

MORPHOMETRIC STUDY OF UPPER END OF TIBIA IN GUJARAT REGION AND ITS CLINICAL IMPLICATION IN KNEE ARTHROPLASTY

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ABSTRACT

Introduction: Upper end of tibia is the component of knee joint. Accurate morphometric anatomical data of the upper end of tibia and morphometric differences according to gender are very important to make design of total knee joint replacement prosthesis. Knee prosthesis made based on morphometric data of components of knee (femur and tibia) and according to gender difference will give better results after surgery in early mobility of patients as well as fewer post-operative complications.

Aim: Present study was done to find out sexual dimorphism in upper end of tibia as well as differences in morphometric data of upper end of tibia between other populations across the world and within India.

Materials and Methods: For the present study the material consisted of 120 dry tibia of known gender were used. Out of them 60 were of male tibia (30 of right side and 30 of left side) and 60 were of female tibia (30 of right side and 30 of left side). We have selected five metrical parameters 1. Bicondylar width (BCW), 2. Medial condylar antero-posterior distance of superior articular surface (MCAPD), 3. Lateral condylar antero-posterior distance of superior articular surface (LCAPD), 4. Medial condylar transverse distance of superior articular surface (MCTD) and 5. Lateral condylar transverse distance of superior articular surface (LCTD) for the present study based on which the tibial component of prosthesis for knee joint replacement surgery is made.

Results: All five parameters which are chosen are found significantly larger in male than females. The findings are smaller than Caucasian population and population of North India and found larger than population of South India.

Conclusion: Present study provides data of measurement of upper end of tibia by direct observation which will be useful to select correct sized knee prosthesis according to measurements. We have also provided data gender-wise and on right and left side which will improve the longevity of knee prosthesis, increased mobility of patient and improve the lifestyle after knee replacement surgery.

KEY WORDS: Dry tibia, upper end, morphometry, knee prosthesis.

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Access this Article online	Journal Information
Quick Response code  DOI: 10.16965/ijar.2017.493	International Journal of Anatomy and Research ICV for 2016 90.30 ISSN (E) 2321-4287 ISSN (P) 2321-8967 https://www.ijmhr.org/ijar.htm DOI-Prefix: https://dx.doi.org/10.16965/ijar 
Article Information	
Received: 02 Nov 2017 Peer Review: 02 Nov 2017 Revised: None	Accepted: 01 Dec 2017 Published (O): 05 Jan 2018 Published (P): 05 Jan 2018

INTRODUCTION

Tibia is the second largest and longest bone in the body. The proximal end of the tibia is widely expanded, has two condyles – medial and lateral, and between condyles there is intercondylar

area. The condyles of tibia are articular and make joint superiorly with corresponding condyles of femur which is the femoro-tibial component of knee joint [1].

As there is high incidence of obesity and world-wide the population is rapidly increasing towards old age, the incidences of osteoarthritis are increasing as well as need of partial as well as total knee replacement (TKR). Total knee replacement is very complex and accurate method considered beneficial for removing pain and improve the lifestyle of patients in severe case of osteoarthritis [2].

So accurate morphometric anatomical data of the upper end of tibia and gender morphometric differences are very important in making the design of total knee joint replacement prosthesis. Mismatch between morphometric data and selected prosthesis for surgery may cause severe complications like cruciate ligament rupture, soft tissue misbalancing, less movements of knee joint after surgery and even prosthesis loosening [3-5]. So knee prosthesis made according to morphometric data of femur and tibia i.e. components of knee joint and according to the gender will give excellent results in early mobility of patients as well as lesser complications after surgery [6,7].

