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## Acetabulum- Morphological and Morphometrical Study.

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### ABSTRACT

Acetabulum is a cup shaped depression on the outer surface of constricted central part of hip bone. All three innominate elements that is ilium, ischium, and pubis contribute to the acetabulum in human beings but unequally. Its central part called acetabular fossa is surrounded by a curved lunate articular surface for articulation with head of femur. This study is to document the relationship between the depth and diameter of acetabulum which will help the orthopedic surgeons for better alignment of acetabular cup placement during total hip arthroplasty. Also to describe the anterior acetabular ridge morphology that can be useful for diagnosing congenital acetabular dysplasia and during treatment of hip joint fractures. 100 human adult unpaired dry hip bones (50 right and 50 left) of unknown age and sex were assessed in the department of Anatomy Mahatma Gandhi Medical College and Research Institute Puducherry and from Sikkim Manipal Institute of Medical Sciences Sikkim. Two morphometrical and Morphological parameters were evaluated. The data of diameter and depth of the acetabulum was taken by digital sliding caliper. Correlation between morphometry parameters were analysed using Pearson's test. We also evaluated the anterior acetabular ridge's shape morphologically and classified them as follows -Curved, Angular, Straight, and Irregular. The mean values for the acetabular depth and diameter were 28.32±1.32mm and 50.99±1.99mm respectively. Positive and significant correlation was found between the depth and the diameter of the acetabulum ( $r=0.416$   $p<0.001$ ). Regarding anterior acetabular ridge shape morphology; the majority were curved 60(60%), 27(27%) were angular, 9 (9%) were irregular, 4 (4%) were straight.

**Keywords:** Acetabulum, Acetabular ridge, Morphology, Morphometry.

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## INTRODUCTION

The hip joint is one of the major weight bearing joints of the body. It was originally referred to as ball and socket joint but now it is being described as rotational conchoids [1]. The femoral head articulates with a cup shaped acetabulum, its centre lying a little below the middle third of the inguinal ligament. Movements at this joint include flexion, extension, adduction and abduction [2]. Osteoarthritis of hip joint is a common condition in western countries and has varied etiology. An incongruous joint is more prone to develop degenerative changes than a joint having normal anatomy. It has been estimated that 25-40% of hip osteoarthritis may be caused by acetabular dysplasia. Dysplastic hip also correlates with the acetabular depth. The normal acetabular depth is 9mm and less than that is regarded as dysplasia [3]. The knowledge of normal anatomical features and morphometry of the acetabulum is vital to understand the mechanics of hip joint. The acetabular images aid the surgeon to determine the correct size of the acetabular cup during total hip arthroplasty and to realign the acetabulum back to normal position [4]. A bigger roof of the acetabular cup means a good grip of the head of the femur inside the acetabulum and hence a better result of arthroplasty [5]. The main problem for acetabular placement will be positioning the acetabular cup implant and acetabular inclination to the correct location according to its acetabular version and the acetabular depth [6]. Akas et al [7] described the acetabular dysplasia frequency and normal hip joint morphometry in adult Turkish population. Gursharan Singh Dhindsa et al [8] measured the diameter and capacity of acetabulum in Ludhiana, Punjab. Basaloglu et al [9] measured the vertical and transverse diameter of acetabulum in both sexes comparatively. Chauhan et al [10] measured the depth and diameter of acetabulum in both sexes in New Delhi. Mukhopadhyaya and Barroah et al [11] also measured the depth and diameter of the acetabulum. Mohammed Yusuf [12] did the morphometric study of the acetabulum in Malaysian population.

