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The relationship between depth and diameter of the human acetabulum in the dry hip bone of Maharashtra population

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ABSTRACT

Background: Anatomy of the hip must be taken into account to perform the various surgical procedures like reconstruction of the acetabulum in patients with significant acetabular bone deficiency. It remains a major challenge in total hip arthroplasty. Appropriate anatomic concepts for surgery to treat femoroacetabular impingement require a precise appreciation of the native acetabular anatomy. Since the acetabulum is not always of the same shape, width or depth, joint congruence is frequent with minor anatomical variations in the shape of the acetabulum. Hence, the present study was undertaken as controversies still exist on the importance of these variations and to prevent problems following surgical procedures such as acetabular reconstruction and femoroacetabular impingement.

Method: 81 dry human hip bones of unknown sex were taken for observation from departments of anatomy at Dr SCGMC Nanded and SRTRGMC Ambajogai. All hip bones were adult-type. The exact age and sex of hip bones were not known. Measurements were taken in millimeters using a sliding digital vernier calliper. The mean and standard deviation of the acetabulum in various dimensions were calculated. Parameters of acetabulum depth and diameter were measured.

Result: The overall goal of this study was to generate data that would be useful to the orthopaedics for geometric modelling. The study would also help the forensic experts. It would also be valuable for the anthropologists in their racial and population studies. The mean SD value of the depth of acetabulum on the right side is 27.121.02mm and on the left side is 27.021.03. The mean S.D. value of the diameter of the acetabulum on the right side is 47.501.27mm and on the left side is 47.451.33.

Conclusion: Morphological study on adult hip bone is useful for anatomists, anthropologists, experts in forensic medicine and orthopaedics for performing surgical procedures in this area.

KEYWORDS: Acetabulum, Depth, Diameter of Acetabulum, Hip arthroplasty, Reconstruction

INTRODUCTION

Acetabulum (L. Shallow vinegar cup) is the large cup-shaped cavity or socket on the lateral aspect of the hip bone that articulates with the head of the femur to form the hip joint. It is directed laterally, downwards and somewhat forward. It is surrounded by an irregular projecting margin which is deficient inferiorly, this gap is termed the acetabular notch. The floor of the cavity is roughened and non-articular and is termed the acetabular fossa. The sides of the cup present a horseshoe-shaped articular surface which is the widest superiorly, in this situation, the weight of the trunk is transmitted to the femur in the erect attitude. The acetabular fossa forms the central floor and is rough and non-articular.[1] The articular lunate surface is the widest above (the 'dome'), where weight is transmitted to the femur. Fractures through this region therefore often lead to poor outcomes. All three innominate elements contribute to the acetabulum, but unequally. The pubis forms the anterosuperior fifth of the articular surface, the ischium forms the floor of the fossa and more than the posteroinferior two-fifth of the articular surface, and the ilium forms the remainder.[2]

The articular surface is deficient inferiorly opposite the acetabular notch and covered by articular cartilage, which is thickest where the surface is broadest. The acetabular

fossa within it is devoid of fibroelastic cartilage but contains fat largely covered by the synovial membrane. [3] Acetabular depth is increased by the acetabular labrum, a fibrocartilaginous rim attached to the acetabular margin. This deepens the cup and bridges the acetabular notch as the transverse acetabular ligament [4]

The diameter of the acetabular cavity is constricted by the labral rim, which embraces the femoral head, maintaining joint stability both as a static restraint and by providing proprioceptive information as stated by Standring. [5, 6] The purpose of this work is to contribute to the scientific literature, providing anatomical data on the similarities and variations. The depth of acetabulum correlates with acetabular diameter so this information may be helpful during hip arthroplasty, treatment of joint fracture and in diagnosing congenital hip dysplasia.

MATERIAL AND METHODS

81 dry human hip bones of unknown sex were taken for observation from departments of anatomy at Dr SCGMC Nanded and SRTRGMC Ambajogai. All hip bones were adult-type. The exact age and sex of the hip bones were not known. They were used for tutorial teaching for medical students. Measurements were taken in millimeters using a sliding digital vernier caliper. The mean and standard deviation of the acetabulum in various dimensions were calculated. The data was analyzed using the SPSS Software. The morphometric values of the two sides were analyzed using an unpaired t-test. The parameters of the acetabulum measured were Diameter and Depth.

The following parameters were used for measurement:

Acetabulum- Depth and Diameter: Measurements were taken as per the norms described in anthropometry. The data was analyzed using the SPSS Software. The morphometric values of the two sides were analyzed using an unpaired t-test

Depth of acetabulum: A thin slide scale was placed across the diameter of the acetabulum. The depth of the acetabulum was measured in mm using the vernier calliper scale from the center of the acetabulum to the sliding scale. Figure 1

Diameter of the acetabulum: Maximum transverse diameter of the acetabulum was measured using vernier calipers Figure 2.

Statistical Analysis: The mean and standard deviation of the acetabulum in various dimensions were calculated. The data was analyzed using SPSS Software. The morphometric values of the two sides were analyzed using an unpaired t-test.

