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Research Article

A STUDY OF ANATOMICAL PARAMETERS OF HIP JOINT IN CADAVERS AND ITS CLINICAL IMPORTANCE

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ABSTRACT
In the recent years measurements on the cadaveric hip joints have not been carried out. As the environment plays an important role in the development of human being it was thought that the change in the environment might have laid to some kind of change in the parameters of the bony component of the hip joint. Therefore, 56 cadaveric hip joints with soft tissue in situ were studied. Dimensions of acetabulum and femoral head were obtained with Vernier scale. It was observed that these dimensions were greater in males when compared with that of females but the difference was statistically insignificant. On the right side the parameters measured were greater than those of the left side in both the sexes but of no statistical significance. Acetabular diameter was greater than the diameter of femoral head in both the genders. Clinically, this knowledge plays an important role in understanding the rarity of occurence of primary osteoarthritis in Indians. The present study is of value to the forensic experts, orthopaedics and prosthetists as it gives the dimensions of acetabulum and femoral head in the present area.

Key Words: *Hip Joint, Acetabulum, Femoral Head, Diameters, Osteoarthritis*

INTRODUCTION
The hip joint which was originally referred to as a ball and socket joint is now being described theoretically as a rotational conchoid. To understand the hip joint mechanics the knowledge of anatomy of proximal femur is a pre-requisite. Also, knowledge of various bony components of hip joint will not only help the radiologists but will also be of immense importance to the orthopaedics and prosthetists. As race, climate, heredity and geographical areas have strong influence over the anthropometric parameters of bone. Therefore, the present study was undertaken to note the average diameter of the femoral head and the average diameter & depth of acetabulum in Western Indian cadaveric hip joints. Although various dimensions of acetabulum and femoral head have been measured by several investigators but all such studies have been conducted on dry specimen. This study is unique in measuring the parameters with soft tissues in situ. Availability of such data can help in constructing best possible prostheses for patients of total hip replacement in Western India. No such study on Western Indian hip joints is available since nearly four decades. Any deviations of these dimensions from normal have strong correlation with development of various kinds of pathologies of hip joint.

MATERIALS AND METHODS
This study was conducted in the Department of Anatomy, Government Medical College, Surat and SMIMER Medical College, Surat. Fifty six cadaveric hip joints belonging to the age group of 45-65 years of both sexes (33 male and 23 female cadavers) were dissected. The specimens were grossly inspected for the presence of any osteoarthritic changes which if present would alter the geometry of the joint. The hip joints were considered normal when (a) the articular cartilage of femoral head was smooth and was of uniform appearance till the margin where it disappeared with no evidence of marginal ossification (b) the acetabulum was hemispherical and cartilage lining it was smooth and horse shoe shaped, ending abruptly at the inner margin framing the acetabular fossa as unbroken line. Outer edge of cartilage and labarum blended without any distinctive demarcation. Acetabular fossa was filled with fibrofatty tissue with a smooth surface. Six hip joints were excluded from the study because of the presence of irregularity in the

cartilage and osteophytes. Various parameters of the acetabulum and the upper end of femur of the fifty hip joint (30 male, 20 female) were measured as following:

1. Depth of acetabulum: A thin metallic strip was placed across the diameter of the acetabulum. Depth of the acetabulum was measured in millimeters using vernier scale from the center of the acetabulum to the metallic strip (figure 1). Measurements could be made as accurate as 1/10 of a millimeter by this scale.

