded from the study. The length and breadth of medial and lateral tibial plateaus are measured with Vernier callipers. The length is measured from anterior end to posterior end of plateau at the point of maximum length. The breadth is measured from the intercondylar eminence of respective side to the corresponding medial and lateral end, at the midpoint [Table/Fig-1].



**[Table/Fig-1]:** The superior surface of proximal end of tibia showing the measurements performed in the present study. AB: length of medial tibial plateau; CD: breadth of medial tibial plateau; EF: length of lateral tibial plateau; GH: breadth of lateral tibial plateau.

All the measurements are taken by using a digital Vernier calliper, which gives precision readings from 0.01 mm and 0.0005 mm. The measurements are performed by the same person on three occasions and the average of the three values is taken as representative measure. The intra observer variation is minimised by taking the measurements three times.

## STATISTICAL ANALYSIS

The data obtained is tabulated and statistically analysed. The data of medial and lateral tibial plateaus without side and the right and left tibia are analysed separately. The statistical analysis is performed between the right and left sides by the t-test for unpaired samples and for between medial and lateral tibial plateaus by t-test for paired samples. The differences are considered significant for p-value less than 0.05.

The statistical online software is used for the calculation of mean, standard deviation and SEM or standard error. The GraphPad scientific software, is used for performing t- test for paired and unpaired samples.

## RESULTS

The length of medial tibial plateau was greater than the lateral. The breadth of the medial tibial plateau was also slightly more than that of lateral. The SEM was less than one. The two-tailed p-value is less than 0.0001 for length and breadth and by conventional criteria; this difference was considered to be extremely statistically significant [Table/Fig-2].

Measurements (in mm)	Medial Tibial Plateau	SEM	Lateral Tibial Plateau	SEM
Length *	42.75±4.1	.68	37.50±3.9*	.66
Breadth *	30.80±2.8	.47	30.61±3.6*	.60

**[Table/Fig-2]:** Morphometric data of medial and lateral tibial plateaus.

\*Values are mean±SD; p<0.05 (t-test for paired samples)

It was observed in the left sided tibiae that the average length of medial tibial plateau was greater than the left lateral tibial plateau. The two-tailed p-value was less than 0.5 for length of medial tibial plateau for right and left sides and by conventional criteria, this difference is considered to be statistically significant. In respect of other parameters no significant statistical differences are observed [Table/Fig-3].

Measurements (in mm)	Right Side	Left Side
<b>Medial Tibial Plateau</b>		
Length	41.38±3.2*	44.11±4.5*
Breadth	30.66±3.2	30.94±2.4
<b>Lateral Tibial Plateau</b>		
Length	37.94±4.4	37.05±3.5
Breadth	30.5±3.4	30.72±3.9

**[Table/Fig-3]:** Comparison of the tibial plateaus between right and left sides.

\*Values are mean±SD; p<0.05 (t-test for unpaired samples)

## DISCUSSION

In the present study the length of medial tibial plateau is greater than the lateral. The breadth of the medial tibial plateau was also slightly more than that of lateral. The SEM was less than one. The two-tailed p-value was less than 0.0001 for length and breadth and by conventional criteria; this difference is considered to be extremely statistically significant.

Further, in the left sided tibiae the average length of medial tibial plateau is greater than the left lateral tibial plateau. The two-tailed p-value is less than 0.5 for length of medial tibial plateau for right and left sides and by conventional criteria, this difference is considered to be statistically significant.

The tibial plateau consists of the medial and lateral superior condylar surfaces of the tibia. The medial and lateral condylar surfaces are separated by the intercondylar eminence.

The morphometry of the tibial plateau widely varies in different populations of the world. The morphometry depends on the stature of the population. Asians have smaller stature compared to the western population.

The tibial prosthesis which is being used in the partial and complete transplant of the knee joint is designed for the western population. The knee prosthesis available in the market may not match with the morphometry of Indian population. Indian patients are at the risk of getting a prosthesis which is oversized in procedures like unicompartmental knee arthroplasty and total knee arthroplasty [8]. Over-sized knee prosthesis can lead to incompatibility with the resected bones [9].

In the French study, it is mentioned that the length of medial tibial plateau is  $50.8 \pm 3.3$  mm and the lateral is  $47.2 \pm 3.3$  mm [3]. In a South Indian study it is mentioned that the length is significantly longer for the medial tibial plateau and measured  $39.8 \pm 3.8$  mm and the lateral plateau measured  $33.6 \pm 3.7$  mm [10]. In the present study, also the length is longer for the medial tibial plateau and it measured  $42.7 \pm 4.1$  and the lateral measured

$37.5 \pm 3.9$ . The comparison of above measurements shows the length given the French study are larger, that may be due to their study which was done on data obtained from CT-scan and also because of ethnic factors. Our study gives morphometry of tibial plateau similar to the South Indian study mentioned.

In Korean cadaveric study, 3D computerized tomography scans were used and they reported that the mediolateral tibial plateau measured  $73.5 \pm 5.6$  mm. In our study the mediolateral tibial plateau measured  $67.2 \pm 5.8$  and this closely resembles the Korean study. This study also reported that the parameters they observed were lower than the size of commercially available knee implants. They also mentioned that the smaller implants could lead to mediolateral under-sizing and the larger ones could cause mediolateral overhang. They believed that their data may offer a guideline for preparing total knee prostheses for Koreans [11].