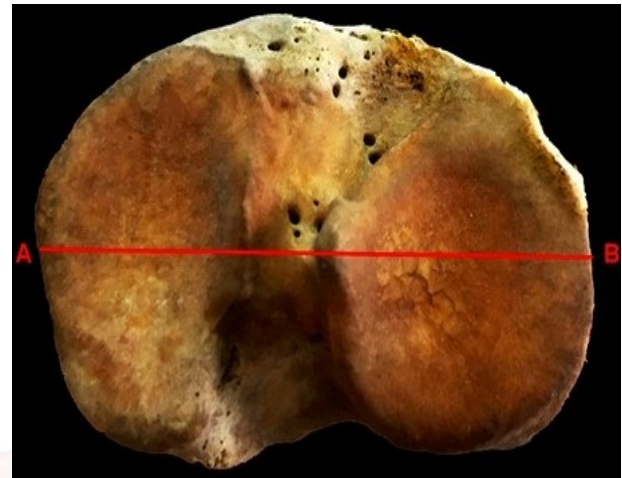
The studies which are done are based on different ethnic groups [2, 7-8]. The morphometric studies are done mostly by measurement by CT scans or magnetic resonance imaging techniques. [3,9-11]. There are very few data available in which the study is done over dry tibia by direct observation [12,13]. We have done morphometric study of upper end of dry tibia and in known gender. The results will give basic data and exact measurements of upper end of tibia gender wise and for population of India especially the eastern part before the knee replacement surgeries.

MATERIALS AND METHODS

For study the material consisted of 120 dry tibia of known gender were used. Out of them 60 were of male (30 of right side and 30 of left side) and 60 were of female (30 of right side and 30 of left side). Gender was assessed by the records available in Department of Anatomy, Government Medical College, Bhavnagar, Gujarat, India. All bones were on gross examination were fully ossified and had no evidence of fractures or congenital or pathological anomalies.

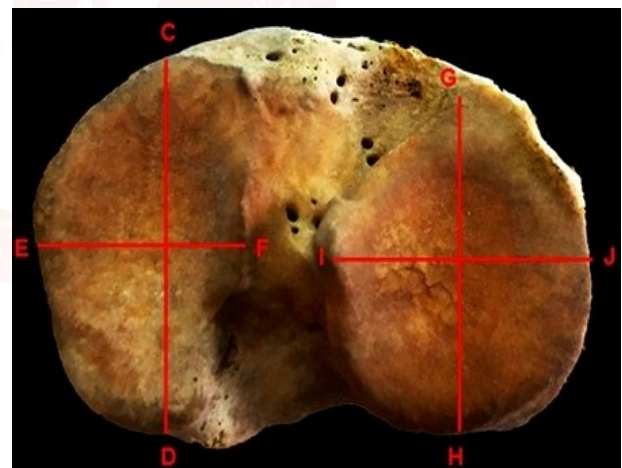
Damaged and bones with arthritic changes were not considered for the study. The collected bones were assessed with sliding caliper (Martin type, 0-200 mm).

Fig. 1: Superior view of upper end of tibia.



Distance AB = Bicondylar width (BCW) – the maximum distance across the tibial condyles in transverse plane.

Fig. 2: Superior view of upper end of tibia.



1. Distance between the CD = Medial condylar antero-posterior distance of superior articular surface (MCPAD)
2. Distance EF = Medial condylar transverse distance
3. Distance GH = Lateral condylar antero-posterior distance of superior articular surface (LCPAD)
4. Distance IJ = lateral condylar transverse distance of superior articular surface (LCTD)

The parameters which were measured are as follows:

1. Bicondylar width (BCW) – the maximum distance across tibial condyles in transverse plane (Distance AB in Figure-1)
2. Medial condylar antero-posterior distance of superior articular surface (MCPAD) - Distance CD in Figure-2.

3. Medial condylar transverse distance of superior articular surface (MCTD) - Distance EF in Figure-2

4. Lateral condylar antero-posterior distance of superior articular surface (LCAPD) - Distance GH in Figure-2

5. Lateral condylar transverse distance of superior articular surface (LCTD) - the Distance IJ in Figure-2

The above data obtained and statistically analysed.

Table 1: Measurements of upper end of the tibia in mm.

