Original Article

Acetabulum of the hip bone: A morphometric study in south coastal region

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Abstract

Introduction: Acetabulum is a cup shaped depression on the outer surface of the constricted central part of the hip bone, where three components meet and subsequently fuse. The acetabulum receives the head of the femur and forms poly axial hip joint. **Aim and Objective:** To study the morphometric parameters of the acetabulum of hip bone. To understand the mechanics of the joint so as to plan for suitable prosthesis. **Material and Methods:** A total number of 131 dried hip bones from the Department of Anatomy, Narayana Medical College, Nellore, of unknown age and sex were taken for the study. All measurements were manually performed directly by placing the digital vernier callipers on the acetabulum. The following parameters were observed: 1) Diameter of the acetabulum: It is the maximum transverse distance between the acetabular cavity. It was measured using digital vernier callipers and readings were noted in cms. 2) Depth of the acetabulum: It is the maximum vertical distance from the brim of the acetabulum to the deepest point in the acetabular cavity. A thin metallic strip was placed across the brim of the acetabular cavity and then the distance from the strip to deepest point in the acetabulum was measured using vernier callipers. The readings were noted in cms. 3) Capacity of the acetabulum: It is the volume of the cavity of the acetabulum. The acetabular cavity was filled with plasticine up to its brims. The plasticine was transferred to a water filled graduated measuring cylinder. The volume of the water displaced gave the capacity of acetabular cavity. 4) Shape of the anterior ridge of the acetabulum: the shape of the anterior ridge of the acetabulum was assessed and classified as curved, irregular, angular and straight. **Results:** Average maximum transverse diameter: is 3.7cms on the right side and 5.74 cms on the left side. Average depth of the acetabular cavity: is 2.0 cms on right side and 3.9 cms on the left side. Total range for the capacity was 20-55ml. Curved shape anterior rim of acetabulum was seen in 50 (38%) of cases, Straight shape in 38 (29%) of cases, irregular shape in 28 (21.3%) of cases and angular in 15 (11.4%) of cases. Diameter of the notch of the acetabulum: is 1.5 cms on the right side and 3.1 cms on the left side. **Conclusion:** The present study is of great use to the Orthopedicians, radiologists and prosthetists for the better understanding of pathophysiology of hip region. This will help them to design an efficient and functional prosthesis to prevent its loosening, dislocation and iliopsoas impingements.

Keywords: Morphometry, Hip Bone, Acetabulum, Anterior Ridge, Prosthesis.

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INTRODUCTION

The acetabulum (L. Shallow vinegar cup) is a deep cup shaped concavity facing laterally and anteroinferiorly. It is a constriction of the innominate bone that articulates with the head of the femur to form the Hip Joint. It is surrounded by an irregular margin which is deficient inferiorly at the Acetabular Notch. Transverse acetabular ligament bridges this gap to form acetabular foramen. Margin of the acetabulum provides attachment to labrum acetabulare which bridges the acetabular notch as Transverse Acetabular Ligament. The acetabular fossa is the cavity's central floor, which is rough and non articular, and a horse shoe shaped articular Lunate surface (Dome Shaped), widest above, where weight is transmitted to the femur. On this crescentic, surface covered with cartilage, the head of the femur slides. Lunate surface is covered by hyaline cartilage while acetabular fossa lodges a pad of fat. All the three innominate elements of the bone contribute to the acetabulum. The pubis forms the anterosuperior 1/5th of

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the articular surface, ischium little more than its posteroinferior 2/5th and forms the floor of the fossa and ilium little less than its superior 2/5th which is the remainder part. All the three innominate elements contribute to the acetabulum in man, but unequally. Thus, fracture of this region leads to poor out come. 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 . Moore describes that the malleable nature of the fat-pad permits it to Change shape to accommodate the variations in the congruity of the femoral head and acetabulum as well as changes in the position of the ligament of the head during joint movements. The acetabulum is divided into three zones to find out the degree of loosening of acetabulum. Zone I -Superior one-third, Zone II –Middle One-third and Zone III-Posteroinferior one-third according to Kulkarni[3]. Since the acetabulum is not always of same shape, width or depth, joint congruence's are 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.

