

# STUDY OF ACETABULAR DEPTH, DIAMETER AND ACETABULAR DEPTH RATIO OF HIP JOINT OF SOUTH INDIAN POPULATION

Sindhu K S<sup>1</sup>, Shubha R<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Anatomy, Kempegowde Institute of Medical Sciences, Bengaluru, Karnataka, India.

<sup>2</sup>Assistant Professor, Department of Anatomy, Kempegowde Institute of Medical Sciences, Bengaluru, Karnataka, India.

Received Date: 26/02/2024

Acceptance Date: 25/03/2024

**Corresponding Author:** Dr Sindhu K S, Assistant Professor, Department of Anatomy, Kempegowde Institute of Medical Sciences, Bengaluru, Karnataka, India.

**Email:** [drsindhusivankutty@gmail.com](mailto:drsindhusivankutty@gmail.com)

## Abstract

**Background:** The hip joint is a ball and socket type of synovial joint comprising of head of femur and acetabulum of hip bone. Morphological variations of hip joint are noticed in different population resulting from racial, ethnic, and sexual differences. Present study was aimed to study acetabular depth, diameter and acetabular depth ratio of hip joint of south Indian population. **Material and Methods:** Present study was prospective, observational study, conducted 264 AP plain radiographs of normal hip joints (147 males and 117 females). The age group ranged from 20-90 years. All linear measurements including acetabular depth, acetabular diameter, Acetabular depth ratio & femoral head diameter were measured using Dicom viewer. **Results:** In the present study, acetabular depth (AD) was observed to be higher in males than in females, Higher mean acetabular diameter value was recorded on right side when compared to left side irrespective of gender. When the AD on the left side of males and females were compared, the difference in mean acetabular depth was found to be statistically significant ( $P < 0.001$ ). Higher mean acetabular diameter value was recorded on right side when compared to left side in both the genders. When comparison of Acetabular diameter was made between both genders irrespective of side, it was found that the value was highly significant ( $P < 0.001$ ). The mean value of Acetabular depth ratio (ADR) was found to be more in men than in women, showing a dysplastic tendency in the former. No statistical significance was found when ADR was compared between male right and left sides ( $p = 0.864$ ) The mean value of ADR was found to be more in men than in women, showing a dysplastic tendency in the former. **Conclusion:** Values of acetabular depth, acetabular diameter, Acetabular depth ratio & femoral head diameter were more in men as compared to women, while laterality has no significant difference.

**Keywords:** morphometric study, hip joint, acetabular depth, acetabular diameter, Acetabular depth ratio, femoral head diameter

## Introduction

The hip joint is a ball and socket type of synovial joint comprising of head of femur and acetabulum of hip bone. Orthopedic surgeons always stress the need for a proper implant-patient match in hip joint replacements, in particular, for a cement less femoral stem. Knowledge of the anatomical parameters of the bony components of the hip joint is very

essential as it will enable a better understanding of the etiopathogenesis of diseases like primary osteoarthritis.<sup>1,2</sup>

During surgery of the acetabular fractures or during the placement of acetabular cups in arthroplasty, placement of the screws in the acetabulum is very critical because of the neurovascular structures that surround it. Therefore, it is very important to know the anatomical landmarks as well as the average length of the screws that can be placed safely at various quadrants of the acetabulum.<sup>3</sup>

Morphological variations of hip joint are noticed in different population resulting from racial, ethnic, and sexual differences.<sup>4</sup> Not many studies have been done pertaining to morphometry of hip joint in Indian population especially gender and age based and also in relation to the side of the joint. Present study was aimed to study acetabular depth, diameter and acetabular depth ratio of hip joint of south Indian population.

### Material And Methods

Present study was prospective, observational study, conducted in department of Anatomy and Department of Radiodiagnosis, Kempegowda Institute of Medical Sciences, Bangalore, Karnataka, India. Study duration was of 2 years (January 2020 to December 2021). Study approval was obtained from institutional ethical committee.

The study sample comprised of 264 AP plain radiographs of normal hip joints (147 males and 117 females). The age group ranged from 20-90 years. Those x rays with unfused acetabulum, hip joint diseases and with joint space width < 2 mm were excluded from the study. All linear measurements including acetabular depth, acetabular diameter, Acetabular depth ratio & femoral head diameter were measured using Dicom viewer.