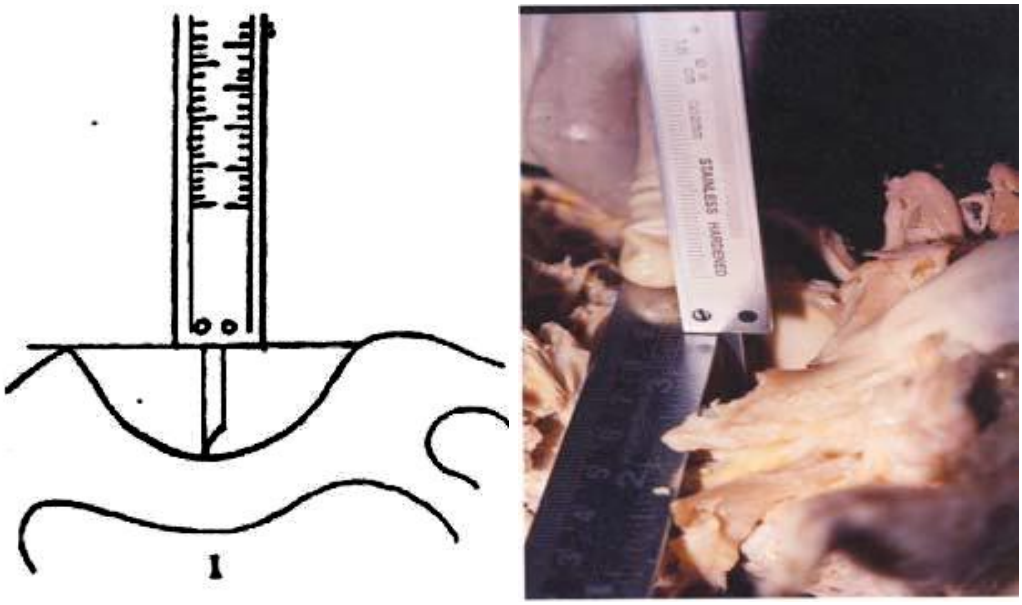

Figure 1: Method of measurement of depth of acetabulam

2. Diameter of acetabulum: Maximum transverse diameter of the acetabulum was measured using vernier scale (figure 2).

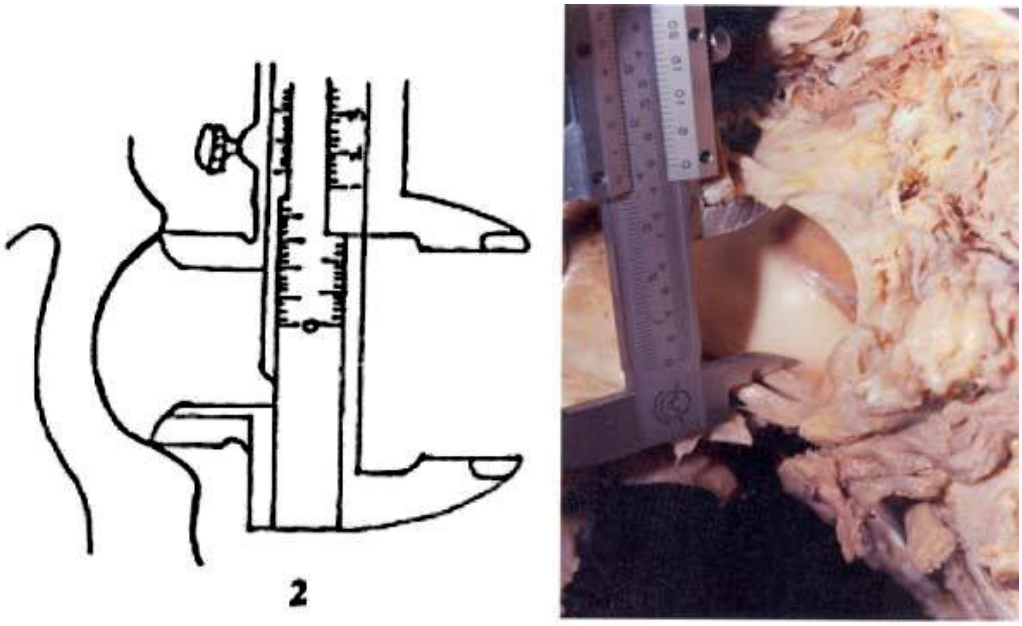

Figure2: Method of measurement of diameter of acetabulam

3. Vertical diameter of femoral head: Vernier scale was used to measure the vertical diameter of the femoral head. It was taken at right angle to the long axis of the neck of femur which meant the straight distance between the most superior to the most inferior points of the femoral head (figure 3).

