

Morphometric Analysis Of Acetabular Depth In Normal Population Hips And Its Clinical Correlation

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Doi: 10.47750/pnr.2022.13. S05.179

Abstract

Introduction: The acetabulum is a concave surface of the pelvis. The head of the femur meets with the pelvis at the acetabulum, forming the hip joint. There are three bones of the os coxae (hip bone) that come together to form the acetabulum. Contributing a little more than two-fifths of the structure is the ischium, which provides lower and side boundaries to the acetabulum. The ilium forms the upper boundary, providing a little less than two-fifths of the structure of the acetabulum. The rest is formed by the pubis, near the midline.

Aim: Morphometric Analysis of acetabular depth in normal population hips and its clinical correlation

Materials And Methods: This is a prospective, descriptive, cross sectional and observational study conducted at Department of Anatomy and Radiology, Government Medical College, Ajamgrah and Department of Anatomy and Radiology, Index Medical College, Indore from January 2020 December 2023. Study group divided into 3 groups:

Group A: 18-35 years, Group B: 36-55 years and Group C: 56-75 years. Acetabular images will be acquired using CT scanner (Somatom, Volume Zoom, Siemens) at 3.0 mm thickness and 12.0 mm table feed per rotation. The four row multi slices CT scanner will be conducted using 120 kV and 90 mAs with recon increment will be set to 1.5 and 1.25 mm collimation.

Result: In our study total 154 subjects were enrolled. This sample was divided by gender with mean, Standard deviation and range value. In our study male was 92 (60%) and female was 62 (40%).

Conclusion: A thorough knowledge of dimensions of acetabulum and femoral head in both sexes will assist the Biomedical Engineers to construct suitable prostheses. This gives the average values of various parameters to near normal situations as encountered in patients at the operation table. Knowledge of the anatomical parameters of bony components of the hip joint are also very much essential to get a better understanding of the etiopathogenesis of primary osteoarthritis and will help in early detection of disputed sex by Forensic experts.

Keywords: Acetabular depth, Hips, Morphometric, Clinical correlation

INTRODUCTION

The acetabulum is a concave surface of the pelvis. The head of the femur meets with the pelvis at the acetabulum, forming the hip joint. There are three bones of the os coxae (hip bone) that come together to form the acetabulum. ^[1] Contributing a little more than two-fifths of the structure is the ischium, which provides lower and side boundaries to the acetabulum. The ilium forms the upper boundary, providing a little less than two-fifths of the structure of the acetabulum. The rest is formed by the pubis, near the midline. ^[2]

It is bounded by a prominent uneven rim, which is thick and strong above, and serves for the attachment of the acetabular labrum, which reduces its opening, and deepens the surface for formation of the hip joint. At the lower part of the acetabulum is the acetabular notch, which is continuous with a circular depression, the acetabular fossa, at the bottom of the cavity of the acetabulum. ^[3] The rest of the acetabulum is formed by a curved, crescent-moon shaped surface, the lunate surface, where the joint is made with the head of the femur. Its counterpart in the pectoral girdle is the glenoid fossa. ^[4]

A deeper acetabulum would confer greater stability but would limit the range of movement. Even with the fibrocartilaginous labrum the socket is not deep enough to accommodate the whole of the femoral head, whose articular

surface extends considerably beyond a hemisphere. The opening of the acetabulum faces downwards and forward (about 30 degrees in each direction).^[5]

The depth of the acetabulum was defined as the distance between the deepest part of the acetabulum relative to the rim plane. The acetabular depth is the length measured along a perpendicular line after joining the superior and inferior lips of the acetabulum from the midpoint of the lips to the deepest point of the acetabulum. This depth is of interest because of its influence on the range of movement of the femoral component and acetabular cover.^[6]

Acetabular dysplasia was assessed by morphometric measurement of the centre-edge (CE) angle and acetabular depth.^[7] Acetabular dysplasia is associated with labral tears and early osteoarthritis (OA), a condition known as lateral rim syndrome. Even a mildly abnormal shallow acetabulum predisposes to the development of premature degenerative chondral changes and labral tears.^[8] Dysplasia of the acetabulum or minor anatomical variation in the fitting of the components of the joint have been suggested as contributory factors in the causation of osteoarthritis.^[9]