Statistical analysis was done by finding the mean, standard deviation and percentage and the parameters were compared between hip joints of males and females on each the two sides and also irrespective of sides. The results were correlated using paired student t test and was considered significant if p value  $\leq 0.05$ .

### Results

In the present study, acetabular depth (AD) was observed to be higher in males than in females, none of the values showed dysplasia (value < 9 mm). The values were statistically significant when comparison was made between right side of males and females, left side of males and females and in both genders irrespective of side.

When the mean values of AD were compared between right side of males and females, the t value was found to be 3.869 which was considered to be statistically significant ( $P < 0.001$ ), Higher mean acetabular diameter value was recorded on right side when compared to left side irrespective of gender

**Table no 1: Comparison of the acetabular depth on right side of male and female hip joints**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Male	12.253	3.163	0.261	1.497	3.869	<0.001
	Female	10.359	3.070	0.284			

When the AD on the left side of males and females were compared, the difference in mean acetabular depth was found to be statistically significant ( $P < 0.001$ ), We measured AD in both genders irrespective of side, the mean AD was recorded to be  $12.307 \pm 3.159$  mm in men and  $10.740 \pm 3.063$  mm in women. The difference in mean value was found to be statistically significant ( $P < 0.001$ ), with a t value of 5.738 when comparison was made between males and females, irrespective of the sides.

**Table no 2: Comparison of the acetabular depth in left side of males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Male	12.558	3.164	0.261	1.637	4.231	<0.001
	Female	10.722	3.069	0.284			

When the mean values of Acetabular diameter (ADr) were compared between right side of male and females, the t value was found to be 3.443 which was considered to be significant (P 0.001). Higher mean acetabular diameter value was recorded on right side when compared to left side in both the genders.

**Table no 3: Comparison of the acetabular diameter on right side of males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
ADr	Male	66.804	11.423.	0.942	4.326	3.443	0.001
	Female	62.478	8.254	0.763			

We measured Acetabular diameter (ADr) on left side in hip joints of males and females The difference in mean acetabular diameter was found to be statistically significant (P<0.001) with a t value of 4.047 when the comparison was made between left side hip joint radiographs of males and females.

**Table no 4: Comparison of the left side acetabular diameter in males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
ADr	Male	67.228	10.439	0.861	4.784	4.047	0.001
	Female	62.443	8.274	0.765			

When comparison of Acetabular diameter was made between both genders irrespective of side, it was found that the value was highly significant (P<0.001).

**Table no 5: Comparison of the acetabular diameter in both genders irrespective of side.**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Male	67.016	10.929	0.637	4.555	5.290	0.001
	Female	62.461	8.247	0.539			

The mean value of Acetabular depth ratio (ADR) was found to be more in men than in women, showing a dysplastic tendency in the former. No statistical significance was found when ADR was compared between male right and left sides (p – 0.864)

**Table 6: ADR in Male right and left sides**

Measurements	Side	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Right	243.857	616.145	50.819	-15.048	-0.172	0.864
	Left	258,905	865.035	71.347			

No statistical significance was found when ADR was compared between female right and left sides (p – 0.994)

**Table 7: ADR in female right and left sides**

Measurements	Side	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Right	197.385	294.693	27.244	-0.274	-0.007	0.994
	Left	197.658	303.125	28.024			

No statistical significance was found when ADR was compared between right side of males and females (p – 0.454)

**Table 8: ADR on right side of males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Male	243.857	616.145	50.819	46.473	0.750	0.454
	Female	197.385	294.693	27.244			

No statistical significance was found when ADR was compared between left side of males and females (p – 0.466)

**Table 9: ADR on left side of males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Male	258.905	865.035	71.347	61.347	0.731	0.466
	Female	197.658	303.125	28.024			

No statistical significance was found when ADR was compared between both genders irrespective of side (p – 0.301)

**Table 10: ADR in both genders irrespective of side**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
AD	Male	251.381	749.728	43.725	53.86	1.035	0.301
	Female	197.521	298.296	19.500			

In the present study, the value of Femoral head diameter (FHD) when compared between males and females showed that, the diameter was higher in males than in females. However, the values were statistically significant when comparison was made between right side of males and females, left side of males and females and in both genders irrespective of side (P <0.001).