RESULT

Following table summarizes the means and standard deviations of depth and diameter of acetabulum of the hip bone.Table 1

Figure 1: Measurement of depth of acetabulum by vernier calliper using thin acrylic scale

Figure 2: Showing measurement of the diameter of the acetabulum by vernier calliper

Parameter	Side of acetabulum	Mean ± SD (mm)	P –value
Depth	Right	27.12 ± 1.02	<0.0001
	Left	27.02 ± 1.03	
Diameter	Right	47.50 ± 1.27	<0.0001
	Left	47.45 ± 1.33	

Table 1: Descriptive statistics of parameter of acetabulum

There is significant difference between bilateral sides of the acetabulum of the hip bone, $p<0.05$.

The mean±SD value of the depth of acetabulum was 27.12±1.02mm, on the right side and 27.02±1.03 on the left side.

The mean±SD value of the diameter of the acetabulum was 47.50±1.27mm on the right and 47.45±1.33 on the left side.

DISCUSSION

The goal of this study was to generate the data that would be useful to the orthopaedicians for geometric modelling. The study would also help the forensic experts. It would also be valuable for the anthropologists in their racial and population studies. Acetabular depth is important in restoring normal hip mechanics and establishing a good range of movement. It is considered a contributing factor in component dislocation. As a result, to get better insight, the present study was compared with that of other workers.

Mukhopadhaya B et al. carried out a study on 100 hip joints of 50 adults obtained from medico-legal post-mortem cases. Three measurements i.e. the depth of the acetabulum, the radii of the acetabulum and the femoral head were made on each hip. They found that the mean depth of the acetabulum was 27.11 mm. [7]

Salamon A et al. measured 30 macerated anatomical specimens of pelvic bones. The mean acetabular depth was 30.3.2 mm (21-38). [8] Saikia KC et al. recorded the mean depth of acetabulum was 2.5 cm. [9]

In the present study, the mean depth of acetabulum is 27.12± 1.02. The mean depth of the present study coincides with the study done by Mukhopadhaya B et al. [7]

Lang C et al. studied a series of mostly unorthodox measurements on a sample of 45 (19 females and 26 males) dry hip bones from the Grant Collection , curated in the Medical Sciences Building at the University of Toronto. They found that mean acetabular depth in males and females was 29.0mm (SD-3.80) and 26.64 mm (SD-2.93) respectively. [10]

Kim YH et al. measured the equatorial and meridian diameter of the acetabulum in 655 Korean adult cadavers and 172 Korean fetuses with a calliper by taking the greatest width of the cavity, and the depth was measured using two wires. The mean depth of acetabulum in males and females was 20.3 mm and 18.1 mm respectively. [11]

Arsuaga J et al studied 34 linear variables and 10 non-metrical (morphological) characters in a series of 418 adult hip bones of known sex (227 males and 191 females). The mean acetabular depth in males and females was 25.1 mm (SD=2.6) and 228 mm (SD=2.2) respectively. They found that acetabulum was deeper in men than in women in both hips and this was significant ($p<0.01$ right hip, $p<0.02$ left hip). [12]

Chauhan R et al carried out the dissection of fifty-four cadaveric hip joints belonging to the age group of 50-70 years of both sexes. The average depth of acetabulum (in mm) on the right side was 27 .49±2.70 (23.o-34.0) and on the left side was 28.18±2.58 (24.3-34.0). [13]

According to Murtha PE et al., the mean depth of acetabulum in males and females was 22.7mm and 19.5 mm respectively. [14] Msamati BC et al. found the mean values of 52 acetabular depths as 31.7mm on the right side and ——mm on the left side. [15]

Saikia KC et al found the mean values of acetabular depth as identical between males: 2.5 cm (1.6-5.6 cm) and females: 2.5 cm (1.4-5.2 cm). [9]

Papaloucas C et al carried out the measurements of 200 hip bones within the Greek population. It was found that in males, in comparison to the females acetabular depth was larger. [16]

According to Funda Tastekin Aksu et al., the depth of the acetabulum of the dried hip bone was 29.49mm. In the present study, it is 27.12mm and is low as compared with the previous study. Whereas the range in the present study lies within the range observed in the previous study. The mean diameter of acetabulum was 54.29mm in the previous study, but in the present study, it's notably lower at 47.50mm. [17]

CONCLUSION

Scientific improvement urges researchers and practitioners in any field of medicine to deepen their knowledge, resulting in the emergence of specialities. Hip surgery being one of them requires more detailed knowledge, about the complex acetabular measurements. Studies based on the depth of acetabulum are relatively few in the literature; hence the findings of the present study can provide a guideline for further studies on acetabulum. Considering that total hip replacement is a common surgery performed nowadays, awareness of the dimensions of the acetabulum is of immense importance to the orthopaedic surgeons. It will assist prosthetists to construct suitable prostheses.

After comparing the findings of the present study with the previous data available, the observations are similar with most of the workers while with some others, it is varying due to formulas used for these calculations. Morphological study on adult hip bone is useful for anatomists, anthropologists, experts in forensic medicine, and orthopedics for performing surgical procedures in this area. A radiological study may be added for further accuracy.

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