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CASE STUDY

MORPHOMETRIC ANALYSIS OF FEMORAL CONDYLES FOR GENDER AND SIDE-TO-SIDE DIFFERENCES IN 200 SOUTH INDIAN FEMORI

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ABSTRACT

Background and Aim: The alarming rise in the incidence of osteoarthritis has consequently increased the number of patients opting for total knee arthroplasty (TKA). Mismatch of the TKA components, namely femoral, tibial and popliteal, remains a major problem for postoperative success and patient acceptability. Numerous studies have indicated significant ethnic variations in the anatomy of the femoral component. Data on the Indian population remains sparse. This study aims to quantify the gender and side to side variations of South Indian femoral condyles.

Materials and Methods: Two hundred dried south Indian femori with no gross deformities were classified based on gender and side. The femoral condyles of each bone were measured using digital vernier calipers along the following parameters: Bicondylar Width (Epicondylar Breadth), Intercondylar Width, Medial Condylar Depth, Lateral Condylar Depth and Intercondylar Depth. Statistical analysis was performed using IBM Statistical Package for the Social Sciences 16 with p-value less than 0.01 considered significant.

Results: All five parameters showed significant gender differences without any significant left-right variation.

Conclusion: Dimensions of the south indian femoral condyles are much lower than comparable caucasian, african american and east-asian femori, suggesting significant ethnic variation.

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INTRODUCTION

Osteoarthritis of the knee joint is the leading cause of disability in adults, particularly the elderly (Lawrence *et al*., 2008). Its prevalence has shown an alarming rise in recent years from 21 million individuals in 1995 to 27 million individuals in 2005 (Lawrence *et al*., 2008). The most common and definitive surgery performed for this condition is Total Knee Arthroplasty; it involves replacement of the Tibial, Femoral and/or Patellar component of the knee joint (Healthline (Internet). (Place Unknown): Samuel Greengard; 2015 February 18). It carries a good patient satisfaction rate (Bourne *et al*., 2010). In a developing country such as India, the recent increase in socioeconomic status and quality of healthcare facilities has allowed a larger proportion of the population to opt for Total Knee Arthroplasty (Ministry of Statistics and Program Implementation-Central Statistics Office-Social Statistics Division; 2011). Development of the prosthesis for total knee arthroplasty largely relies on osteometric data of the bones of the knee joint acquired from developed nations, particularly the western world. It has been observed there are significant differences in these parameters across various ethnicities, hence, there is a need to manufacture prosthesis which are tailor-made for each ethnic group, and if possible, each individual (Srivastava *et al*., 2012; Terzidis *et al*., 2012; Alunni-Perret *et al*., 2008; Mahfouz *et al*., 2012). There is a significant lack of data in the Asian subcontinent, particularly, the South Indian population. This study aims to quantify the gender and side to side variations of South Indian femoral condyles.

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MATERIALS AND METHODS

Two hundred South Indian dry femoral bones with no gross deformities, were obtained from the Department of Anatomy at Vydehi Institute of Medical Sciences and Research Center, Bangalore. The specimens were differentiated into male and female based on assessment of general and specific features. The former being the bony and muscle attachments being more pronounced and prominent in males. Specific features included the head of the femur, which is larger and forms 2/3 or more of a sphere in males, the neck shaft angle being more obtuse (about 125 degrees) in a male, the angle of the shaft with the condyles having an angle of about 80 degrees in males

compared to females which is more acute. Out of the 200 chosen specimens, 114 were male and 86 female. They were also grouped into left and right taking by placing the femur into anatomical position using features such as the greater trochanter which is lateral, the head which is medial, the lineaaspera being posterior and the adductor tubercle and the larger medial condyle being medial; after placing it in its anatomical position, the contralateral side the head pointed at was taken as the actual side of the femur. Out of which 104 were left sided and 96 right sided. Femori displaying indeterminate gender and/or side variations were left out of the study.

Five parameters of the femoral condyles were assessed using a digital vernier caliper:

Bicondylar Width (Epicondylar Breadth): Maximum distance between the femoral condyles along the transverse plane.

Intercondylar Width: Distance between half of the anteroposterior diameter of the lateral surface of medial femoral condyle and half of the anteroposterior diameter of the medial surface of the lateral femoral condyle.

Medial Condylar Depth: Maximum anteroposterior diameter of the medial femoral condyle.

Lateral Condylar Depth: Maximum anteroposterior diameter of the lateral femoral condyle.

Intercondylar Depth: Vertical distance between the most anterior point on the inferior margin of the intercondylar notch and a tangential plane along the posterior surface of the femoral condyles.

Each measurement was taken thrice and the average recorded. Statistical analysis was performed using IBM SPSS 16 software with p value less than 0.01 considered as significant.

RESULTS

The data collected showed that Bicondylar Width (Epicondylar Breadth) showed statistically significant gender differences. However, it did not show any significant left-right differences. Intercondylar Width did not show any significant gender or left-right differences.

Lateral Condylar Depth showed statistically significant gender differences without any significant left-right differences. Intercondylar Depth showed statistically significant gender differences but no significant left-right differences. Medial Condylar Depth showed statistically significant gender differences but no significant left-right differences.