Parameters	Side	Male (Mean±SD)	Combined (Male) (Mean±SD)	Female (Mean±SD)	Combined (Female) (Mean±SD)	p-Value*
BCW (AB in figure-1)	Right	74.44±2.16	74.50±2.40	67.48±2.13	67.06±2.41	<0.05
	Left	74.57±2.64		66.65±2.69		
MCAPD (CD in figure-2)	Right	44.27±1.93	44.43±2.06	39.53±1.97	39.71±2.03	<0.001
	Left	44.57±2.18		39.87±2.10		
MCTD (EF in figure-2)	Right	28.31±1.66	28.32±3.88	26.47±1.33	26.19±1.43	<0.01
	Left	28.32±1.35		25.91±1.52		
LCAPD (GH in figure-2)	Right	38.26±2.43	38.38±2.39	35.36±2.27	35.50±2.37	<0.001
	Left	38.51±2.35		35.64±2.46		
LCTD (IJ in figure-2)	Right	27.13±1.86	27.26±1.92	25.86±1.32	28.87±1.37	<0.01
	Left	27.38±1.97		25.91±1.42		

* The p-values are calculated for comparison across genders

Table 2: Comparison of studies of various authors on morphometric study of upper end of tibia (data in Mean±SD in mm).

S. No.	Author, year and method of study	Country and region	BCW	MCAPD	LCAPD	MCTD	LCTD
1	Moghtadaei M et al [2], 2014, CT scan	Iranian males (n=96)	78.00±3.81	51.00±2.77		-	-
		Iranian females (n=54)	68.50±3.83	44.20±3.51		-	-
2	Li P et al [10], 2014, CT scan and MRI	Chinese males (n=61)	77.40±3.30	49.60±2.40		-	-
		Chinese females (n=87)	69.10±2.80	44.20±2.30		-	-
		Caucasian males (n=79)	79.40±4.30	49.50±2.90		-	-
		Caucasian females (n=48)	70.20±2.70	45.20±2.30		-	-
3	Loures FB et al [11], 2016 Intraoperative	Brazilian males (n=33)	79.80±5.80	53.90±6.10		-	-
		Brazilian females (n=85)	69.60±4.30	46.00±4.00		-	-
4	Gandhi S et al [12], 2014, dry tibia	India (North Indian) Males (n=50)	-	48.09±4.26	40.76±4.05	29.78±2.99	28.72±3.11
		India (North Indian) Females (n=50)	-	42.38±4.43	37.04±4.42	27.11±2.62	26.07±2.79
5	Murlimanju BV et al [13], 2016, dry tibia	India (South Indian) Right side (n=33)	-	40.60±3.90	34.80±3.90	26.90±2.90	26.50±3.40
		India (South Indian) Left Side (n=40)	-	39.20±3.60	32.60±3.40	26.60±2.70	25.70±2.50
6	Present study	India (Gujarat) males (n=60)	74.50±2.40	44.43±2.06	38.38±2.39	28.32±3.88	27.26±1.92
		India (Gujarat) females (n=60)	67.06±2.41	39.71±2.03	35.50±2.37	26.19±1.43	28.87±1.37

RESULTS

The morphometric measurements of the lower end of the femur are summarized in Table 1.

According to Table 1 the mean bicondylar width (BCW) of tibia in males of Gujarat region was 74.50 ± 2.40 mm (74.44 ± 2.16 mm on right side and 74.57 ± 2.64 mm on left side) while in females it was 67.06 ± 2.41 mm (67.48 ± 2.13 mm on right side and 66.65 ± 2.69 mm on left side) [$p < 0.05$]. The medial condylar anteroposterior distance of superior articular surface (MCAPD) in males was 44.43 ± 2.06 mm (44.27 ± 1.93 mm on right side and 44.57 ± 2.18 mm on left side) while in females it was 39.71 ± 2.03 mm (39.53 ± 1.97 mm on right side and 39.87 ± 2.10 mm on left side) [$p < 0.001$]. The medial condylar transverse distance of superior articular surface (MCTD) in males was 28.32 ± 3.88 mm (28.31 ± 1.66 mm on right side and 28.32 ± 1.35 mm on left side) while in females it was 26.19 ± 1.43 mm (26.47 ± 1.33 mm on right side and 27.91 ± 1.52 mm on left side) [$p < 0.01$]. The lateral condylar anteroposterior distance of superior articular surface (LCAPD) in males was 38.38 ± 2.39 mm (38.26 ± 2.43 mm on right side and 38.51 ± 2.35 mm on left side) while in females it was 35.50 ± 2.37 mm (35.36 ± 2.27 mm on right side and 35.64 ± 2.46 mm on left side) [$p < 0.001$]. The lateral condylar transverse distance of superior articular surface (LCTD) in males was 27.26 ± 1.92 mm (27.13 ± 1.86 mm on right side and 27.38 ± 1.97 mm on left side) while in females it was 28.87 ± 1.37 mm (25.86 ± 1.32 mm on right side and 25.91 ± 1.42 mm on left side) [$p < 0.01$].