In Indians, congenital dislocation is also rare and primary osteoarthritis of the hip is uncommon.^[10] Radiologically, it may appear that primary osteoarthritis of hip joint is rare in Indians but gross examination of the joint reveals that the disease is not as rare as it was earlier thought to be. Erosion of the cartilage was the commonest pathology observed. Anterosuperior quadrant of the acetabulum and femoral head cartilage was the most frequent site of involvement.^[11]

Keeping in view the more generally accepted views and the discrepant claims of many workers an attempt has been made in the present study to observe and verify the depth of the acetabulum and assess sexual dimorphism if any.

To set standardized acetabular parameters as Indian standard, comparable with international standards for pre-templating in surgeries like total hip arthroplasty, hemiarthroplasty, in diagnosis of common clinical conditions like osteoarthritis, protrusion acetabuli, congenital dislocation of hip, dysplastic dislocation of hip and also in forensic analysis.

AIM: Morphometric Analysis of acetabular depth in normal population hips and its clinical correlation

MATERIALS AND METHODS

This is a prospective, descriptive, cross sectional and observational study conducted at Department of Anatomy and Radiology, Government Medical College, Ajamgrah and Department of Anatomy and Radiology, Index Medical College, Indore from January 2020 December 2023.

Inclusion criteria:

- Age > 18 years of either gender will be included.
- Persons willing to give consent.

Exclusion criteria

- Patients with hip pain on presentation will be excluded.
- Persons not willing to give consent.
- Pregnant women, those who experienced previous femoral injury, wearing implant or prosthesis.

Study group divided into 3 groups:

Group A: 18-35 years

Group B: 36-55 years

Group C: 56-75 years

Acetabular images will be acquired using CT scanner (Somatom, Volume Zoom, Siemens) at 3.0 mm thickness and 12.0 mm table feed per rotation. The four row multi slices CT scanner will be conducted using 120 kV and 90 mAs with recon increment will be set to 1.5 and 1.25 mm collimation. Subjects will be asked to lay down at supine position with their feet stabilized using the specially designed wood jig to standardize the position of feet during image acquisition.

The following data will be collected before the study: patient's age, gender, weight and height. The parameters involved will be

1) Center Edge Angle (CE): It is described as the angle between the line joining the centre of femoral head and lateral margin on the acetabular roof and the vertical line from the centre of femoral head. (Fig 5a)

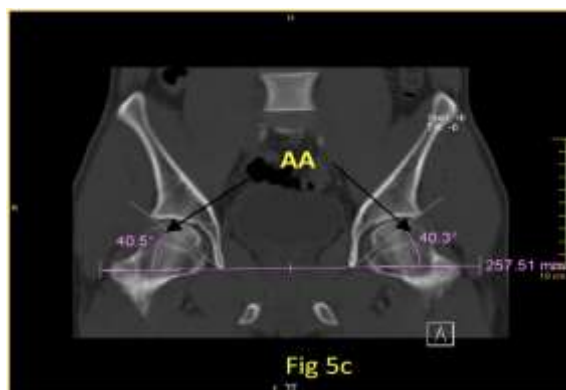


2) **ACETABULAR DEPTH:** It is the maximum distance from acetabular roof to the line joining the two lateral margins of the acetabulum. (Upper margin – roof, lower margin – tear drop). (Fig 5b)



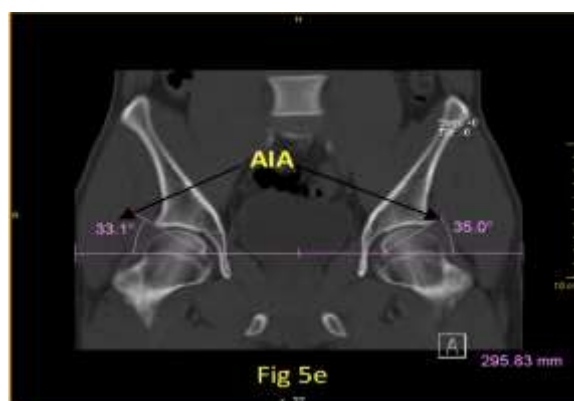
3) **ACETABULAR ANGLE:**

The angle is formed by the angle between the line connecting the left and right sides of the pelvic tear drop and a line joining the lateral edge of the acetabular roof and the inferior tip of the pelvic tear drop. (Fig 5c)