Morphology of Anterior acetabular ridge is clinically important during total hip arthroplasty. Govsa et al [13] described the anterior acetabular ridge's shape morphologically. Posterior acetabular ridge almost always forms a simple semicircle. However the anterior acetabular ridge shows variations and because of this variations, the amount of anteversion is affected by the point of measurement along the anterior ridge [14]. Geometric discrepancies between the natural acetabulum and implant can result in painful iliopsoas impingement attributable to prosthetic overlap at the anterior acetabular ridge over which the iliopsoas tendon extends to leave the pelvis [15]. A well known complication of anterior cup overlap after total hip arthroplasty is iliopsoas impingement syndrome caused by chronic infection between iliopsoas tendon and the rim of the implant. The syndrome can occur with all acetabular implants but it is observed more frequently in cases in which the implant is oversized [16]. Govsa S et al identified four types of anterior acetabular ridges. Funda Tastskin Aksu et al [17] identified four types of acetabular ridges. Gaurang Paramara et al [18] identified three types of acetabular ridges.

## MATERIALS AND METHODS

100 human adult unpaired dry hip bones (50 right and 50 left) of unknown age and sex were collected from the Department of Anatomy Mahatma Gandhi Medical College and Research Institute, Puducherry and Sikkim Manipal Institute of Medical Sciences, Sikkim. Specimens with Osteoarthritis of hip, evidence of trauma or any other skeletal disorders were excluded. Two morphometrical and one morphological parameters were evaluated. The data of diameter and depth of the acetabulum was taken by digital sliding caliper and they were measured as follows

Diameter of the acetabulum (AD1)—The distance between the acetabular ridge nearest to the body of ischium and anterior iliac margin intersecting the acetabular ridge was named as acetabular diameter. [Fig1]

Depth of the acetabulum (AD2)—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 centre of the acetabulum to the metallic strip. Measurements could be made as accurate as 1/10 of a millimeter by this scale [Fig2].

Correlation between morphometrical parameters were investigated using Pearson's test.

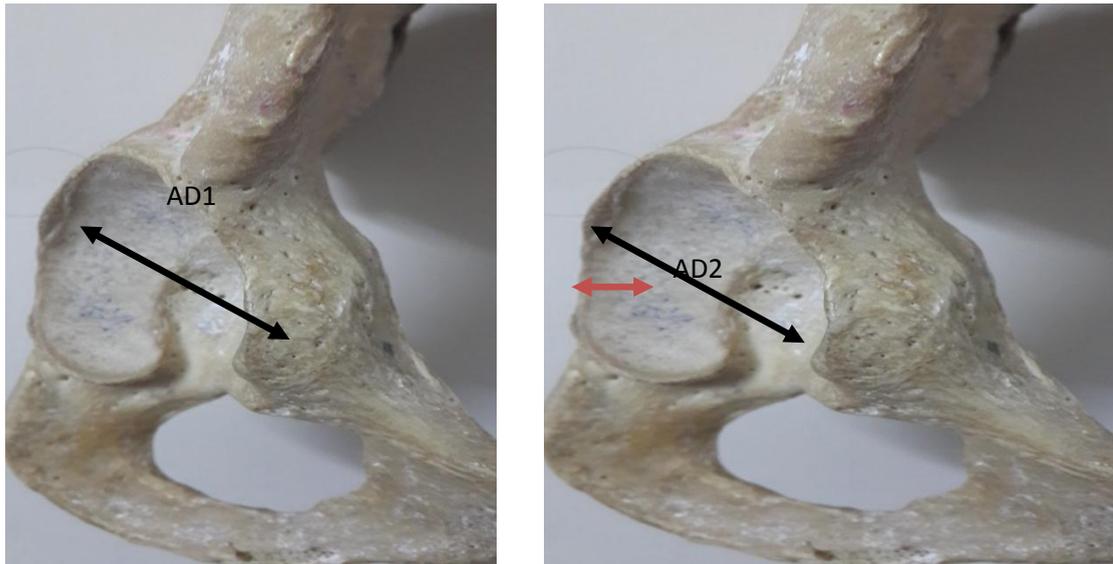


Figure 1: Shows the measurement of transverse diameter of acetabulum



Figure 2: Measurement of Depth

**RESULTS**

**Morphological measurements**

Regarding anterior acetabular shape morphology; majority was curved 60(60%) (Fig 3 ), 27 (27%) were angular (Fig 4 ), 9 (9%) were irregular (Fig 5 ), 4(4%) were straight (Fig 6 )