The mean femoral head diameter noted on right side in males was  $52.36 \pm 5.34$  mm & in females it was  $46.68 \pm 3.31$  mm. The t value was 10.051 which was considered to be statistically significant (P<0.001).

**Table no 11: Comparison of the left side femoral head diameter in males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
FHD	Male	52.36	5.34	3.420	9.225	10.051	< 0.001
	Female	46.68	3.311	0.302			

The difference in mean femoral head diameter (FHD) on left side hip joint of males and females, was found to be statistically significant (P<0.05) when the comparison was made between left side hip joint radiographs of males and females

**Table no 12: Comparison of the left side femoral head diameter in males and females**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
FHD	Male	55.880	41.464	3.420	9.225	2.400	0.017
	Female	46.655	3.271	0.302			

Higher mean value for mean femoral head diameter (FHD) was recorded in men when the 2 genders were compared irrespective of side. The difference in mean was found to be statistically significant ( $P < 0.001$ ) with a t value of 3.835.

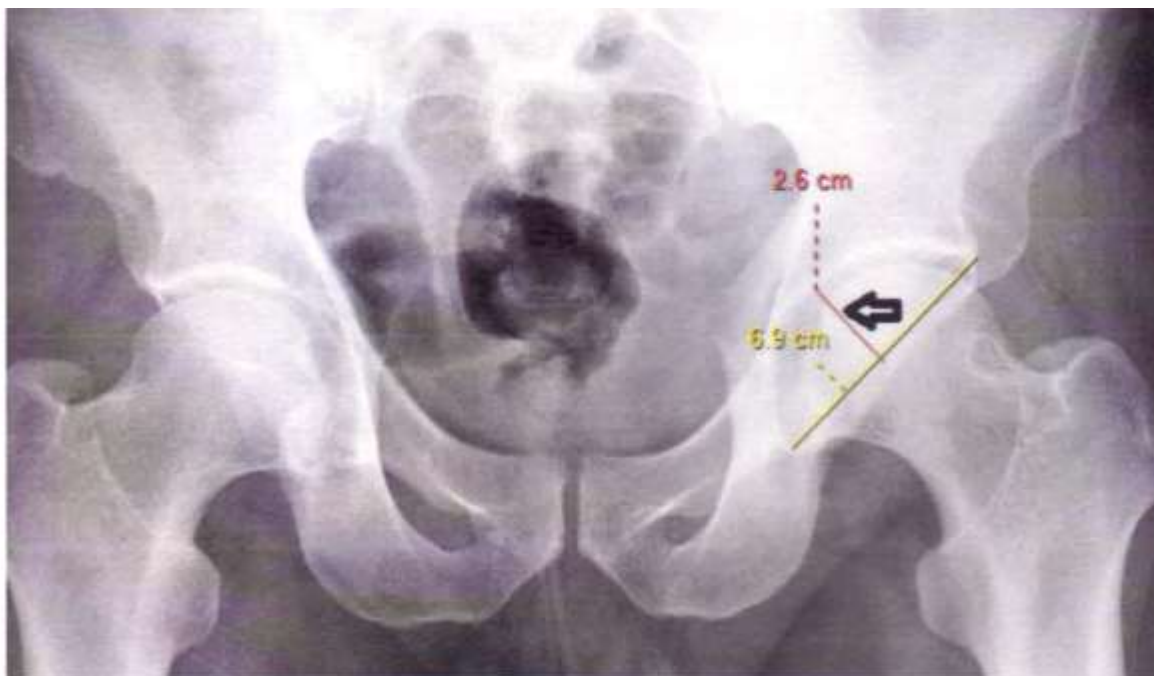
**Table no 13: Comparison of the femoral head diameter in both genders irrespective of side**

Measurements	Gender	Mean	SD	SE of Mean	Mean difference	T	P-Value
FHD	Male	54.121	29.563	1,724	7,449	3.835	<0.001
	Female	46.672	3.285	0.215			