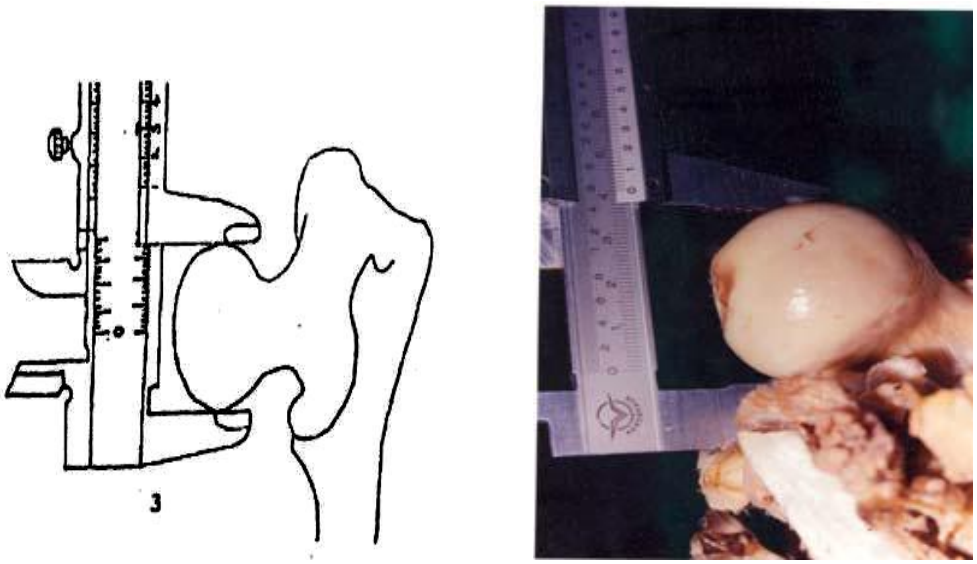

Figure 3: Measurement of Vertical diameter of femoral head

Intra-observer variation was avoided by measuring each parameter three times by each of the three investigators and mean of the reading obtained was recorded.

RESULTS AND DISCUSSION

Fifty six hip joints were dissected and grossly inspected. Six of these displayed osteoarthritic changes in the form of erosion of cartilage and presence of osteophytes. The remaining hip joints which grossly appeared normal were measured. The data obtained was analysed in the following manner:

a. Measurements of right side in males were compared with measurements of right side in females.
b. Measurements of left side in males were compared with left side measurements in females.
c. Right side measurements were compared with left side measurements in males.
d. Right side measurements were compared with left side measurements in females.

It was observed that the depth of the Acetabulum was greater in males than females both on right and left side (Table 1). On the right side the difference being statistically significant. It was noticed that the depth of the right acetabulum was greater than that of the left side in both sexes but the difference was statistically insignificant .

Table 1: Mean depth of acetabulum

	Male(n=30)		Female(n=20)	
	Right(15)	Left(15)	Right(10)	Left(10)
Minimum Value	25	24.5	22.21	22
Maximum Value	35.1	33.60	32.22	31
Mean	29.96	30.37	27.44	27.57
SD	2.96	2.52	2.71	2.63

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The diameter of acetabulum was greater in males than females as can be depicted by Table 2. On the right side there was marginal statistically significant difference in the diameter of acetabulum between the two sexes. In males right acetabulum had greater diameter than that of left side but of no statistical significance.

