



MORPHOMETRIC STUDY OF CONDYLAR PLATEAU OF TIBIA IN RAJASTHAN POPULATION AND ITS CLINICAL IMPLICATION IN KNEE ARTHROPLASTY

Dr. Awantika Thakur

Tutor, Department of Anatomy, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh

Dr. Prasenjit Bose*

Senior Resident, Department of Anatomy, All India Institute of Medical Sciences, Raipur, Chhattisgarh *Corresponding Author

Dr. Swati Bang

Tutor, Department of Anatomy, Ananta Institute of Medical Sciences and Research Centre, Udaipur, Rajasthan

ABSTRACT

BACKGROUND: Total knee arthroplasty has become the standard treatment for various disabling disorders of the knee and has proven long term success. In total knee replacement, the shape of the knee prosthesis is very important because many complications may arise from a mismatch between the prostheses and the bones. The present study was conducted to measure, tabulate and analyze various parameters of the condylar plateau of proximal end of tibia in Rajasthan population and also to compare the data with the previous studies done in different Indian populations and other ethnic groups by various researchers. **Methods:** For this study, 500 human adult dry tibia bones (250 of right and 250 of left) of unknown age and sex were collected from the population of Rajasthan (India). **Results:** On comparing the two condyles, it was seen that mean antero-posterior diameter was greater in medial condyle and mean transverse diameter was greater in lateral condyle on both sides. **Conclusion:** The present study shows that there are striking variations in knee morphology between the Asian and Western population.

KEYWORDS : Tibial plateau, Total Knee Arthroplasty, Lateral Condyle, Medial Condyle,

INTRODUCTION

Total knee arthroplasty (TKA) has become the standard treatment for various disabling disorders of the knee and has proven long term success [1]. The adequacy of the fit of the prosthesis to the tibia is an important variable in the outcome of TKA [2]. Total knee replacement, being a precise surgical procedure, shape match between the prosthesis and the resected surface of the tibia is a vital factor for long-term success. The components of the knee implants are required to cover maximum surface in order to achieve a successful outcome [3]. It is known that the tibial component is more prone to complications in TKA as compared to the femoral component. Thus, it becomes important to properly size the tibial prosthesis to the surface of proximal tibia to achieve the best stability and longevity for the implant [4]. Asian sub-populations are known to have a smaller build and stature compared to their Western counterparts, owing to a shortage of data on the distal femur and proximal tibia in this population, implants designed for knees of the Western population are being used without modifications for the ethnic group. This leads to the problem of an implant size mismatch with the resected bony surface in the Asian patients [3]. Optimizing bone coverage with the tibial component may avoid complications such as post operative bone bleeding, subsidence, loosening, and component overhang [5].

In the current era there is growing shift from the symmetric non-anatomical tibial component to the more anatomical component. Hence, the present study aims to assess different morphometric parameters of condylar areas on superior surface of tibia, to compile and analyze the results, and formulate a baseline data for future studies with relevance to Indian population (Rajasthan) which can be used to guide treatment and monitor outcome of Total Knee Replacement surgeries in Indian scenario.

MATERIALS AND METHODS

The present study was carried out in the Departments of Anatomy of Mahatma Gandhi Medical College (Jaipur), Sawai Man Singh Medical College (Jaipur), National Institute of Medical Sciences (Jaipur), Rajasthan University of Health Sciences (Jaipur) and Government Medical College (Kota). For this study, 500 human adult dry tibia bones (250 of right and 250 of left) of unknown age and sex were collected from the population of Rajasthan (India). All the measurements were taken with the help of Digital Vernier Callipers.

Following metric parameters were noted:

1. MEDIAL CONDYLE

a) Antero-posterior (A-P) diameter - The maximum distance between anterior and posterior borders of superior articular surface of medial condyle **Figure 1(a)**.



Figure 1(a).

b) Transverse diameter - The maximum transverse diameter of superior articular surface of medial condyle **Figure 1(b)**.



Figure 1(b).

a) Antero-posterior (A-P) diameter - The maximum distance between anterior and posterior borders of superior articular surface of lateral condyle **Figure 1(c)**.

Figure 1©.



b) **Transverse diameter** - The maximum transverse diameter of superior articular surface of lateral condyle **Figure 1(d)**.



Figure 1(d).

3. AREAS OF MEDIAL AND LATERAL CONDYLES

Determined by using the formula –

Area (A in mm²) = length (A-P diameter in mm) × width (Transverse diameter in mm)

All the parameters were statistically interpreted.