### Discussion

The study of the morphometry of hip joint in both males and females has been considered important with regard to its clinical application in the etio pathogenesis of diseases like primary osteoarthritis of the hip joint. It is also of immense help for orthopedicians and prosthetists in constructing suitable prosthesis and also in early detection of disputed sex by forensic experts etc. Awareness of the average dimensions of the acetabulum and femoral head will assist prosthetists in designing a suitable prosthesis according to the need of a particular individual.<sup>5</sup>

Photograph 1: X ray of the Hip Joint with the line indicated by the arrow shows the Acetabular Depth



Acetabular depth (AD) is defined as the greatest perpendicular distance from acetabular roof to a line joining the lateral margin of acetabular roof and upper corner of symphysis pubis on the same side. An acetabular depth of 9 mm is considered dysplastic. In the figure shown below, line A shows the acetabular depth.

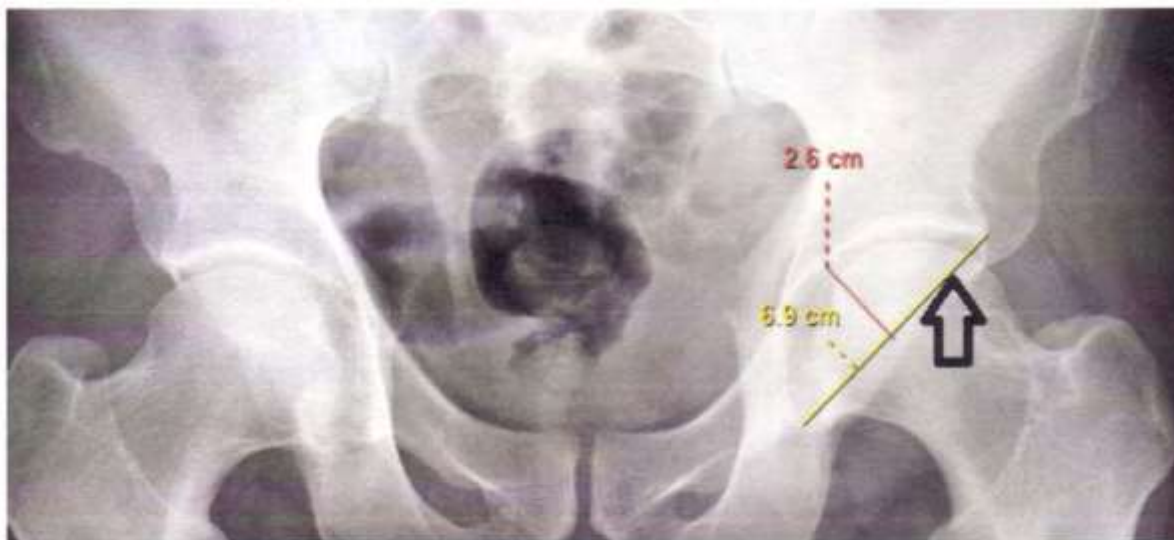
In the present study significant value in the acetabular depth was observed among right side of males ( $12.25 \pm 3.16$  mm) and females ( $10.75 \pm 3.07$  mm), left side of males ( $12.35 \pm 3.1$  mm) and females ( $10.72 \pm 3.06$  mm) and in males ( $12.30 \pm 3.15$  mm) and females ( $10.74 \pm 3.06$  mm) irrespective of side with a P value  $< 0.001$  Because males are significantly taller than females, its assumed that the sex difference in acetabular dimension is attributed to the difference in body height.<sup>6</sup>

**Table no. 14 Comparison of acetabular depth values with other studies**

Authors	Population	Age group	Mean value	SD
Lequesne <i>et al.</i> , <sup>6</sup>	Paris	18-89	11.64	2.46
Saikia <i>et al.</i> , <sup>7</sup>	India	20-70	17	8
Jeremic <i>et al.</i> , <sup>8</sup>	Serbia	21-65	12.5	2.5
Yiming Zeng <i>et al.</i> , <sup>9</sup>	China	44-60	18	-
Present study	India	20-40	12	3.1

In the study done by Jeremic *et al.*, the value in males was  $12.5 \pm 2$  mm and in females  $11.2 \pm 2.7$  mm, which is identical to the present study. In a few studies quoted by the author in Turkish, Austrian and Korean population, the acetabular depth values were  $13.8 \pm 3.6$ ,  $17.9 \pm 1.2$  and  $11.5 \pm 2.6$  respectively, which shows that the findings were similar in all. Since the acetabular depth decreases with an increase in age and is found to be less in females than males, acetabular depth may not be a good measure for acetabular dysplasia.<sup>10</sup>