Table 2: Diameter of acetabulum

	Male(n=30)		Female(n=20)	
	Right(15)	Left(15)	Right(10)	Left(10)
Minimum Value	41.00	41	36	35.5
Maximum Value	49.1	48.50	45.50	46.50
Mean	45.42	45.07	41.76	41.98
SD	2.80	2.43	2.28	2.32

The vertical diameter of femoral head was greater in males than in females both on right and left sides (Table 3) but was statistically insignificant. It was also noticed that in both sexes the vertical diameter was more on the right side than the left side though the difference was statistically not significant.

Table 3: Vertical Diameter OF Head OF Femur

	Male(n=30)		Female(n=20)	
	Right(15)	Left(15)	Right(10)	Left(10)
Minimum Value	39	37	35.29	34.25
Maximum Value	49	48.05	45.42	46
Mean	44	44.53	41.12	41.06
SD	2.95	2.54	2.43	2.46

Hip joint is one of the major joints of the body. Though described conventionally as a ball and socket variety of synovial joint, Menschik (1997) reports it to be a rotational conchoid. Knowledge of the anatomical parameters of the bony components of hip joint is very essential as it will open new horizons into better understanding of etiopathogenesis of diseases like primary osteoarthritis of hip joint. An incongruous joint is more prone to develop degenerative changes than a joint having normal anatomy (Murray 1965) Awareness of the average dimensions of the bones of the hip joint in both sexes will also help in early detection of disputed sex by Forensic experts. As total hip replacement is a common surgery performed now a days, a knowledge of the dimensions of acetabulum and femoral head will assist prosthetists to construct suitable prostheses for western Indians. To the best of our knowledge not much literature is avaialble on these parameters of western Indian hip joints therefore the need for the present study to be carried out was felt. Studying cadaveric hip joints is of immense importance as various dimensions were taken with the soft tissues in place. This gives the average values of various parameters to near normal situations as would be encountered in the patients at operation table. Assessment of these parameters to detect the sex by radiographs, CT scans and MRI would include magnification errors and may not be cost effective for a developing nation like ours.

Study conducted on the femora of Nigerians revealed that the mean vertical diameter of the head of femur on the right and left sides in males is 54.23 mm and 54.08 mm respectively and in females it is 47.14 mm and 46.83 mm (Asala, Mbajiorgu and Papandro, 1998). According to chauhan, paul and dhaon study the vertical diameter of head of femur was 44.44 mm and45.84 mm in males and 43.87 mm and 44.76 mm in females both on right and left side respectively in North Indian population. It was noticed by Prasad *et al.*,

(1996) that the vertical diameter of the head of dry femora had an average value of 44.31 mm and 44.76 mm in males and 39.74 mm and 39.42 mm in females both right and left side respectively in South Indian population.. In contrast according to the present study the femoral head diameter on an average were 44.84 mm and 44.53 mm in males and 41.12 mm and 41.06 mm in females both on right and left side respectively (Table-3, 6). According to Isaac *et al.*, (1997) short statured have smaller diameter of femoral head which can be easily appreciated when the present study was compared with that of Asala et al (1998). Nigerians were taller than average Indians and so their femoral heads were bigger than that of Indians. There was not much of difference in the measurement of femoral head diameter amongst western and South Indians. Javadekar (1961) was of the opinion that the average diameter in males is 45.26 mm and in females is 40.37mm. Cartilage adds 3 mm to the diameter (Javadekar 1961). Average vertical diameter of femoral head is nearly the same as seen by Mukhopadhaya and Barooah (1967) though minor variations may persist as they had not segregated the joints according to sex.

A particular sex can not be determined only by visual examination of the bone as reported by Krogman (1946) and Stewart (1948) though to some extent it could be possible by seeing the hip bone as reported by Asala *et al.*, (1998). Therefore, in addition to the already existing knowledge on the hip bone for determining sex of an individual it would be benificial if the dimensions of acetabulum could also be incorporated. Measurements of depth of acetabulum were scarcely found in literature as far as our knowledge extends. Average depth of acetabulum according to *Chauhan et al.,* (1967) on right and left sides were 27.49 mm and 28.18 mm in males and 24.68 mm and 25.70 mm in females respectively. According to South Indian study average depth of acetabulum on right and left side were 28 mm and 28.52 mm in males and 27.09 mm and 26.73 mm in females respectively. Difference in their observations when compared with the present study exists as they included the dimensions of both the sexes while calculating the mean. Also, they worked upon fresh specimens whereas the study in question was on preserved specimens. It is likely that in preserved materials, the soft tissues shrink and therefore the emergence of higher values in the present study. Average depth of acetabulum in our study were 29.96 mm and 30.37 mm in males and 27.44 mm and 27.57 mm in females respectively (Table-4).

