Research Article

Morphometric Analysis of Lower End of Human Adult Dry Femur in the Zone of Eastern Odisha – An Observational Study

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ABSTRACT

The human knee is the largest compound and complex joint in the body involving distal end of femur along with the proximal end of tibia and patella. Accurate morphometric anatomical data of the lower end of femur plays an important role in designing prosthesis material for total knee joint replacement. The aim of our study is to do a morphometric analysis of human adult dry femur bones taking their lower ends into study which would assist orthopedicians in designing appropriate knee prosthesis to ensure early mobility with fewer complications after total knee joint surgery. The present study was a cross-sectional observational study, conducted on 111 human adult dry femur bones obtained from the Department of Anatomy S.C.B. Medical college & Hospital, Cuttack and IMS & SUM Hospital, Bhubaneswar, Odisha, India. We selected six parameters related to the lower end of Femur i.e. 1. Bicondylar width (BCW), 2. Medial condylar anteroposterior distance (MCAPD), 3. Lateral condylar antero-posterior distance (LCAPD), 4. Medial condylar transverse distance (MCTD), 5. Lateral condylar transverse distance (LCTD) and 6. Intercondylar notch width (ICW), for our study, based on which the prosthesis for knee joint replacement surgery is made. All measurements from the right and left femur were recorded separately and the data were entered in Microsoft Excel sheet for statistical analysis where p-value < 0.05 was considered statistically significant. The average bicondylar width for the right and left sides were 69.31 mm and 70.00 mm. The average medial condylar antero-posterior distance for the right and left sides were 53.70 mm and 54.68 mm. Inter-condylar notch width for the right and left sides were 19.98 and 19.82 mm respectively. In this study, there were no statistically significant differences between the parameters of right and left femur bones. Our study provides morphometric data of measurement of femoral condyles by direct observation method, which may be useful to select accurate knee replacement prosthesis as per measurements, and minimize the post- operative complications after implants. The data will also help orthopedicians to plan placement of intramedullary nails, plates, screws and pins when required.

Keywords: Femur, Condyles, Inter-condylar notch, knee-joint, Knee Prosthesis.

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INTRODUCTION

The thigh bone femur is the largest, longest and strongest bone of the human body providing attachment to powerful muscles for locomotion and maintenance of erect posture. Distal end of femur presents medial and lateral condyles separated by intercondylar notch.[1] The expanded condyles of femur articulate inferiorly with the corresponding condyles of tibia and anteriorly with patella to form the complex and compound variety of modified hinge joint known as knee joint providing stability during locomotion and in long standing erect posture.[2] As regards its structure, position and function, the knee joint is very much vulnerable to traumatic and degenerative diseases especially in elderly persons. Often total knee replacement arthroplasty becomes necessary for individuals suffering from osteoarthritis for pain alleviation and better mobility. Anatomical knowledge of distal end of femur is very important for orthopedicians, as knee replacement surgery needs the implant to be placed accurately as far as possible.[3]

Non-invasive methods like radiography, MRI, CT scanning have been used for measurement of morphometric data of lower end of femur and upper end of tibia for making prosthesis required for total knee arthroplasty which are relatively indirect methods with higher inaccurate data.[4,5,6] Discrepancy between the size of femoral condyles and the prosthesis may result in non-fitting of implant with impaired mobility.[7,8] So it is necessary to design exact size of prosthetic femoral condyles for total knee arthroplasty which can be done by direct measurement of morphometric data in respect of lower end of femur. The intention of our study is to analyse the various parameters of morphometric data of lower end of femur in the Eastern zone population of Odisha by taking samples of dry femur specimens to help the radiologists and orthopedicians considering knee replacement as the treatment of choice.

MATERIALS AND METHODS

The study materials consisted of 111 dry specimens of adult femur bones present in Anatomy departments of S.C.B. Medical College & Hospital, Cuttack and IMS & SUM Hospital, Bhubaneswar, Odisha. The study was an observational and descriptive type based on various anatomical parameters of lower end of femur. Total 111 femurs present were the combinations of 56 right sided and 55 left sided bones. Unossified or broken femurs and femurs with fractures, tumours or any other pathological deformities were excluded from our study. With the help of a Sliding calliper the following six parameters were measured and recorded [Fig. 1-4].

Figure 1: Measurement of BCW

Figure 2: Measurement of ICNW

Figure 3: Measurement of LCAPD

Figure 4: Measurement of LCTD

1. Bicondylar width (BCW) - The maximum distance between medial and lateral condyles in transverse plane.

2. Medial condylar antero-posterior distance (MCAPD) - The maximum anterior to posterior distance of medial femoral condyle.

3. Lateral condylar antero-posterior distance (LCAPD) -The maximum anterior to posterior distance of lateral femoral condyle.

4. Medial condylar Transverse distance (MCTD) - The maximum medial to lateral surface distance of medial femoral condyle.

5. Lateral condylar Transverse distance (LCTD) - The maximum medial to lateral surface distance of lateral femoral condyle.

6. Intercondylar notch width (ICW) - the maximum distance of posterior aspect of medial and lateral surface of Intercondylar notch.

