

COMPUTERISED TOMOGRAPHIC STUDY OF HIP AND KNEE DIMENSIONS IN INDIAN FEMALES WITH ARTHROPLASTY PERSPECTIVEVinoth Kumar T. K¹, Suraj J²**HOW TO CITE THIS ARTICLE:**

Vinoth Kumar T. K, Suraj J. "Computerised Tomographic Study of Hip and Knee Dimensions in Indian Females with Arthroplasty Perspective". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 49, October 02; Page: 11755-11761, DOI: 10.14260/jemds/2014/3544

ABSTRACT: INTRODUCTION: Hip and knee replacement surgeries have become one of the most commonly performed surgeries in India. Most of the arthroplasty implants are designed and manufactured based on western dimensions, which are not suited for some of the Indian females. In this study we measured the various dimensions of hip and knee using computerised tomography in 30 Indian females. **MATERIALS AND METHODS:** We measured 8 parameters in the hip and 5 parameters in the knee with CT Scan in 30 females (30 hips, 30 knees) while maintaining a specified and fixed configuration while taking CT cuts. The parameters measured in the hip are Cup size, Cup version, Cup inclination, Head size, Neck shaft angle, Version of neck, Offset and diameter at the level of isthmus. The parameters measured in the knee are patellar thickness, Anteroposterior diameter of distal femur, Mediolateral diameter of distal femur, Anteroposterior diameter of proximal tibia, Mediolateral diameter of Proximal Tibia. **RESULTS:** We calculated the mean, median, range, standard error of the mean and subjected the values to KS test and P value test. The observations in different subjects are listed in the Tables. **DISCUSSION:** The measurements from these study are compared with the sizes of the smallest implant dimensions and recommendations for the implant sizing has been given.

KEYWORDS: Anthropometry, Indian females, Arthroplasty, oversized implants.

INTRODUCTION: Total hip and knee arthroplasties have become the standard of treatment in management of advanced degenerative joint pathology. Traditionally implants for total hip and knee replacements are made based on anthropometric measurements of western population which are not suitable for Indian females.¹

We, working in a major multispecialty hospital in a major city of India perform approximately 20 arthroplasty surgeries per week and half of these patients are females, we found the current implants available are not suitable for some patients. The purpose of this study is to determine the normal anatomic variations of normal hip and knee joint in Indian females using computerized Tomography and to statistically compare it with available implants. The implant manufacturers would be in a better position to manufacture implants suitable for Indian female population based on these data.

Since Indian females are more apt to floor level activities they tend to externally rotate their hips and extreme flexion of knees and use them in extreme range of motion⁵. No comprehensive study has been reported on the normal values of hip and knee anthropometry in Indian Females which comprises 1/12th of world population. The precise measurement of hip and knee anthropometry has always been difficult, with lots of shortcomings and lack of reproducibility.

Measurement of anthropometry dry bone is considered to be the most accurate method. But the greatest drawback is the involvement of femoral skeleton of pathological conditions cannot be ruled

out and then they may affect the statistical analysis.³ It may not be relevant for clinical practice since clinical measurement may be different from those measured in dry femur.

MATERIALS AND METHODS: We evaluated 30 Indian females with radiologically normal hip and knee aged between 30 to 90 years, height ranging from 4 feet 6 inches to 6 feet, weight ranging from 45 to 70 KG, who have consented for the study. The individuals of different ethnic background who are admitted in our hospital for unrelated orthopedic problem were included in the study.

Even the radiology exposure in CT scan is well within the normal limits, to limit the exposure to radiation to foetus during early pregnancy and to reduce the cost of study in doing pregnancy tests in females undergoing CT scan; we limited our study to females who have attained the menopause and those who have undergone hysterectomy.

After taking a history, the subjects were evaluated clinically and radiologically to rule out any hip or knee pathology. The height and weight of each individual was measured.

We measured 8 parameters in the hip and 5 parameters in the knee with CT scan in 30 females (30 hips, 30 knees) while maintaining a specified and fixed configuration while taking CT cuts. The CT scan was done in supine position with hips and knees extended and lower limbs secured to tables with straps. The limbs were kept in identical position and were parallel to CT machine. The parameters measured in the hip are Cup size, Cup version, Cup inclination, Head size, Neck shaft angle, Version of neck, Offset and diameter at the level of isthmus.