Table 4: Comparison of Depth of Acetabulum of present study with North Indian and South Indian Study

		Male		Female	
		Right	Left	Right	Left
North Indians (Chauhan *et al.*, 2002)	Mean	27.49	28.18	24.68	25.7
	SD	2.70	2.58	1.20	2.11
South Indians (Prasad et al. 1996)	Mean	28.00	28.51	27.09	26.73
	SD	2.17	2.22	2.22	2.26
Present Study	Mean	29.97	30.37	27.45	27.58
	SD	2.97	2.53	2.72	2.64

Average diameter of acetabulum according to chauhan, paul & Dhaon (2002) on right and left side were 47.10 mm and 47.48 mm in males and 44.38 mm and 46 mm in females respectively. In South Indian study the diameter of acetabulum on right and left side were 45.22 mm and 45.39 mm in males and 40.65 mm and 40.21 mm in females respectively. In our study the diameter of acetabulum on right and left side were 45.42 mm and 45.07 mm in males and 41.76 mm and 41.98mm in females respectively (Table-5).

Table 5: Comparison of Diameter of Acetabulum of present study with North Indian and South Indian study

		Male		Female	
		Right	Left	Right	Left
North Indians (Chauhan *et al.*, 2002)	Mean	47.10	47.48	44.38	46.00
	SD	2.90	3.05	3.01	2.28
South Indians (Prasad *et al.*, 1996)	Mean	45.22	45.39	40.65	40.21
	SD	3.07	2.75	1.95	1.74
Present Study	Mean	45.42	45.07	41.77	41.98
	SD	2.80	2.43	2.29	2.33

Table 6: Comparison of Vertical Diameter of Head of Femur of present study with North Indian and South Indian study

		Male		Female	
		Right	Left	Right	Left
North Indians (Chauhan *et al.*, 2002)	Mean	45.44	45.84	43.87	44.67
	SD	3.07	3.20	2.99	2.80
South Indian (Prasad *et al.*, 1996)	Mean	44.31	44.76	39.74	39.42
	SD	2.75	2.67	1.52	1.34
Present Study	Mean	44.84	44.53	41.12	41.07
	SD	2.96	2.55	2.44	2.47

It would be noticed that in the Western Indian hip joints belonging to males or females, the average diameter of femoral head was smaller than the average diameter of acetabulum impressing upon the fact that the femoral head is snugly fitted into the acetabulum which is one of the major reasons why primary osteoarthritis of hip joint is so uncommon in Indians. Various parameters measured had a higher value on left side than right. Chhibber and Singh (1970); Dogra and Singh (1971) suggest that left limb is dominant. Whether a person was right handed or left handed more people use left lower limb for weight bearing (Chhibber and Singh 1970). Therefore, the dimensions of the bones forming the hip joint of left side should be more so as to bear greater loading force on femur. Though, in the present study right hip joint dimensions were greater than the left yet they are statistically insignificant. There should not be much of a difference between the sides otherwise everyone would be walking with an abnormal gait. The present study hence provides valuable parameters which would help the forensic anthropologist, orthopaedics and prosthetists to deliver excellent performance in their respective specialities. It was concluded from this study that the regional variations in the parameters measured do exist when the data of two different countries are considered but within a country there was not much variation. Moreover, in last four decades the dimensions of the bony components of the hip joints studied had not changed much.

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