

Study of morphometric analysis of acetabulum and its clinical correlation in South Indian population

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ABSTRACT

Introduction: Acetabulum is a cup shaped cavity on the outer surface of the constricted central part of the hip bone, where three components meet and subsequently fuse. In modern world, orthopaedic surgeons and biomedical engineers are trying to make the best possible prosthesis for planning the total hip replacement. Body proportion and absolute dimension vary widely in respect to age, sex and racial groups. While partially due to variability in muscularity and adiposity, such variations are chiefly in skeletal system.

Purpose of study: The main intention of this study was to obtain the morphometric data of acetabulum. This data suffices the mechanics of the hip joint so as to plan for suitable prosthesis and various surgical approaches.

Material and method: The study was conducted in the department of Anatomy. Hundred hip bones of both sexes were used. In this study we included only healthy adult bones, deformed and eroded bones were excluded from the study. The osteometric parameters such as diameter, depth and capacity of acetabulum, notch width and shape of the anterior acetabular ridge were measured using digital Vernier calipers and measuring jar. The data was analysed statistically using SPSS software.

Results: The mean diameter of acetabulum in males was found to be 5.03 cm and in females it was 4.44 cm, whereas on right side it was 4.70 cm and on left side it was 4.77 cm. The mean depth of acetabulum in males was 2.85 cm and in females it was 2.49 cm, whereas on the right side was 2.71 cm and 2.63 cm on the left. The mean notch width of the acetabulum in males was 2.07 cm and in females it was 1.71 cm, whereas on the right side it was 1.92 cm, and 1.85 cm on the left. Total range for the acetabular capacity was 22-30.68 ml. The curved shape anterior acetabular ridge was the most predominant type (39%) and the least type was irregular shaped (15%).

Conclusion: The acetabular parameters such as acetabular diameter, depth, capacity and notch width of the acetabulum was greater in males compared to the females. Statistically the comparison was highly significant. Most common anterior acetabular ridge shape is curved type (39%), least was Irregular type (15%). Morphometric data of acetabulum is essential for clinical correlation and it also helps in the detection of disputed sex by Forensic experts. It also helps the orthopaedic surgeons for planning the total hip replacement

KEY WORDS: Hip bone, Acetabular Diameter, Acetabular Depth, anterior ridge, Notch.

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INTRODUCTION

Hip joint is one of the most important weight carrying joint of the body. Originally hip joint was referred to as ball and socket variety, a type of synovial joint, however, it is being referred to as rotational conchoids at the moment [1]. The acetabulum (L. Shallow vinegar cup) is a deep cup shaped cavity present on the lateral aspect of the hip bone, which is contributed by three bones (i.e - ilium, ischium & pubis) bounded by a ridge known as rim of acetabulum [2]. It comprises of an articular and a non-articular part. The non-articular, rough part forms the central floor and is called the acetabular fossa. The articular part is called the lunate surface. The lunate surface is widest above through which weight is transmitted to the femur [3].

Development of normal acetabular cavity is essential for proper biomechanism of hip joint. Cavity starts developing from 4th to 6th week of intra-uterine life. During 7th week of gestation pre-cartilaginous pattern is seen and entire acetabulum is fully formed at 8th week of foetus. Displacement of hip joint is one of the commonest congenital disorders in which the head of femur is not properly articulated inside the shallow acetabular cavity. In this situation patient has to undergo hip arthroscopy at the earliest [4]. Morphometry of acetabular fossa serves as a baseline data for construction of prostheses of acetabulum in clinical practice. Orthopaedic surgeons use measurements of acetabular parameter for operative treatment [5, 6]. Acetabular and Center Edge (CE) angle amongst other parameters were used to evaluate hip dysplasia and to assess patients recovery [7]. Knowledge of the anatomical parameters is very much essential for better learning the complexity and etiopathogenesis of diseases like primary osteoarthritis of the hip joint.