In a study done by Saikia *et al.*,<sup>7</sup> the value was found to be higher i.e., 17 mm, which may be due to the age group studied i.e., 61-70 years and also due to a small sample size. The increased acetabular depth in Caucasians was due to a larger head diameter. The North Eastern part of India is inhabited by numerous endogenous tribes and castes that have their own distinct social, linguistic and biological identity. Plethora of migration has contributed to the present day population of North East India. Findings identical to the present study was found by Lequesne *et al.* in which the mean acetabular depth was  $11.64 \pm 2.46$  mm.<sup>6</sup>



Photograph 2: X ray of the Hip Joint with the line indicated by the arrow shows Acetabular diameter

Acetabular diameter (ADr) is the line joining the lateral margin of acetabular roof and upper corner of symphysis pubis on the same side. In the present study, the value of acetabular diameter (ADr) was found to be higher in males than in females. This can be due to the pelvic morphology and body weight of men. The acetabular diameter value was found statistically significant when compared on the right side in males and females, on left side in males and females and in both genders irrespective of side.

In the present study, the average value of acetabular diameter was found to be 67 mm in males and 62 mm in females. The values were found to be higher in the present study when compared to previous studies. This can be due to the fact that the comparison was made between Chinese population and Indian population

**Table no 15: Comparison of acetabular diameter with previous studies**

Author	Population	Age group	Female (left)	Female (right)	Males (Left)	Males (right)	P'	P''
Hecheng <i>et al.</i> , <sup>11</sup>	China	20-80	51.0 ± 3.4	49.3 ± 2.5	56.1 ± 3.1	56.3 ± 2.7	< 0.001	0.05
Yiming <i>et al.</i> , <sup>9</sup>	China	40-60	51.0 ± 2.07	51.4 ± 2.38	56.0 ± 3.33	55.2 ± 3.11	< 0.001	0.27
Present study	India	20-90	62.4 ± 8.2	62.4 ± 8.25	67.22 ± 10.4	66.8 ± 11.4	< 0.001	< 0.001

Even in normal subjects there is a great variation in acetabular morphology. An understanding of the normal range of acetabular parameters is important to distinguish acetabular deformity from normal anatomical variation. However, the range of normal acetabular variation may differ between races. The present study when compared with the Chinese reveals this. There is evidence that the acetabular dimensions are significantly larger in men than in women. The present study confirmed this. The body weight and height significantly correlated with acetabular dimensions ( $p < 0.05$ ). Because males are significantly taller than females its assumed that the sex difference in acetabular dimension is attributed to the difference in body height

**Table no 16: Correlation of acetabular diameter and depth according to Yiming Zeng *et al.*,<sup>9</sup>**

	Acetabular diameter		Acetabular depth	
	Males	Females	Males	Females
Age	-0.001	0.188	-0.163	0.075
Height	0.548	0.491	0.657	0.342
Weight	0.479	0.368	0.431	0.174
BMI	0.223	0.133	0.106	0.007

**Table 17: Comparison of acetabular diameter in different groups by Hecheng MA *et al.*,<sup>11</sup>**

	Female	Male
Chinese	51.4 ± 2.01	56 ± 3.3
Austrian	48.3 ± 3.3	49.5 ± 2.3
Italian	47.8 ± 2.3	56.3 ± 2.6

The Chinese population showed higher values when compared to Austrian and Italians. The values showed that there exists a significant difference in the acetabular morphology among different races. This may be attributed to the difference in their body statures.<sup>11</sup> The differences in the value of acetabular diameter in the present study when compared with that of other studies could be attributed to the racial differences in the population studied and variations in the methodology.

Acetabular depth ratio (ADR) is one of the radiographic discriminator of HD and is considered to be a useful parameter in clinical and epidemiological studies. The width is measured from the inferior end of the tear drop to the lateral rim of the acetabulum, and the depth is measured perpendicularly from the midpoint of the width line. In the present study,

the value was not statistically significant neither among the genders nor among the two sides. Values were found to be more in men than in women showing a high dysplastic tendency in men. The higher acetabular dimensions could be due to increased height and weight in men than in women.