Bicondylar Width					
Gender	Specimens	Measurement (mm)	Range (mm)	T - Value	P - Value ($p < 0.01$)
Male	114	74.96 ± 5.04	61.98 - 85.82		
Female	86	71.90 ± 5.85	60.69 - 87.01	2.741	0.007
Left	104	73.91 ± 5.93	60.69 - 87.01		
Right	96	73.35 ± 5.23	61.6 - 85.16	0.501	0.617
Total	200	73.65 ± 5.59	60.69 - 87.01		

Intercondylar Width					
Gender	Specimens	Measurement (mm)	Range (mm)	T – Value	P - Value ($p < 0.01$)
Male	114	21.85 ± 3.00	14.65 - 28.38		
Female	86	21.10 ± 2.67	15.44 - 26.95	1.308	0.193
Left	104	21.80 ± 2.88	15.37 - 28.38		
Right	96	21.23 ± 2.86	14.65 - 26.95	0.996	0.322
Total	200	21.53 ± 2.87	14.65 - 28.38		

Medial Condylar Depth					
Gender	Specimens	Measurement (mm)	Range (mm)	T – Value	P - Value ($p < 0.01$)
Male	114	57.80 ± 3.66	50.77- 64.87		
Female	86	54.83 ± 3.62	44.43 - 61.30	4.04	0.0001
Left	104	56.53 ± 3.97	47.07 - 64.87		
Right	96	56.52 ± 3.89	44.43 - 64.33	0.0204	0.984
Total	200	56.52 ± 3.91	44.43 - 64.87		

Lateral Condylar Depth					
Gender	Bone Specimens	Measurement (mm)	Range (mm)	T – Value	P - Value ($p < 0.01$)
Male	114	58.536 ± 3.694	46.35 - 64.92		
Female	86	55.379 ± 3.981	47.26 - 65.57	4.049	0.0001
Left	104	57.253 ± 4.068	48.12 - 65.57		
Right	96	57.097 ± 4.202	46.35 - 64.92	0.188	0.851
Total	200	57.178 ± 4.112	46.35 - 65.57		

Intercondylar Depth					
Gender	Bone Specimens	Measurement (mm)	Range (mm)	T – Value	P - Value ($p < 0.01$)
Male	114	27.62 ± 3.01	18.61 - 32.72		
Female	86	26.07 ± 2.56	17.58 - 31.13	2.78	0.007
Left	104	26.95 ± 3.01	17.58 - 32.72		
Right	96	26.95 ± 2.85	18.90 - 31.93	0.0102	0.992
Total	200	26.95 ± 2.92	17.58 - 32.72		

		North Indian [6]	East Asian [9]	Caucasian [9]	Caucasian-Greek [7]	French [8]	African American [9]	South Indian [Present Study]
Bicondylar Width (mm)	Male	76.83	85.4	85.9	88.6	84.3	84.9	74.96
	Female	68.28	74.8	75.8	78.5	74.8	76.8	71.9
Intercondylar Width (mm)	Male	-	-	-	22	-	-	21.85
	Female				18.7			21.1
Medial Condylar Depth (mm)	Male	59.38	62.6	65.7	61.1	-	66.9	57.8
	Female	54.05	56.4	59.4	55.9		63.9	54.83
Lateral Condylar Depth (mm)	Male	60.27	64.8	67.8	61.1	-	71.1	58.54
	Female	55.56	57.8	61.4	55.4		64.1	55.38
Intercondylar Depth (mm)	Male	-	-	-	27.8	-	-	27.62
	Female				23.7			26.07

DISCUSSION

Our study utilized direct measurements of femoral component of knee joint using a digital vernier caliper. Several studies have shown that the more widely used indirect measurement techniques such as 3D modeling, magnetic resonance imaging and radiography are inaccurate even after various correction techniques have been applied (White and Folkens, 2000; Anderson *et al*., 2007; Horsman *et al*., 1977). The indirect methods may allow for a larger sample size to beassessed, but, direct methods appear to give more reliable data. The dried specimens used in our study did not have articular cartilage. The cartilage is thickest towards the center of the condyles which bears the most weight. However, it is safe to presume that the measurements taken towards the periphery were accurate as it contains the least amount of articular cartilage as they bear the least weight. In general, male values for all five parameters were significantly higher than the female counterparts across various studies (Srivastava *et al*., 2012; Terzidis*et al*., 2012; Alunni-Perret *et al*., 2008; Mahfouz *et al*., 2012). This can be explained by the more robust stature of males. No significant left-right differences were found in either gender, suggesting that the contralateral knee can be used as a template for prosthetic design of the diseased knee.Mahfouz *et al*. observed that Caucasians (American), Africans and East Asians (Japanese, Korean, Chinese) measurements were significantly higher than the South Indian Population across all parameters. The same was observed in Greek Caucasians and French Caucasians (Terzidis *et al*., 2012; Alunni-Perret *et al*., 2008). The data from the North Indian population closely followed that of the present study (Terzidis *et al*., 2012). The short stature of Asians, particularly those belonging to the Indian subcontinent, may account for the smaller dimensions of the femoral condyles.

Conclusion

Numerous studies have noted significant ethnic and gender differences in the femoral component of the knee joint; data from the African American and Caucasian population being significantly larger than data from the Asian subcontinent (Srivastava *et al*., 2012; Terzidis *et al*., 2012; Alunni-Perret *et al*., 2008; Mahfouz *et al*., 2012). This indicates that manufacturing of the femoral component of the prosthetic template needs to be tailor-made to suit the needs of particular ethnic groups. As only a few studies are available concerning the Asian populations, and even fewer for the Indian subcontinent, this study was undertaken. The results obtained can potentially be used for the designing of anatomically appropriate femoral condyle prosthesis for the South Indian population. The data obtained can also be put to use in the field of Anthropology and Forensic Sciences for identification and human migration studies. Conduct of larger scale studies pertaining to the assessment of all three components of the knee joint, namely femoral, tibial and patellar, of each of the above populations will allow for further substantiation and improvement of our study.

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