OBJECTIVE

To study the morphometry of the acetabulum in 131 adult dry human hip bones (74 right and 57 left) in Indian population to: Evaluate various parameters of acetabulum.

MATERIAL AND METHODS

A total number of 131, out of which 74 belonged to the right side and 57 left dried hip bones from the Department of Anatomy, Narayana Medical College, Nellore, of unknown age and sex were taken for the study. All measurements were manually performed directly by placing the digital vernier callipers on the acetabulum. All the hip bones selected were dry, complete and showed normal anatomical features. Specimens showing an evidence of any previous trauma or skeletal disorders were excluded from the study. All the measurements were taken with the help of vernier calliper, measuring cylinder and plasticine. Three readings were taken for each parameter at different times and the average was recorded. The raw data obtained was statistically analysed. Range, mean, standard deviation and standard error of mean were determined for each parameter. All values were compared with series of other workers to draw the conclusions.

The following parameters were observed:

1. **Diameter of the acetabulum:** It is the maximum transverse distance between the acetabular cavities. It was measured using digital vernier callipers and readings were noted in cms.
2. **Depth of the acetabulum:** It is the maximum vertical distance from the brim of the acetabulum to the deepest point in the acetabular cavity. A thin metallic strip was placed across the brim of the acetabular cavity and then the distance from the strip to deepest point in the acetabulum was measured using vernier callipers. The readings were noted in cms.
3. **Capacity of the acetabulum:** It is the volume of the cavity of the acetabulum. The acetabular cavity was filled with plasticine up to its brims. The plasticine was transferred to a water filled graduated measuring cylinder. The volume of the water displaced gave the capacity of acetabular cavity.
4. **Shape of the anterior ridge of the acetabulum:** the shape of the anterior ridge of the acetabulum was assessed and classified as curved, irregular, angular and straight.

RESULTS

Morphological evaluation of shape of the anterior ridge of acetabulum was done on 131 dry hip bones, out of them 74 were belonged to right side and 57 to left side. The shape was classified as Curved shape anterior rim of acetabulum which was seen in 50 (38.2%) of cases, Straight shape in 38 (29.00%) of cases, irregular shaped was seen in 28 (21.3%) of cases and angular shape was seen in 15 (11.5%) of cases. The average maximum transverse diameter: is 3.7cms on the right side and 5.74 cms on the left side. The average depth of the acetabular cavity: is 2.0 cms on right side and 3.9 cms on the left side. Total range for the capacity was 20-55ml.

DISCUSSION

The main intention of this study was to accentuate the importance of morphology of acetabulum. This data suffices the Orthopedicians for geometric modelling and proper development of prosthetic implants.

Table 1: Comparision of diameter and depth of acetabulum by various authors

Authors	Diameter of acetabulum (Cms)		Depth of acetabulum (Cms)	
	Right	Left	Right	Left
Lander	5.70	5.60	-------	---------
Chauhan	4.71 (Male)	4.75 (Male)	2.75 (Male)	2.82 (Male)
Chauhan	4.44 (Female)	4.60 (Female)	2.47 (Female)	2.57 (Female)
Mukopadhyaya Band Barooh B			2.47 Unknown sex	2.45 Unknown sex
Luna MP et.al			2.58 unknown sex	
Dhindsa	5.13	5.03	2.67	2.64
KK Vyas	4.83	4.79	2.71	2.65
Salamon A *et al*			3.0	
Genser-Strobl B and Sora MC			1.64	
Present study	4.85	4.74	3.0	3.06