MATERIALS AND METHODS

A total of 100 Indian adult dry hip bones of known sex were studied from teaching collection of the Anatomy Department, Yenepoya Medical College, Mangalore. We selected 50 male and 50 female hip bones. Among 100 bones, 51 bones belonged to the right side

and 49 belonged to the left side. All the hip bones selected were dry, complete and showed normal anatomical features. Specimens showing osteoarthritic changes, evidence of any previous trauma or skeletal disorders were excluded from the study. All the measurements were taken with the help of digital vernier calipers. Two readings were taken for each parameter at different times and the average was recorded. Mean, standard deviation and standard error of mean and t-value, p-value, were determined for each parameter. All values were compared with series of other workers to draw the conclusions.

The following parameters were observed:

Diameter of the acetabulum: The maximum antero-posterior distance of acetabulum, measured by the digital vernier caliper.

Depth of the acetabulum: The maximum vertical distance from the brim of the acetabulum to the center deepest point in the acetabular fossa. It was measured by placing a metallic scale across the brim of the acetabular cavity.

Width of acetabular notch: The distance between the two ends of the lunate shaped articular part of the acetabulum.

Capacity of the acetabulum: It is the volume of the cavity of acetabulum. The acetabular cavity was filled with plasticine up to margin of brim. The plasticine was then transferred to a water filled graduated measuring glass cylinder. The volume of water displaced gave the capacity of acetabular cavity.

Shape of the anterior ridge of the acetabulum: The shape of the anterior ridge of acetabulum was assessed and classified as curved, angular, straight, and irregular.

Sex Determination: All 100 hip bones were separated into males and females depending on seven visual criteria of human hip bones. Bones which fulfil all these criteria were selected for the study. These criteria were:

Preauricular sulcus [8]: Preauricular sulcus was seen or felt as a depression just inferior to auricular part of sacropelvic surface of ilium. This was deeper in female and absent or shallower in male.

Greater sciatic notch [8]: The greater sciatic notch is present posteriorly, bounded above by the ilium, below by the ilium and ischium. It is formed by turning of the posterior border of hip bone horizontally forwards for about 3cm and then turning down and back to join the posterior ischial border. The width and posterior angle of the notch was observed in the entire bones. Greater sciatic notch is wider in female and narrower in male.

Obturator foramen [8]: The shape of obturator foramen which is present below and slightly anterior to the acetabulum was noted in both the sexes. The shape of obturator foramen was oval in male and triangular in female.

Iliac fossa [8]: The depth of iliac fossa i.e. the internal cavity of ilium forming the wall of greater pelvis was compared in both the sexes. Iliac fossa was deep in male and shallow in female.

Ischiopubic ramus eversion [8]: Presence or absence of eversion of ischiopubic ramus was looked for in both the sexes. Ischiopubic ramus was everted in male because of attachment of crus of penis. This was not everted in female.

Subpubic concavity [8]: This was seen from the dorsal aspect as a small curve of the ischiopubic ramus, a short distance below the lower margin of pubic symphysis. Subpubic concavity was present in female and absent in male.

Comparison between diameter of acetabulum and the distance of its anterior rim from pubic symphysis [8]: This was done to assess the size of acetabulum in both the sexes. Acetabular diameter was more than distance of its anterior rim from pubic symphysis in male as compared to female.

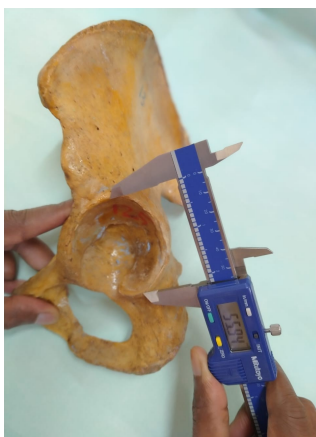


Fig. 1: Measurement of diameter of acetabulum.



Fig. 2: Measurement of depth of acetabulum.



Fig. 3: Measurement of width of acetabular notch.



Fig. 4: Measuring capacity of acetabulum.