1. **Cup Size:** The acetabular cup size was measured in CT coronal cuts. The distance between the superior lip and inferior lip of acetabulum was measured and corrected with CT measurement scales.
2. **Cup Version:** Acetabular anteversion was measured on axial cuts that pass through the center of the hip joint by computed tomography that corresponds to the anatomical anteversion described by Murray.⁴
3. **Cup Inclination:** The acetabular cup inclination was measured in coronal cuts of the hip. The angle formed by the horizontal line drawn at the level of radiological tear drop and the line joining the superior and inferior lip of acetabulum is measured.
4. **Head Size:** On coronal CT cuts the diameter of the femoral head is measured and adjusted to normal scales based on the CT scales.
5. **Neck Shaft Angle:** In CT coronal cuts the angle formed between the line drawn through the long axis of femoral shaft and the line drawn through the center of the neck and head of the femur is measured.
6. **Version of Neck:** The patient was examined in the supine position and strapped to the table to immobilise the lower limbs while the proximal and distal cuts are being done. The centre of the neck was then marked at its proximal and distal ends. By joining these two points, we obtained the central axis of the neck. The condylar axis was drawn by joining the two most posterior aspects of the femoral condyles. The angle between the axis of the neck and the condylar axis was measured and it represented the degree of version.
7. **Offset:** In coronal cuts the distance between the centre of the head and the tip of greater trochanter is measured and adjusted to normal scales based on the CT scales.
8. **Diameter of the Isthmus:** In axial cuts at the level of the isthmus the inner diameter of the femur is measured and adjusted to normal scales based on CT scales.

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The parameters measured in the knee are patellar thickness, Anteroposterior diameter of distal femur, Mediolateral diameter of distal femur, Anteroposterior diameter of proximal tibia, Mediolateral diameter of Proximal Tibia:

1. **Patellar Thickness:** On sagittal section of the knee joint the thickness of the patella is measured and adjusted to normal scales using CT scales.
2. **Anteroposterior Diameter of Distal Femur:** On sagittal section at the centre of the knee joint the distance between the anterior and posterior margin of the femur is measured and adjusted to normal scales based on CT scales.
3. **Mediolateral diameter of Distal Femur:** On coronal section of the knee joint the diameter of the distal femur is measured and adjusted to normal scales using CT scales.
4. **Anteroposterior Diameter of Proximal Tibia:** On sagittal section at the centre of knee joint the distance between the anterior and posterior cortex is measured and adjusted to normal scales using CT scales.
5. **Mediolateral Diameter of Proximal Tibia:** On coronal cuts at the level of knee joint the diameter of the proximal tibia is measured and adjusted to normal scales using CT scales.

The values were tabulated for each patient and the arithmetic mean of each of the parameter measured is calculated and their standard deviations were determined.

RESULTS: We calculated the mean, median, range, standard error of the mean and subjected the values to KS test and P value test. The observations in different subjects are listed in Table 1, the mean; median and the range of the individual values are listed in Table 2. The Mean, Standard Deviation, Sample size, Standard error of the mean, Lower 95% confidence limit, Upper 95% confidence limit, Minimum value, Median(50th percentile), Maximum value, Normality test KS, Normality Test P value, Passed Normality test or not Have been mentioned in Table 3.

The results of study are given below:

No.	Variables	Mean	Median	Range
1	Cup size(cm)	5.14	5.2	4.1 to 6.2
2	Cup Version(Degrees)	23.8	24	19 to 29
3	Cup inclination(Degrees)	42.7	42	29 to 58
4	Head size(cm)	4.05	4.05	3.1 to 4.9
5	Neck shaft angle(Degrees)	126	126.5	119 to 137
6	Version of neck(Degrees)	21.5	21.5	2 to 38
7	Offset(cm)	4.49	4.5	2.7 to 6
8	Diameter of isthumus (cm)	1.15	1.1	0.8 to 1.8
9	Patellar thickness(cm)	1.87	1.93	1.4 to 2.2
10	A-P Diameter of distal femur(cm)	5.01	5.05	3.2 to 6.9
11	M-L Diameter of distal femur(cm)	6.44	6.4	5.1 to 7.9
12	A-P Diameter of proximal tibia(cm)	4.63	4.4	3.2 to 6.9
13	M-L Diameter of proximal tibia(cm)	6.45	6.45	5.1 to 7.8

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The statistical analysis of the data is done using standard protocol for this descriptive data and given below.

In the following two tables the column stands for:

A=Mean, B=Standard deviation, C=Sample size, D=Standard error of mean, E=Lower 95% confidence limit, F=upper 95% confidence limit, G=Minimum, H=Median (50th percentile), I= Maximum, J= Normality test KS, K=Normality test P value, L= Passed Normality test?