DISCUSSION

In this study we have selected five morphometric parameters of upper end of dry tibia and data collected by using the sliding caliper by direct observation. Most of the morphometric studies are done with measurement by radiographs, CT scans or magnetic resonance imaging techniques which are indirect methods [2, 7-11].

There are certain studies which are done in past suggest that indirect method of measurement like CT scan and MRI are found inaccurate and not precise even though correction done by the projection methods as well as by the resolutions [14,15]. So obviously direct method of measure-

ments are certainly beneficial over the indirect methods like CT scan and MRI and direct method will give the accurate morphometric data. Because the direct method of measurement is accurate we can match these morphometric data to make knee prosthesis for knee joint replacement surgery with the resected surface of the knee that will improve long term success of prosthesis and lesser complications in and after total knee joint replacement.

There are several studies done which are based on western population and also the prosthesis available in market is based on western Caucasian population [2,13] although the Indian population have smaller knees as compared to them. This study will provide data of upper end of tibia for Indian population and will influence in the clinical outcome to design improved knee prosthesis based on our Indian knee measurements.

There is significant difference in morphometric data of the upper end of tibia in various populations of countries across world as well as populations within India. (Table 2) The bicondylar width of tibia in male was 74.53 ± 2.34 mm and in female was 67.06 ± 2.41 mm which was significantly greater in male than females ($p < 0.05$). The measurements are very high in Iranian, Caucasian, Chinese and Brazilian populations in male as well as females [2,10-12].

The medial condylar anteroposterior distance of superior articular surface (MCAPD) in males was 44.43 ± 2.06 mm while in females it was 39.71 ± 2.03 mm which was significantly higher in male than female ($p < 0.001$). The lateral condylar anteroposterior distance of superior articular surface (LCAPD) in males was 38.38 ± 2.39 mm while in females it was 35.50 ± 2.37 mm which was significantly higher in male than female ($p < 0.001$). These measurements were lower than Iranian [2], Chinese [4], Caucasian [4], Brazilian [11] and North Indian [12] populations but higher than South Indian population [13].

The medial condylar transverse distance of superior articular surface (MCTD) in males was 28.32 ± 3.88 mm while in females it was 26.19 ± 1.43 mm which was significantly higher in male than female ($p < 0.01$). The lateral condylar transverse distance of superior articular

surface (LCTD) in males was 27.26 ± 1.92 mm while in females it was 28.87 ± 1.37 mm which was significantly higher in male than female ($p < 0.01$). These measurements were again lower than Iranian [2], Chinese [4], Caucasian [4], Brazilian [11] and North Indian [12] populations but higher than South Indian population [13].

CONCLUSION

Present study provides morphometric data of upper end of tibia by direct observation which will be useful to select correct prosthesis of suitable size according to measurements. We have also provided data gender-wise and on right and left sides which will improve the longevity of prosthesis, will increase mobility of patients and improve lifestyle of patient after knee replacement surgery. Females will surely benefit from newly designed prosthesis which is gender specific.

Conflicts of Interests: None

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How to cite this article:

Ankur Z Zalawadia, Shailesh M Patel. MORPHOMETRIC STUDY OF UPPER END OF TIBIA IN GUJARAT REGION AND ITS CLINICAL IMPLICATION IN KNEE ARTHROPLASTY. Int J Anat Res 2018;6(1.1):4871-4875. DOI: 10.16965/ijar.2017.493