In a study on North Indian population the average length of the medial and lateral tibial plateau of the right tibia measured 38.63 mm and 36.47 mm. The length on left side specimens, measured 39.94 mm and 36.94 mm. The breadth measured 29.73 mm and 29.21 for right side and 27.5 mm and 29.77 for left side [12]. [Table/Fig-4] gives comparison of some of the Indian studies and a Nigerian study [12,13]. The comparison is done in respect of length and breadth of medial and lateral plateaus of right and left sides.

With the above comparison we can conclude that there is no significant difference in the morphometric parameters of the tibial plateau among the North and South Indian populations. But significant differences exist with the Nigerian population with respect to most of the parameters.

In another study done on 100 total arthroplasty knees by using the radiographic films, medial and lateral tibial plateaus were evaluated and it was observed that the lateral tibial plateau is smaller than the medial one; therefore the need was highlighted for a knee arthroplasty procedure which takes into

Study and year	Right				Left			
	Length Medial Plateau (in mm)	Breadth Medial Plateau (in mm)	Length Lateral Plateau (in mm)	Breadth Lateral Plateau (in mm)	Length Medial Plateau (in mm)	Breadth Medial Plateau (in mm)	Length Lateral Plateau (in mm)	Breadth Lateral Plateau (in mm)
Muralimanju BV et al. (2016)[10]	40.6±3.9	26.9±2.	34.8±3.7	26.5±3.4	39.2±3.6	26.6±2.7	32.6±3.4.	25.7±2.5
Srivastava A et al. (2014) [12]	38.63	29.73	36.47	29.21	39.94	27.5	36.94	29.77
Ugochukwu EG et al. (2016) [13]	46.1±5.1	30.3±4.3	48.0±5.1	29.6±4.1	45.1±3.1	31.5±4.1	49.2±2.4	31.3±2.4
Present study (2018)	41.4±3.2	30.7±3.2	37.9±4.4	30.5±3.4	44.1±4.5	30.9±2.4	37.0±3.5	30.72±3.9

[Table/Fig-4]: comparison of Indian studies and Nigerian study.

account the difference to ensure complete tibial coverage [14]. The lateral tibial plateau would need a different tibial implant, round in shape and with a smaller length and breadth [15].

In the surgical practice, the orthopaedists avoid implants with incomplete coverage of the tibia as this may induce the collapse of the implant [16,17]. Hence, the implant designing needs knowledge of the size of the tibial plateau. The morphology of the tibial prosthetic component should match the resected surface in order to restore the stability and load transmission after knee replacement [9]. Total Knee Arthroplasty (TKA) and unicompartmental knee arthroplasty are both accurate surgeries which require optimum prosthesis sizing. This is important to ensure a better prognosis and prosthesis long term survival, which would lead to normal function post operatively [18].

Moghtadaei M et al., in their CT scan study of knee joints observed that besides precise surgical techniques in TKA, proper sizing of the prosthesis is mandatory for a successful and long-life outcome. Any mismatch in the form of overhanging or under sizing of the components can lead to altered soft-tissue tensioning and impaired patello-femoral tracking [1].

They further observed that in order to enhance the quality of the fitness yielded by prostheses, morphometric studies from diverse ethnicities are mandatory. They stated that as the Asian populations have smaller knee compared with Caucasians, there is need for alteration in sizing and configuration of current prostheses to best fit them.

They further mentioned that anthropometric surveys from China, Korea, Japan, India, Malaysia and Thailand were conducted to construct Asian knee profile. But, there were delicate discrepancies in methodology and results of these studies that can affect the outcome of TKA in a different manner from Western population.

To avoid misinterpretation, they mentioned that we should first delineate with what stance we are viewing the results: whether clinically or anatomically. For example, they mentioned that a glance to an anatomical study conducted by Mahfouz M et al., [19] shows that they defined most of their anthropometrical parameters based on the longest length of them. On the other hand, they mentioned that in clinical studies like most of the works related to arthroplasty, the same parameters were defined based on some different considerations.

In addition, they mentioned that within the same population either Caucasian or Asian, sometimes all the available studies are not fully scrutinised before coming up with a conclusion. These should be regarded while comparing the results.

Further, they opined that on the tibial side, all prostheses were undersized for small knees (ML sizes were too small for the same AP value) and oversized for larger knees. The same they said was mentioned in Chinese, Korean and Thai population studies.

Hence, they reiterated the need for alteration in prostheses shape in addition to their sizing; especially considering this point that most candidates of TKA in Asian countries need smaller or medium sized components [1].

## LIMITATION

A limitation of the present study is the lack of parameters for comparison between genders.

## CONCLUSION

The present study measured morphometry of tibial plateau in local South Indian population. It is observed that medial tibial plateau is larger than the lateral. It is also observed in the left sided tibiae that the average length of medial tibial plateau is greater than the left lateral tibial plateau. The data of this study may assist the concerned medical persons in designing meniscal implants and artificial prostheses suitable for local population. The data is also essential to the forensic and physical anthropologists.

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