In a study done by Yiming *et al.*,<sup>9</sup> the larger acetabular dimension in men was attributed to greater body height independent of sex. Two types of hip disease, acetabular dysplasia and pincer femoro acetabular impingement, are associated with morphological abnormalities of the acetabulum, including acetabular width, depth and orientation. The body height and weight strongly correlated with acetabular dimensions. Because males are significantly taller than females, its assumed that the sex difference in acetabular dimensions is attributed to the difference in body height

**Table no 18: Comparison of Adr in the present study with that of previous studies**

Author	Population	Age group	Males (right)	Males (Left)	Female (right)	Female (left)
Jacobsen <i>et al.</i> , <sup>12</sup>	Denmark	20-90	10.7	9.8	8.4	7.7
Yiming <i>et al.</i> , <sup>9</sup>	China	40-60	34.9	34.7	33.8	33.9
Lane <i>et al.</i> , <sup>13</sup>	Norway	18.6	29.45	29.72	29.77	30.01
Present study	India	20-90	24.38	25.89	19.73	19.76

The mean values of Jacobsen *et al.* compared well to the present and other studies. In the study done by Lene *et al.* the slight variation in the values could be due to the lower age group studied. Hip dysplasia has been assumed to be a significant etiological factor in the development of premature hip osteoarthritis. Reduced areas of load transfer in dysplastic hips may lead to premature degeneration of cartilage. From the present study, it's found that sex related differences are found in acetabular morphology, male acetabulae being marginally more dysplastic than female acetabulae. Variation in the values among different studies could be due to the variation in the body measurements of the population studied.

Awareness of the femoral head dimensions will assist prosthetists in designing a suitable prosthesis according to the need of a particular individual. The volume of implants in the femoral head was calculated by using the formula  $d^2/4 * l$ , where d is the diameter of femoral head and l is the length of the implant.

Photograph 3: X ray of the Hip Joint showing the Femoral Head Diameter indicated by the arrow



In the present study, the femoral head diameter was found to be statistically significant when right side of males was compared with right side of females ( $p < 0.001$ ), when left side of males was compared with left side of females ( $< 0.05$ ) and in case of males and females irrespective of side ( $p < 0.001$ ). The values were found to be more in men than in women. This could be due to the fact that the diameter of the femoral head is considered to be



larger in taller individuals (men). Value was comparable and was more in males than in females which could be due to tall stature

**Table no 19: Comparison of femoral head diameter with previous studies**

Author	Population	Age group	Males	Female	P value
Seikia <i>et al.</i> , <sup>7</sup>	India	20-70	44.6	42.3	0.01
Rawal <i>et al.</i> , <sup>14</sup>	India	40-81	48.24	42.33	0.001
Present study	India	20-90	53.36	36	<0.001

Saikia *et al.*,<sup>7</sup> have reported that the diameter of the femoral head was larger in taller individuals. In a study done by him on the femora of Nigerians revealed a mean diameter of 54.23 in males and 54.08 in females which was higher than the values of North Indians, which show that on an average North East people were shorter. This was true in case of Caucasians and Mongoloids, where Caucasians were found to be taller than Mongoloids and was found to have a larger diameter of femoral head.<sup>7</sup>

In studies done by Siwach *et al.*<sup>15</sup> and Bulent *et al.*,<sup>16</sup> the average values of femoral head diameter was found to be 43.53 +/- 3.4 mm and 45.8 +/-4.17 mm respectively. These values were comparable with that of other studies and slightly lower than the present study. In this study age, side or gender was not taken into consideration. In the study done by Bulent *et al.*" on Turkish subjects showed a higher value for femoral head due to valgus position of femoral head-neck angle, a narrower proximal femoral metaphysis and a narrower medullary canal with a longer isthmic segment. In a study done by Eduardo *et al.*, the values on right and left were 47.1 + 3.1 and 46.43.7 mm respectively with a p value 0.3011. In this study age and gender were not considered.<sup>17</sup>

## Conclusion

A thorough knowledge of hip joint anatomy is a prerequisite to understand its biomechanics. The normal values are needed to set the limits of significant early radiographic alteration in patients with osteoarthritis. Values of acetabular depth, acetabular diameter, Acetabular depth ratio & femoral head diameter were more in men as compared to women, while laterality has no significant difference.