RESULTS

The mean value of Acetabular Diameter, Depth, and Notch Width in male and female hip bones:

The acetabular diameter was greater in males (5.03cm) when compared with females (4.44 cm), while depth of acetabulum was greater

in males (2.85 cm) and it was less in females (2.49 cm). Similarly notch width in males was greater (2.07 cm) than the females (1.71 cm). The acetabular capacity in males (30.68 ml) was found to be more than females (22.20 ml) in our study. All the parameters showed p value ≤ 0.001 which is statistically highly significant as seen in table no 1.

The mean value of Acetabular Diameter, Depth, and Notch Width on right and left hip bones: The mean value of diameter of acetabulum on the right side was 4.70 cm and 4.77 cm on the left side, while the mean depth of acetabulum was 2.71 cm on right side and 2.63 cm on the left side. The notch width of acetabulum was 1.92 cm on the right side and 1.86 cm on the left side. The acetabular capacity was 28.04 ml on right side and 26.86 ml on left side. The results were statistically not significant as seen in table no 2.

DISCUSSION

Hip joint is one of the major joints of the body described as ball and socket variety of synovial joint [9]. Morphometric data of acetabulum is essential for clinical correlation and it also helps detection of disputed sex by Forensic experts. It also helps the orthopaedic surgeons for planning the total hip replacement. The main intention of this study was to accentuate the importance of morphometric data of

acetabulum. This data suffices the orthopaedicians for geometric modelling and proper development of prosthetic implants.

Acetabular diameter, depth and notch width:

Many workers have studied the acetabular diameter. In the present study, the mean acetabular diameter in males was found to be 5.03 cm and in females was 4.44 cm. Kalpana Purohit et.al [10] showed higher values when compared to the present study while K Yugesh et al [11] values are consistent with our study.

In the present study, the mean depth of acetabulum in males was 2.85 cm and in females it was 2.49 cm. The values noted by Kalpana Purohit et.al [10], K Yugesh et al [11], Leena Khobragade et al [3] are consistent with present study values.

The mean notch width of acetabulum in males was 2.07 cm in males and 1.71 cm in females. K Yugesh et al [11] showed higher values when compared to the present study.

In most of the studies, all parameters in females showed higher values than males in contrast to our study where all the parameters in males were higher than females as seen in table no 3.

In the present study acetabular parameters when compared to right and left, showed mean diameter of acetabulum to be 4.70 cm

Table 1: Acetabular measurements in cm in male and female.

Parameters	Sex	Number	Mean	Standard Deviation	t-value	p-value
Acetabular Diameter	Male	50	5.03	0.309	9.18	<0.001
	Female	50	4.44	0.338		
Acetabular Depth	Male	50	2.85	0.272	6.324	<0.001
	Female	50	2.49	0.295		
Notch Width	Male	50	2.07	0.389	9.11	<0.001
	Female	50	1.71	0.386		
Acetabular capacity	Male	50	30.68	4.56	4.58	<0.001
	Female	50	22.2	4.742		

Table 2: Acetabular measurements in cm in left and right side.

Parameters	Side	Number	Mean	SD	t-value	p-value
Acetabular Diameter	Right	51	4.7	0.398	0.78	0.437
	Left	49	4.77	0.479		
Acetabular Depth	Right	51	2.71	0.357	1.06	0.292
	Left	49	2.63	0.31		
Notch width	Right	51	1.92	0.45	0.754	> 0.05
	Left	49	1.86	0.4		
Acetabular Capacity	Right	51	28.04	6.158	0.648	> 0.05
	Left	49	26.86	6.465		

Table 3: Showing the comparison of morphometric parameters of acetabulum of male and female with other studies.

Authors	Sex	Acetabular Diameter	Acetabular Depth	Notch width
Kalpana Purohit et.al [10]	Male	5.29 cm	2.43 cm	2.02 cm
	Female	5.65 cm	2.52 cm	2.34cm
K Yugesh et al [11]	Male	4.87 cm	3.00 cm	3.05 cm
	Female	4.62 cm	2.15 cm	3.18 cm
Leena Khobragade et al [3]	Male	-	2.69 cm	-
	Female	-	2.53 cm	-
Present study	Male	5.03 cm	2.85 cm	2.07 cm
	Female	4.44 cm	2.49 cm	1.71 cm

Table 4: Showing the comparison of morphometric parameters of acetabulum of right and left side with other studies.

