

A STUDY ON MORPHOMETRIC MEASUREMENT OF VOLUME OF ACETABULUM

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ABSTRACT

Background: Hip joint represents an unique functional unit and has complex biomechanical construction. In today's era where total hip replacement surgeries have made their way it has become imperative for the anatomists to know the variations in acetabular dimensions. Reconstruction of acetabulum in patients with significant acetabular bone deficiency remains a challenge. Hence the present study was carried out with the aim to study the morphometric measurement of volume of acetabulum in both the sexes.

Materials and Methods: Material of the study consisted of 110 human hip bones (60 males and 50 females). Volume of Acetabulum (VA) was measured on these hip bones on both the sides. Statistical analysis was done using SPSS (Statistical Package for the Social Sciences) version 11 and Microsoft Excel 2007.

Results: The mean volume of acetabulum in male was 23.13 ml and female was 17.88 ml. The mean volume of acetabulum on right side was 20.55 ml and left side was 20.91 ml. Volume of the acetabulum was greater in males as compared to females and the differences were statistically significant. Volume was greater on the left side as compared to the right side but the difference was statistically non significant.

Discussion: Analysing the differences on human acetabulum is helpful in understanding not only morphological but also medicolegal aspects.

Conclusion: Volume of the acetabulum was greater in males as compared to females.

KEY WORDS: Acetabulum; Volume; Hip replacement; Reconstruction.

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INTRODUCTION

The 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. The acetabular fossa forms the central floor and is rough and non articular. The articular lunate surface is 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 rather more than the posteroinferior two-fifths of the articular surface, and the ilium forms the remainder. The acetabular 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 cartilage but contains fibroelastic fat largely covered by synovial membrane. 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. 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 Standing [1]. Moore [2] 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 congruences 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.

MATERIALS AND METHODS

The present study was conducted in the Department of Anatomy, Padmashree Dr. D.Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune. Material of the study consisted of 110 human hip bones (60 males and 50 females). All the bones were fully ossified (adult) and free from any pathological or congenital defect. The hip bones studied were collected from the various departments of Dr. D.Y. Patil Medical College, Pimpri, Pune, Dr. D.Y. Patil College of Ayurved and Research Centre, Pimpri, Pune and MIMER'S Medical college, Talegaon, Pune. Volume of acetabulum was measured on these hip bones on both the sides. Classification of the bones regarding gender was carried out. The diameter of the acetabulum and

the distance between its anterior rim and symphysis pubis, width of greater sciatic notch, preauricular sulcus, obturator foramen, ischiopubic ramus and features of ilium and pubis were considered for the classification of the hip bones regarding gender.

Method of measurement used for volume of acetabulum (VA) :

The acetabular notch was packed with Plaster of Paris by dissolving the Plaster of Paris in water. The ratio of Plaster of Paris and water was 3:1. A special type of piece of polythene paper ('Press N Seal') was spread and sealed all over the internal surface of the acetabular cavity. The acetabular cup was filled with water completely and covered with 'Press N Seal'. A small hole was made with the divider and enlarged with the help of scissors, and emptied the water into the Graduated cylinder. The reading was noted.

Fig. 1: Acetabular notch packed with Plaster of Paris.

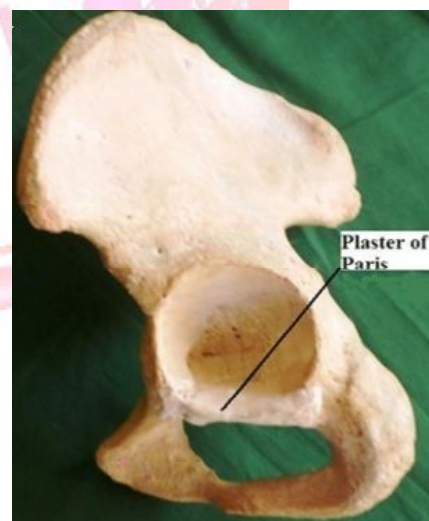


Fig. 2: Acetabulum filled with water.



Fig. 3: Measurement of volume of Acetabulum with 'Press N seal'.



The data obtained for volume was analysed in the following manner:

- a) Measurements of males were compared with measurements of females.
- b) Measurements of right side were compared with measurements of left side.
- c) In males right side measurements were compared with left side measurements.
- d) In females right side measurements were compared with left side measurements.
- e) Measurements of right side in males were compared with measurements of right side in females.
- f) Measurements of left side in males were compared with measurements of left side in females.

The data obtained for volume was tabulated and analysed statistically to find Mean, Standard deviation (SD) and Range in both the sexes and both the sides. The results were analysed statistically, by unpaired Student's 't' test. P value of ≤ 0.05 was considered for Statistical significance, Mahajan [4]. Statistical analysis was done using SPSS (Statistical Package for the Social Sciences) version 11 and Microsoft Excel 2007.