RESULTS

The current study establishes the morphometric attributes of superior surface of proximal end of tibia in Rajasthan population of India. The study revealed the following important observations:

1. Medial Condyle; Table - 1

The mean A-P diameter (Right- 41.71 mm, Left- 42.24 mm) and mean transverse diameter (Right- 29.28 mm, Left- 29.69 mm) **are more in left sided bones.**

It can also be seen that the areas covered by medial condyle in left sided bones (1261.59 mm²) are greater than that covered by right sided bones (1229.75 mm²).

2. Lateral Condyle; Table - 1

The mean A-P diameter (Right- 37.6 mm, Left- 36.93 mm) **is more in right sided bones** whereas the mean transverse diameter (Right- 29.69 mm, Left- 30.16 mm) **is more in left sided bones.**

The area covered by lateral condyle in right sided bones (1123.91 mm²) are greater than that covered in left sided bones (1119.43 mm²) contrary to medial condyle.

On comparing the two condyles, it was seen that mean A-P diameter was greater in medial condyle and mean transverse diameter was greater in lateral condyle on both sides.

Table – 1: Comparison of parameters of condylar plateau of right and left tibia

		Right Tibia (N=250)	Left Tibia (N=250)
		Mean ± S.D. (mm)	Mean ± S.D. (mm)
Medial Condyle	Antero-posterior (mm)	41.71 ± 4.37	42.24 ± 4.05
	Transverse (mm)	29.28 ± 2.87	29.69 ± 2.95
	Area (mm ²)	1229.75 ± 225.01	1261.59 ± 218.73
Lateral Condyle	Antero-posterior (mm)	37.6 ± 3.35	36.93 ± 3.44
	Transverse (mm)	29.69 ± 3.10	30.16 ± 2.94
	Area (mm ²)	1123.91 ± 199.79	1119.43 ± 184.88

1. N = Total number of bones

2. Greater values in bold

DISCUSSION

Commercially available TKA implants do not cater to anthropometric differences observed across different ethnicities. Most of the existing commercial implants are designed to suit the knee anatomy of the Western population. Asian sub-populations are known to have a smaller build and stature compared with their Western counterparts.

1. Medial Condyle

A. Antero-posterior diameter (A-P)

In the previous studies in **Non-Indian population** such as Kwak et al. (2007), Servien et al. (2008), Omer et al. (2014), Yang et al. (2014), Moghtadaei et al. (2015) and Hafez et al. (2016) [4,6,7,8,9,10] measured the mean A-P diameter of the medial and lateral condyles in both sexes. On comparison with various studies done on Indian population such as Gandhi et al. (2014), Shrivastava et al. (2014), Gupta et al. (2015) [11,12,13] it can be seen that the mean A-P diameter of medial condyle of **Indian knees is smaller than their Western counterparts.**

Gandhi et al. (2014) [11] measured the mean A-P diameter of medial condyle with respect to sides and sexes in Delhi region of North India. The mean A-P diameter is greater in males on both right and left sided bones. It can be seen that the values of present study are smaller than the values observed in males and closer to their values observed in females.

Shrivastava et al. (2014) and Gupta et al. (2015) [12,13] measured the mean A-P diameter on both sides in North Indian and South Indian population respectively. On comparison it can be seen that the mean values of the present study (Right- 41.71 mm, left- 42.24 mm) done in Rajasthan population is more than the North Indians (Right- 38.63 mm, Left- 39.94 mm) but less than the South Indian populations (Right- 45.5 mm, Left- 43.6 mm).

B. Transverse diameter of medial condyle

The present study is in accordance with a study conducted by Gupta et al. (2015) [13] which reported transverse diameter to be more on left sided bone. In contrast, Shrivastava et al. (2014) and Gandhi et al. (2014) [12,11] found it to be more in right sided bones. Gandhi et al. (2014) [11] reported that the mean transverse diameter of medial condyle are greater in males for both sides. It can be seen that the mean values of the present study are less than the values of males and closer to the values of their females.

The findings of the present study is in accordance with the study conducted in South Indian population, Gupta et al.(2015) [13] reported almost equal values of mean transverse diameter of medial condyle in both right and left sided bones. (Right- 29.28 mm, Left- 29.69 mm).

C. Area (in mm²) of medial condyles

In the present study, **areas covered by the medial condyle is greater in left sided bones** contrary to the findings reported by Gupta et al. (2015) and Shrivastava et al. (2014) [13,12].