For hip:

Column Title	Cup size	Cup version	Cup inclinatin	Head Size	Neck shaft angle	Neck version	Offset	Diameter of isthmus
A	5.08	23.8	42.7	4.05	126.9	21.5	4.49	1.15
B	0.5563	2.413	6.385	0.42	4.86	7.389	0.720	0.2583
C	30	30	30	30	30	30	30	30
D	0.1316	0.4405	1.166	0.076	0.887	1.349	0.131	0.04716
E	4.221	22.899	40.316	3.896	125.1	18.741	4.221	1.054
F	4.759	24.701	45.084	4.21	128.8	24.259	4.759	1.246
G	2.7	19	29	3.1	119	2	2.7	0.8
H	4.6	24	42.5	4.1	127.5	22	4.6	1.1
I	6.2	29	58	4.9	137	38	6	1.8
J	0.1762	0.1664	0.1284	0.122	0.100	0.1676	0.150	0.1566
K	0.0182	0.0335	>0.10	>0.1	>0.10	0.0312	0.081	0.0585
L	No	No	Yes	Yes	Yes	No	Yes	Yes

For knee:

Column Title	Patellar thickness	AP diameter distal femur	ML diameter distal femur	AP diameter proximal tibia	ML diameter proximal tibia
A	1.87	5.01333	4.63667	4.63667	6.45
B	0.822	0.814	0.6911	0.8298	0.5692
C	30	30	30	30	30
D	0.03327	0.1486	0.1262	0.1515	0.1039
E	1.802	4.709	6.179	4.327	6.237
F	1.938	5.317	6.695	4.946	6.663
G	1.4	3.2	5.1	3.2	5.1
H	1.9	5.1	6.4	4.45	6.55
I	2.2	6.9	7.9	6.9	7.8
J	0.1504	0.07797	0.08782	0.151	0.1039
K	0.0812	>0.10	>0.10	0.0791	>0.10
L	Yes	Yes	Yes	Yes	Yes

DISCUSSION: The basic drawback of this study is small sample size. To further validate the study a larger study sample would be required. Based on which the implant manufacturers would be able to produce a better sized implants for the Indian female patients, for whom the currently available implants may be oversized.

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A long term study would also be required on Indian female population who had undergone total hip total knee arthroplasties with the currently available implants to find out the function and longevity of the implants used to suggest such manufacture of smaller sized implants are really necessary to improve the outcome of the arthroplasty surgeries.

The measurements of the smallest available total hip and total knee arthroplasty implants are given below:

Variables	Cemented Hip arthroplasty	Uncemented hip arthroplasty
Cup size	40mm	40mm
Offset	33mm	30mm
Tip diameter	8mm	7.5mm
Neck shaft angle	132 degrees	132degrees
Neck anteversion	10-15degrees	10-15degrees
Total hip arthroplasty		

	Cemented	Uncemented
Stem Diameter	10.5mm	13mm
Revision Total hip arthroplasty		

Variables	Measurements
Patellar thickness	8mm
Anteroposterior diameter of the femoral component	53mm
Mediolateral diameter of the femoral component	57mm
Anteroposterior diameter of the tibial component	41mm
Mediolateral diameter of the distal component.	8mm
Total knee arthroplasty	

As per the statistical analysis of our study we recommend the following dimensions for the smallest implants for the implant manufacturers which will suit the Indian female population

Cup size	37mm
Offset	27mm
Stem Diameter(Revision prosthesis)	6mm(cemented), 8mm(Uncemented)
Neck shaft angle	119 to 137 degrees
Anteversion	2 to 38 degrees
Total hip arthroplasty	

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Anteroposterior diameter of the femoral component	32mm
Mediolateral diameter of the femoral component	51mm
Anteroposterior diameter of the tibial component	32mm
Mediolateral diameter of the tibial component	51mm
Patellar thickness	2mm(Highly cross linked polyethylene)
Total knee arthroplasty	

Apart from implant sizes, the surgical techniques while performing a total hip arthroplasty has to be relooked in context to Indian female population. As the traditional teaching the optimal inclination for the acetabular cup is 45 degrees and the optimal degree of acetabular anteversion is 20 degrees. As the femoral broaching is done along the axis of the neck there should not be any technical error in femoral anteversion except in cases in which the femoral neck is lost such as pathological lesions of the neck and post traumatic patients.

As per our study the mean anteversion of the acetabular cup is 23.8+/- 4.8, assuming this to be the representative of whole Indian female population, arthroplasties done with the acetabular anteversion of 20 degrees, nearly 50% of the patients would have anteversion which is about 5 degrees more than the original anteversion.

As of the cup inclination was 42.7+/-12.6 in our study. Providing a cup inclination of 45 degrees cup inclination to all the patients about 50% of the patients would have the cup inclination more than the original inclination. As previously stated large scale studies are required to estimate the cup inclination and the version of the Indian female population and long term studies to validate the effects of these scales of variations on the outcome of the study is require to recommend these changes in the surgical techniques.

We would like to recommend that the cup version and inclination has to be individualized in each patient Computerized tomography measurements may be done, especially to accurately measure the acetabular version to plan the surgery accordingly. But the cost effectiveness of such recommendation needs further evaluation.

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