Many workers have studied the diameter of acetabulum. In the present study, mean diameter of acetabulum is 4.85 cm on right side and 4.74 cm on left side. As it can be seen in the table no.7 values noted by most of the authors are consistent with present study values. The values noted by Lander and Rosenberg KR *et al* are higher than the present study values. The mean depth of acetabulum in present study is 3.0 cm on right side and 3.06 cm on left side. The values are consistent with values noted by Mukhopadhaya and Barooah , Luna and Chauhan *et al* . The reading of Salamon *et al* is higher than the present study readings, which may probably be due to racial variations. The values noted by Genser- Strobl and Sora are lower than the present study values because of difference in method used in measurement. Many authors like Croft *et al* , Lau *et al* , Smith *et al* , Lane *et al* and Lequesne *et al* studied the depth of acetabulum on radiographs. As a result their studies show much lower values as compared to present study values. The capacity of acetabulum in present study is 36.68 ml on right side and 33.56 ml on left side. In a study done by Taher the values were quite low as compared to present study. The lower values may probably be due to the regional variations.

Table 2: Comparision of capacity of acetabulum in present and previous study

Author	Capacity of acetabulum		
	Male	Female	Unknown sex
Taher SA	28	21.50	
Dayanand			36.68 (Right), 33.56(Left)
Present study			36.68 (Right), 33.56 (Right)

Table 3: Comparison between the shapes of right and left acetabulum

Shape of anterior acetabular ridge	Number and Incidence of shape				Total No. %	
	Right Acetabulum No.%		Left Acetabulum No. %			
Curved	26	39.4%	24	37.1%	50	38.2%
Angular	10	15.2%	05	7.7%	15	11.5%
Irregular	10	15.1%	18	27.6%	28	21.3%
Straight	2.	30.3%	18	27.6%	38	29.0%
Total	**66**	**100%**	**65**	**100%**	**131**	**100%**

Table 4: Comparision of shapes of acetabular ridge by various authors

Shape of anterior acetabular ridge	Govsa et. Al.	Maruyama	AKSU et.al.	KK Vyas	Present study
	No.%	No. %	No. %	No. %	No. %
Curved	98(43.3%)	121(60.5%)	71(46.1%)	57(37.5%)	50(38.2%)
Angular	64(28.3%)	51(25.5%)	26(16.8%)	19(12.5%)	15(11.5%)
Irregular	37(16.3%)	19(9.5%)	21(13.6%)	28(18.4%)	28(21.3%)
Straight	27(11.9%)	9(4.5%)	36(23.3%)	48(31.6%)	38(29.0%)
Total	**226(100%)**	**200(100%)**	**154(100%)**	**152(100%)**	**131(100%)**

In the present study, the various shapes of the anterior ridge of the acetabulum was evaluated (Table11) and compared with findings of the other studies (Table 12). These findings suggest that there is no significant difference on the right and left side except of irregular shape. 38.2 % of ridges were of curved shaped. These findings are much lesser than the findings of Marumaya *et al* (60.5%) and lesser then the findings of Aksu *et al*

(46.1%) and Govsa *et al* (43.3%). Straight shaped ridge comprised of 38%, as compared to findings of Marumaya *et al* (4.5%) and Govsa *et al* (11.9%). Other shapes are angular (15%) and irregular (28%). Findings in the present study are more or less comparable with the findings of Aksu *et al* (Table 11). After 10 years of surgical implantation of a hip prosthesis, there is a disturbing progression level mechanical loosening of the acetabulum. In the present study, 68.4% anterior ridge of acetabulum is curved, angular or irregular type. . The use of side specific cups that replicate the curvaceous acetabular profile could prevent prosthetic overlap and reduce the incidence of iliopsoas impingement. All parameters showed a higher value for the right side as compared to the left side. The most striking difference between the right and left side values was seen in case of the capacity of the acetabulum. These parameters are at a variance from the past researchers. One of the probable reasons could be that the hip bones we measured were taken at random, i.e. the right and left sided bones were not from the same skeleton. Hence, ideally the measurements of the two sides should be taken from bones belonging to the same skeleton.

CONCLUSION

The values of the present findings will be helpful for the clinicians, Orthopedicians, prosthetists and radiologists to better understand the pathophysiology of hip region and preparing suitable prosthesis which are more functional to prevent common complications like prosthetic loosening and dislocation. Since present study was performed on limited dry hip bones of unknown age and sex further cadaveric and radiological study of known age and sex is indicated.

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