2. LATERAL CONDYLE

A. Antero-posterior (A-P) diameter

On comparing the previous studies in **Non- Indian population such as** Kwak et al. (2007), Servien et al. (2008), Yang et al. (2014), Omer et al. (2014), Moghtadaei et al. (2015), Hafez et al. (2016) [4,6,8,7,9,10] with studies on Indian population such as Gandhi et al. (2014), Shrivastava et al. (2014), Gupta et al. (2015) [11,12,13] it can be inferred that **the mean values are definitely more in other ethnic groups than studies done in different Indian populations. The present study is in accordance with a previous study done by** Gupta et al. (2015) [13] which concluded that **the measurements of the right sided bones are greater** (Right- 37.6 mm, Left- 36.93 mm).

B. Transverse diameter of lateral condyle

The mean transverse diameter of lateral condyle was found to be greater in left sided bones in the present study (Right- 29.69 mm, Left- 30.16 mm). Similar findings have been reported by Shrivastava et al. (2014) [10].

C. Area (in mm²) of lateral condyles

The mean values of the area covered by lateral condyle is more in right sided bones as reported by the present study and Shrivastava et al. (2014) [12] whereas Gupta et al. (2015) [13] reported greater values in left sided bones.

CONCLUSION

In the present study it can be concluded that all the parameters measured on superior surface of proximal end of tibia were greater on the left sided bones than on the right sided bones. Measurements of lateral condyle however varied. The mean A-P diameter and mean area of lateral condyle was greater in the right sided bones whereas mean transverse diameter observed to be greater in left sided bones. Anthropometric studies and present study have shown that there are striking variations in knee morphology between the Asian and Western population. The asymmetry of the medial and lateral condylar areas and the variations seen in Indian population compared to other ethnic groups should be kept in mind while designing prostheses for Total knee arthroplasty. The current challenges in knee prosthetic design are centered on attempting to produce normal kinematics, reducing wear and tear and hence achieving greater longevity. Research on implant mismatching carried out in various Asian countries has led to the conclusion that the Asian-Pacific population should have specific designs of Total Knee arthroplasty implants.

REFERENCES-

- Berger RA, Crosssett LS, Jacobs JJ, Rubash HE. Malrotation causing patellofemoral complications after total knee arthroplasty. Clin Orthop Relat Res. 1998; 356: 144-153.
- Wevers HW, Simurda M, Griffin M, Tarrel J. Improved fit by asymmetric tibial prosthesis for total knee arthroplasty. Med Eng Phys. 1994; 16 (4): 297-300.
- Darshan S Shah, Rupesh Ghyar, et al. Morphological measurements of knee joints in Indian population: Comparison to current knee prostheses. Open J Rheu and Autoimmune Diseases. 2014; 4: 75-85.
- Kwak DS, Surendran S, et al. Morphometry of the proximal tibia to design the tibial component of total knee arthroplasty for the Korean population. The Knee. 2007; 14: 295-300.
- Wernicke GC, Harris IA, et al. Comparison of tibial bone coverage of 6 knee prostheses: a magnetic resonance imaging study with controlled rotation. J Orthop Surg. 2012; 20 (2): 143- 147.
- Servien E, Saffarini M, Lustig S, Chomel S, Neyret P. Lateral versus medial tibial plateau: morphometric analysis and adaptability with current tibial component design. Knee Surg Sports Traumatol Arthrosc. 2008; 16 (12): 1141-1145.
- Omer Faruk E, Kucukdurmaz F, et al. Anthropometric measurements of tibial plateau and correlation with current tibial implants. Knee Surg Sports Traumatol Arthrosc. 2015; 23 (4): 1-8.
- Yang B, Song CH, Yu JK, et al. Intraoperative anthropometric measurements of tibial morphology: comparisons with the dimensions of current tibial implants. Knee Surg Sports Traumatol Arthrosc. 2014; 22 (12): 2924-2930.
- Moghtadaei M, Moghimi J, Farahini H, Jahansouza A. Morphology of proximal tibia in Iranian population and its correlation with available prostheses. Med J Islam Repub Iran. 2015; 29: 225.
- Hafez MA, Sheikhdress SM, Saweeres ESB. Anthropometry of Arabian arthritic knees: Comparison to other ethnic groups and implant dimensions. J Arthroplasty.

2016; 31 : 1109-1116.

- Gandhi S, Singla RK, Kullar JS, et al. Morphometric analysis of upper end of tibia. J Clin Diagn Res. 2014; 8(8): AC10- AC13.
- Shrivastava A, Yadav A, Thomas RJ, Gupta N. Morphometric study of tibial condylar area in the North Indian population. J Med Sci Clin Res. 2015; 2:515-519.
- Gupta C, Kumar J, Kalthur S, D'Souza AS. A morphometric study of the proximal end of the tibia in South Indian population with its clinical implication. Saudi J sports Med. 2015; 15: 166-169.