RESULTS AND TABLES

Following tables summarize the observations and results of the present study.

Table 1: Volume of Acetabulum (VA) in Male and Female.

Sex	n	Volume (ml)			P value
		Mean	S.D.	Range	
Male	60	23.13	5.37	11-37	<0.0001
Female	50	17.88	3.12	12-27	

In the present study, the mean VA in Male > Female. The difference is statistically significant ($P < 0.0001$).

Table 2: Volume of Acetabulum (VA) on Right and Left sides.

Side	n	Volume (ml)			P value
		Mean	S.D.	Range	
Right	51	20.55	4.96	12-34	>0.05
Left	59	20.91	5.4	11-37	

The mean VA on Left > Right. The difference is statistically non- significant.

Table 3: Comparison of Volume of Acetabulum (VA) in Male and Female with respect to side.

Volume of Acetabulum (VA) in ml				
	Male (Right)	Female (Right)	Male (Left)	Female (Left)
Mean \pm SD	23.58 \pm 4.71	17.4 \pm 2.81	22.79 \pm 5.87	18.36 \pm 3.39
Range	15 - 34	12-24	11 - 37	13 - 27

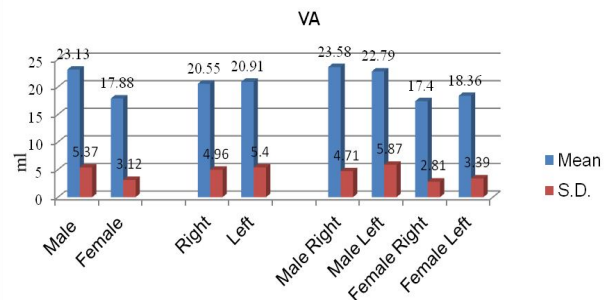
In case of male, the mean VA on Right > Left. The difference is statistically non- significant ($P > 0.05$).

In case of female, the mean VA on Left > Right. The difference is statistically non- significant ($P > 0.05$).

The mean VA in Male Right > Female Right. The difference is statistically significant ($P < 0.0001$).

The mean VA in Male Left > Female Left. The difference is statistically significant ($P < 0.001$).

Graph 1: Comparison of Volume (VA) with respect to sex and side in total and subtotal sample.



DISCUSSION

As a result to get a better insight, the present study was compared with that of other workers.

Tan et al [5] studied fifty-five embalmed hips. The volume of the acetabulum without the labrum was 31.5 cm³ ; with the labrum, it was 41.1 cm³ ($P < .0001$). There was no side- to - side difference in contribution of the labrum to either surface area or volume between right and left hips. In the present study, the mean volume of acetabulum is 20.74 ml \pm 5.18(range 11-37).

Volume of acetabulum is 23.13 ± 5.37 (range 11-37) ml in case of male and 17.88 ± 3.12 (range 12-27)ml in case of female. In the present study, the mean VA in Male > Female. The difference is statistically significant ($P < 0.0001$). Present study also showed that volume was greater on left side as compared to right side, but the difference was statistically not significant.

Kordelle et al [6] mentioned the shape of the acetabulum described by the height , width , depth, acetabular volume and surface. The mean acetabular volume was 26.3 mm^3 (range 16.0-45.4) .

Chung et al [7] states that if the definition of acetabular volume is the depth of the acetabulum that contains the femoral head, then it will increase after a Dega osteotomy. They believe this definition to be preferable when assessing pelvic surgery for acetabular deficiency of acetabular volume.

Table 4: Comparison of Volume of Acetabulum with present study.

Sr. No.	Study	Sample size	Volume		
			Mean	S.D.	Range
1	Tan V ⁵	55	31.5 cm^3	-	-
2	Kordelle J ⁶	32	26.3 mm^3	-	16.0-45.4
3	Chung CY ⁷	17	14.2 ml	6	-
4	Present study	110	20.74ml	5.18	11-37

Chibber et al [8] suggest that left limb is dominant. 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. Study done by Chauhan et al [9] found that left hip joint dimensions were greater than the right yet they were statistically insignificant. In the present study also it is found that the volume was greater on left side as compared to right side but was statistically non significant.

CONCLUSION

Knowledge of the anatomical parameters of the acetabulum is of immense importance to the Orthopaedic surgeons. Hip surgery being one of them requires more detailed knowledge, about the complex acetabular measurements in order to fulfil the need for verifying the validity of various surgical procedures under practice. The volume studied on acetabulum showed statistically significant differences between

males and females. Studies based on Volume of acetabulum are relatively few in the Literature, hence the findings of the present study can provide a guideline for further studies on acetabulum. The present study hence provides measurements of volume of acetabulum that would help the anatomists, anthropologists, orthopaedicians, prosthetists, radiologists and forensic experts to deliver excellent performance in their respective specialities.

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Conflicts of Interests: None

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