Statistical analysis was done after entering all the recorded data for right and left sided examined femurs separately in the Microsoft Excel sheet. Mean and Standard Deviation (SD) were derived with the help of SPSS software. Differences in the parameters in the left and right sided femurs were found out by doing independent t-test. When the p-value was calculated to be < 0.05, it was considered as statistically significant.

RESULTS AND DISCUSSION

Total 111 dry femur bones taken into the study consisted of 56 right sided bones and 55 left side bones. Mean Bicondylar width calculated for right side was 69.31mm and for left side was 70.00 mm with a SD of 6.72 and 6.23 respectively having a p-value of 0.5762. Average Medial condylar antero-posterior distance was found to be 53.70 mm for the right side and 54.68 mm for left sides with a SD of 4.91 and 4.65 respectively having a P-value of 0.2804. Mean Lateral condylar antero-posterior distance was observed to be 54.80 mm for the right side and 55.84 mm for left sides with a SD of 5.00 and 4.16 respectively having the P-value 0.2374. Mean Medial condylar transverse distance for the right and left sides were computed to be

22.20 mm and 23.57 mm respectively, with respective SD of 2.25 and 4.80 having a p-value of 0.0620. Mean Lateral condylar transverse distance for the right and left sides were found to be 21.56 mm and 22.16 mm respectively, with respective SD of 2.35 and 2.56 having a P-value of 0.2022. Average Inter condylar notch width for the right and left sides were 19.98 and 19.82 mm respectively, with respective SD of 3.24 and 3.14 having a P-value of 0.7966.

Morphometric parameters of right and left femurs did not show any statically significant difference between each other.

The remaining details of the morphometric data from distal end of femur are presented in Table-1.

Table 1: Shows Mean, SD & p-values for various parameters of the examined femoral condyles

Parameter	Right			Left			P- value
	Range (mm)	Mean	SD	Range (mm)	Mean	SD	
BCW	51.3–82.4	69.31	6.72	56.8-81.5	70.00	6.23	0.5762
MCAPD	43.7–65.3	53.70	4.91	46.1-64.1	54.68	4.65	0.2804
LCAPD	42.2–67.2	54.80	5.00	48.0-69.3	55.84	4.16	0.2374
MCTD	18.5–27.9	22.20	2.25	18.0-52.8	23.57	4.80	0.0620
LCTD	17.3-27.8	21.56	2.35	17.3-29.7	22.16	2.56	0.2022
ICNW	9.8-25.6	19.98	3.24	12.7-26.6	19.82	3.14	0.7966

Table 2: Comparison of various parameters of femoral condyles of our study with that of other studies (measured data are expressed in mm)

Author, Year, Region and method of study	BCW		MCAPD		LCAPD		MCTD		LCTD		ICNW	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Ravichandran et al., (6). 2010, Tamil Nadu. Dry femur	74.58 ± 0.57	73.97± 0.61									18.89± 0.29	18.65 ± 0.27
Terzidis et al., (13). 2012, Greek, Dry Femur	MALE											
	88.6±0.42		61.1±034		61.1±033						22.0±0.18	
	FEMALE											
	78.5±0.30		55.9±0.29		55.4±0.21						18.7±0.10	
Ameet et al., (8). 2014, Nepal. Dry femur	72.5± 5.3	73.3± 5.3									18.0± 3.0	17.9± 2.5
Mistri et al., (12). 2015, West Bengal, Dry femur	74.43 ± 6.10	73.98± 5.99									19.12± 2.5	18.65 ± 2.8
Magetsari et al., (17), 2015. Indonesia, CT Scan	MALE											
	70.56 ± 5.17		44.2± 4.91		43.30 ± 6.75							
	FEMALE											
	61.40±4.01		40.85±5.73		40.95±5.17							
Moghtadaei et al., (10), 2016, Iran, CT Scan	MALE											
					63.35±3.1		24.62±1.9		24.42±2.0		21.76±3.0	
	FEMALE											
					56.53±2.98		21.33±0.2		21.37±1.6		17.37±2.5	
Neelima et al., (11). 2016, Andhra			57.83±0.69		58.0±0.51		21.33±0.43		21.08±0.44		22.83±0.41	