**Conflict of Interest:** None to declare

**Source of funding:** Nil

## References

1. Siwach RC, Dahiya S. Anthropometric study of proximal femur geometry and its clinical application. *Indian J Orthop.* 2003;37:247–51.
2. Najjar EI, McWilliams ER. *Forensic anthropology: The structure, morphology and variations human bone and dentition.* Springfield, IL: Charles C Thomas; 1978.
3. Pathrot D, Ul Haq R, Aggarwal AN, Nagar M, Bhatt S. Assessment of the geometry of proximal femur for short cephalomedullary nail placement: An observational study in dry femora and living subjects. *Indian J Orthop.* 2014;50:269–76.
4. Rawal B, Ribeiro R, Malhotra R, Bhatnagar N. Anthropometric measurements to design best-fit femoral stem for the Indian population. *Indian J Orthop.* 2012;46:46–53.
5. Ornetti, P.; Maillefert, J.F.; Paternotte, S.; Dougados, M.; Gossec, L. Influence of the experience of the reader on reliability of joint space width measurement. A cross-sectional multiple reading study in hip osteoarthritis. *Joint Bone Spine* 2011, 78, 499–505.
6. Lequesne, M.; Malghem, J.; Dion, E. The normal hip joint space: Variations in width, shape, and architecture on 223 pelvic radiographs. *Ann. Rheum. Dis.* 2004, 63, 1145–1151.

7. Saikia KC, Bhuyan SK, Rongphar R. Anthropometric study of the hip joint in Northeastern region population with computed tomography scan. *Indian J Orthop.* 2008;42 (3):260-66.
8. Jeremić D, Macuzić IZ, Vulović M. Sex differences in anatomical parameters of acetabulum among asymptomatic Serbian population. *Vojnosanitetski preglod.* 2011;68:935–939.
9. Yiming Zeng,<sup>1</sup> You Wang,<sup>1</sup> Zhenan Zhu,<sup>1</sup> Tingting Tang,<sup>1</sup> Kerong Dai<sup>1</sup> and Shijing Qiu, Differences in acetabular morphology related to side and sex in a Chinese population, *J. Anat.* (2012) 220, pp256–262
10. Garbuz DS, Masri BA, Haddad F, *et al.* (2004) Clinical and radiographic assessment of the young adult with symptomatic hip dysplasia. *Clin Orthop Relat Res* 418, 18–22
11. Ma H, Han Y, Yang Q, Gong Y, Hao S, Li Y, Liu J. Three-dimensional computed tomography reconstruction measurements of acetabulum in Chinese adults. *Anat Rec (Hoboken).* 2014 Apr;297(4):643-9.
12. Jacobsen S, Sonne-Holm S. Hip dysplasia: a significant risk factor for the development of hip osteoarthritis. A cross-sectional survey. *Rheumatology* 2005; 44: 211–8.
13. Lane NE, Lin P, Christiansen L, *et al.* (2000) Association of mild acetabular dysplasia with an increased risk of incident hip osteoarthritis in elderly white women: the study of osteoporotic fractures. *Arthritis Rheum* 43, 400–404.
14. Rawal B, Ribeiro R, Malhotra R, Bhatnagar N. Anthropometric measurements to design best-fit femoral stem for the Indian population. *Indian J Orthop.* 2012;46:46–53.
15. Siwach R. Anthropometric study of proximal femur geometry and its Clinical Application. *Ann Natl Acad Med Sci (India).* 2018;54(4):203-15
16. Bulent, A., Ali, O., Omur, O., Mazhar, T., Mumtaz, A. (2007). Osteometry of the femora in Turkish individuals: A morphometric study in 114 cadaveric in femora as an anatomic basis of femoral component design. *Acta Orthop Traumatol Turk*, 41(1), 64-68
17. Eduardo de Farias TH, Borges VQ, de Souza ES, Miki N, Abdala F. Radiographic study on the anatomical characteristics of the proximal femur in Brazilian adults. *Rev Bras Ortop.* 2015 Feb 18;50(1):16-21.