**Figure 4: Curved type of anterior acetabular ridge**



**Figure 4: Angular type of anterior acetabular ridge**



Figure 5: Irregular type of anterior acetabular ridge



Figure 6: Straight type of anterior acetabular ridge

**Morphometric measurement**

The mean values for the acetabular depth and diameter were 28.32±1.32mm and 50.99±1.99mm respectively (table). The maximum and minimum measurements of acetabular diameter were 61.5mm and 42.8mm. The maximum and minimum measurements of acetabular depth were 34.6mm and 21.8mm respectively.

**Table 1: Comparison of morphological parameters reported in the present study with other Studies**

Shape of the anterior acetabular ridge	Funda Tastekin Aksu et al	Maruyama et al	Govasa F et al	Gaurang parmara et al	Present study
Curved	71 (46.1%)	121 (60.50%)	98 (43.36%)	61 (61%)	60 (60%)
Straight	36 (23.3%)	9 (4.50%)	27 (11.94%)	20 (20%)	4 (4%)
Angular	26 (16.8%)	<b>51 (25.50%)</b>	64 (28.33%)	Not found	27 (27%)
Irregular	21 (13.6%)	19 (9.50%)	37 (16.37%)	19 (19%)	9 (9%)
Total	154 (100%)	200 (100%)	226 (100%)	100 (100%)	100 (100%)

**Table 2: Comparison of morphometric parameters of the present study with other authors**

	Funda Tastekin Aksu et al	Gaurang parmara et al	Present study
Average acetabular depth	29.49 ± 4.2mm	19.07 ± 2.47mm	28.32 ± 1.32mm
Average acetabular diameter	54.29±3.8mm	42.54 ± 3.6mm	50.99 ± 1.99mm

**Table 3: Comparison of Maximum and Minimum morphometric parameters of the present study**

	Funda Tastekin Aksu et al		Gaurang Paramara et al		Present study	
	Max.	Mini.	Max.	Mini.	Max.	Mini.
Acetabular depth	38.6 mm	22.6 mm	32.13mm	19.07 mm	34.6 mm	21.8 mm
Acetabular diameter	65.5 mm	44.8 mm	56.60 mm	42.54 mm	61.5 mm	42.8 mm
r value	0.498		0.437		0.416	
P value	p<0.001		P=0.001		P<0.001	

Positive and significant correlation was found between depth and the diameter of the acetabulum (r= 0.416, p<0.001)

**DISCUSSION**

As total hip replacement is a common surgery performed nowadays, awareness of the average dimensions of the acetabulum and morphology of anterior acetabular ridge is essential as it will help the prosthetists and the surgeon to determine the correct size of the acetabular cup during total hip arthroplasty and to realign the acetabulum back to normal position [4]. Maruyama et al evaluated the morphology of anterior acetabular ridge to perform the hip joint implants correctly. Our results are similar to Maruyama et al (Table- 1) but different from Funda Tastekin Aksu et al, Govasa F et al, Gaurang parmara et al, particularly the high incidence of straight type of anterior acetabular ridge may be due to ethnical origins.

The main problem for acetabular placement will be positioning the acetabular cup implant and acetabular inclination to the correct location according to its acetabular version and the acetabular depth .Dysplastic hip correlates with the acetabular depth. The normal acetabular depth is 9mm and less than that is regarded as dysplasia .In our study the measurement of average acetabular depth and average acetabular diameter are in accordance with the study done by Funda Tastekin Aksu et al, but differ from Gaurang parmara et al (Table-2 and Table-3). Maximum and minimum measurements of acetabular depth and diameter, r value, p value, are similar to the study done by previous authors.

## CONCLUSION

We would like to accentuate the importance of morphological and morphometrical study of acetabulum and we hope that it will benefit the orthopedic surgeons and implants manufacturer.

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