Pradesh, Dry femur												
Shweta et al., (5). 2017, Delhi Dry Femur	73.1± 6.14	72.16± 6.58									20.82± 2.57	21.0± 3.13
Biswas et al., (7) l. 2017, West Bengal, Dry femur	71.71 ± 4.50	70.71± 5.25	52.97 ± 3.77	54.74 ± 3.85	56.20 ± 3.36	56.05 ± 4.29	25.48 ± 2.05	27.28 ± 2.29	27.80 ± 2.91	28.03± 2.56	20.86± 2.52	19.45 ± 2.57
Zalawadia et al., (3), 2017, Gujarat, Dry femur	MALE											
	74.48 ± 1.90	74.59± 2.75	57.21 ± 2.53	57.77 ± 2.15	58.36 ± 3.03	59.68 ± 2.16	30.31 ± 1.66	31.32 ± 1.35	31.32 ± 1.72	31.99± 1.15	20.31± 2.94	20.91 ± 1.32
	FEMALE											
	67.42 ± 1.93	66.7± 2.59	53.44 ± 1.82	54.37 ± 2.20	54.98 ± 1.89	54.66 ± 2.87	27.47 ± 1.33	27.91 ± 1.52	28.76 ± 1.47	28.96± 1.33	19.42± 2.32	19.27 ± 2.74
Chavda et al., 2019 (14), Gujarat, Dry femur	69.6± 5.04	69.8± 4.96	52.9± 4.99	53.5± 4.15	54.7± 4.01	55.0± 4.31	26.7± 2.03	26.9± 2.23	30.3± 3.05	29.6 ± 2.03	20.4± 3.17	18.7± 2.52
Mahalakshmi Rajan et al. 2020(2), Chennai, Dry femur	72.82 ± 3.89	71.62± 5.67	56.6± 4.19	57.14 ± 4.82	58.52 ± 3.44	56.92 ± 4.41	22.64 ± 3.96	23.12 ± 2.17	22.86 ± 3.12	23.12± 2.34	21.66± 2.69	21.5± 4.64
Present study	69.31± 6.72	70.00± 6.23	53.70± 4.91	54.68± 4.65	54.80± 5.00	55.84± 4.16	22.20± 2.25	23.57± 4.80	21.56± 2.35	22.16± 2.56	19.98± 3.24	19.82± 3.14

The knee joint in human body is the largest and complex joint liable for injury by multiple factors.[9] As knee joint arthroplasty has become popular in the treatment of degenerative diseases of the joint, perfect knowledge of morphometric data of lower end of femur is very essential for designing a matching prosthesis which plays the pivot role in the desired success.[10] In this study morphometric data were measured by Vernier calliper directly and the data were summarized in table-1. Various parameters about lower end of femur were put for comparison with other studies in Table-2.

In our study the mean bicondylar width of all specimens was found to be 69.65± 6.47 mm which was 69.31 ± 6.72 mm on right side and 70.0 ± 6.23 mm on left side. Similar results were found in Gujrati population studied by Chavda et al.[11] where mean bicondylar width was 69.6± 5.04 on right side and 69.8± 4.96 on left side. The results of the observations conducted by Mistri et al.[10], Ravichandran et al.[12] and Shweta et al.[13] were found to be little higher than our study. Similar studies done abroad by Terzidis et al.[3] showed higher values than our study. In this study statistically significant difference between right and left sides for bicondylar width was not observed.

The mean medial condylar antero-posterior distance of the present study is 54.19±4.78mm. Zalawadia et al.[14] also observed similar results in female specimens of their study while higher values were observed by them with male population. Biswas et al. observed lower values.[15] Magetsari et al. also observed lower values than the present study in their CT scan study.[16]

The mean lateral condylar antero-posterior distance of the present study was 55.32±4.58 mm. Terzidis et al.[3] observed similar values in females and higher values in males. Mahalakshmi Rajan et al.[17] noted higher values and Chavda et al.[11] had lower values than the present study. CT scan values of Magetsari et al.[16] had lower values and those of Moghtadaei et al.[18] had higher values than the present study.

Statistically significant difference was not observed in both MCAPD and LCAPD in our study.

In this study, the mean medial condylar transverse distance was 22.88±3.52 mm. Similar values were seen in Mahalakshmi Rajan et al.[17] and higher values were observed in the study by Zalawadia et al.[14] on Gujarati population. CT scan values by Moghtadaei et al.[18] were slightly higher than this study.

The mean Lateral condylar transverse distance observed in our study was 22.86±2.45 mm. Mahalakshmi Rajan et al.[17] observed same values while higher values were observed by Chavda et al.[11] and Zalawadia et al.[14] There were no statistical significant differences between the mean values of transverse distances of medial and lateral condyles.

The average Intercondylar width in our study was 19.9±3.19 mm. Similar values were found by Zalawadia et al.[14] and Biswas et al.[15] Moghtadaei et al.[18] studied CT scan in Iranian population who showed higher values than our study. Lower values were reported by Ameet et al.[19]

The differences found in the measurements amongst different studies from different regions could be attributed

to influence of heredity, race, environment, lifestyle and effects of civilization, which may in turn alter the build, stature and bony dimensions of individuals.

Limitations of the study

Our study was conducted on 111 dry Femur bones which involved a small sample size. Also, it was very difficult to segregate the bones basing on their gender, as sex of the bones were not known. Moreover, the right and left femur bones studied did not belong to the same individual.

CONCLUSION

This anatomical study about the morphometric data of femoral condyles by direct method from adult population of Eastern Odisha may add to similar other studies which may help clinicians and orthopaedicians of the region to plan for total knee replacement which is considered as the gold standard treatment for management of patients with osteoarthritis of the knee joint. This would be beneficial in selecting accurate prosthesis, minimizing the mismatch and reducing the post-operative complications after total knee replacement surgery and in turn making the operation a successful one.

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