Authors	Side	Acetabular Diameter	Acetabular Depth	Notch width
Gangavarapu et.al [24]	Right	4.94 cm	2.5 cm	2.2 cm
	Left	4.8 cm	2.52 cm	2.3 cm
K. Yugesh et. al [11]	Right	4.74 cm	2.9 cm	3.1 cm
	Left	4.80 cm	2.9 cm	3.1 cm
Kareddy pratib et.al [16]	Right	3.7 cm	2.0 cm	1.5 cm
	Left	5.74 cm	3.9 cm	3.3 cm
Kalpana purohit et.al [10]	Right	5.3 cm	2.3 cm	2.2 cm
	Left	5.5 cm	2.6 cm	2.2 cm
Lander et al [14]	Right	5.60 cm	-	-
	Left	5.70 cm	-	-
Gursharan Singh Dhindsa [13]	Right	5.13 cm	2.67 cm	-
	Left	5.03 cm	2.64 cm	-
Kintu Vyas et al [18]	Right	4.83 cm	2.71 cm	-
	Left	4.97 cm	2.65 cm	-
Present study	Right	4.70 cm	2.71 cm	1.92 cm
	Left	4.77 cm	2.63 cm	1.85 cm

Table 5: Showing comparison of shape of the anterior acetabular ridge with other studies.

Shape of the anterior acetabular ridge	Curved	Angular	Straight	Irregular
Govsa et.al [17]	43.30%	28.30%	11.90%	16.30%
Kintu vyas et.al [18]	37.50%	12.50%	31.60%	18.40%
Thoudam Bedita Devi et.al [19]	60%	4%	9%	27%
Funda Tastekin Aksu et. al [20]	46.10%	16.80%	23.30%	13.60%
Kareddy pratibha,et.al [16]	38.20%	11.50%	29.00%	21.30%
Maruyama et.al [21]	60.50%	25.50%	4.50%	9.50%
Gaurang parmara et.al [22]	61%	Not found	20%	19%
Ina bahl et al [23]	41.10%	26.00%	5.50%	27.40%
Kalpana Purohit et.al [10]	43.90%	38.60%	5.30%	12.30%
Present study	39%	24%	22%	15%

on right side and 4.77 cm on left side. The mean depth of acetabulum was 2.71 cm on right side and 2.63cm on the left side. The mean notch width of acetabulum was 1.92 cm on right side 1.85 cm on the left side. Values noted by most of the authors are consistent with present study values, as it can be seen in the table number 4.

Shape of anterior acetabular ridge: In the present study, the most common shape of anterior acetabular ridge is curved type (39%) whereas the least was irregular type (15%). The results are consistent with the previous studies who found curved type to be the most common type as seen in table no 5. Studies done by Funda Tastekin Aksu et.al [20],

Gaurang parmara et.al [22] showed irregular type to be the least common type which correlates to our study.

Capacity of acetabulum: The capacity of acetabulum in males was 30.68 ml and in females it was 22.20 ml. These values are consistent with values noted by Taher SA [15]. The mean capacity of acetabulum was 28.04 ml on right and 26.86 ml on left side.

CONCLUSION

In the present study, the parameters of the acetabular depth, diameter, capacity and notch width showed statistically highly significant ($p\hat{A}0.001$) difference between males and females. Most common anterior acetabular ridge shape is curved type (39%) and least common was irregular type (15%). This information may be helpful for the total hip replacement by orthopaedic surgeons. Morphometric study will help detection of disputed sex by Forensic Experts. It will also help to assist prosthetists to construct suitable prostheses.

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Author Contributions

Bollavaram Pullanna: Substantial contributions to conception and design and achievement of data, Drafting the article, revising it critically for important intellectual content, Final approval of the version to be published.

Gautham Kamble: Substantial contributions to conception and design and achievement of data, Drafting the article, revising it critically for important intellectual content, Final approval of the version to be published.

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Conflicts of Interests: None

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