4) **ACETABULAR INDEX ANGLE:**

The horizontal line passing through the fovea of the head of the femur and a Line connecting the lateral part of the acetabular limbus and the fovea on the femoral head. (Fig 5e)



5) ACETABULAR VERSION:

The anterior and the posterior margins of the acetabulum should be 1.5 cm apart as measured from the centre of the femoral head in a plane that is vertical to the anterior aspect of the acetabular rim. (Fig 5k)



6) JOINT SPACE WIDTH:

3 measurements are taken through the joint space.

- 1) Through fovea of the femoral head.
- 2) Laterallimbus of the acetabulum.
- 3) Lower part of acetabulum.(near the inferior tip of the tear drop.) (Fig 5l)



RESULT

In our study total 154 subjects were enrolled. This sample was divided by gender with mean, Standard deviation and range value.

Table 1: Distribution of Gender and age

Gender	N	Mean (Year)	Standard deviation	Minimum	Maximum
Male	92 (60%)	31.23	4.24	19	50
Female	62 (40%)	29.42	3.14	19	40
Total	154 (100%)				

In our study male was 92 (60%) and female was 62 (40%).

Table 2: Acetabular morphometric measurement-Center Edge Angle (CE)

Gender	Measurement Mean±SD	Range	p-value
Male	33.43±4.24	24.14-49.53	0.893
Female	29.63±3.64	21.42-44.63	

Table 3: Acetabular morphometric measurement-Acetabular Depth (AD)

Gender	Measurement Mean±SD	Range	p-value
Male	17.43±1.64	11.53-21.64	0.683
Female	13.64±1.74	11.73-20.72	

Table 4: Acetabular morphometric measurement-Acetabular Angle of Sharp (SA)

Gender	Measurement Mean±SD	Range	p-value
Male	41.73±5.85	34.63-47.60	0.793
Female	40.84±5.57	33.45-48.58	

Table 5: Acetabular morphometric measurement-Acetabular Index Angle (AA)

Gender	Measurement Mean±SD	Range	p-value
Male	10.43± 4.24	1.53-16.49	0.936
Female	9.63± 3.64	2.63-15.59	

Table 6: Acetabular morphometric measurement-Acetabular Version (Acet AV)

Gender	Measurement Mean±SD	Range	p-value
Male	14.50± 2.50	5.54-25.53	0.683
Female	13.53± 2.57	6.53-24.64	

Table 7: Acetabular morphometric measurement-Joint Space width (JSW)

Gender	Measurement Mean±SD	Range	p-value
Male	6.74± 0.47	4.62-7.49	0.574
Female	5.73± 0.63	4.36-8.47	

DISCUSSION

Hip joint is one of the major joint of the body described as ball and socket variety of synovial joint Williams et al. [12]. Various parameters of the acetabulum viz., diameter of acetabulum and depth of acetabulum were carried out by Lane et al. [13] essentially to assist Orthopedic Surgeons, Biomedical Engineers to make suitable hip joint prostheses, detection of disputed sex by Forensic Experts and to understand the etiopathogenesis of diseases like the primary osteoarthritis. Bavornrit et al. [14] stated that it is necessary to evaluate the diameter of the acetabulum as a part of preoperative planning in order to estimate the size of the acetabular cup in surgical procedures of acetabulum especially in total hip arthroplasty.

Stulberg and Harris [15] reported the pattern of damage to the acetabular cartilage and the labrum depends upon the shape of the hip. In the normal hip the labrum merges with the acetabular cartilage through a transitional zone without any gap. Chauhan et al. [16] reported in North Indian population, the average diameter on the right and left side of males showed no significant differences but, in case of females, the right side was found to be less when compared to left side. Loder et al. [17] reported the acetabular depth has been regarded by many authors as an important measurement to define acetabular dysplasia. An acetabular depth of less than 0.9 cm is considered to be dysplastic.

Sharp and Hull reported that shallow acetabulum is more prone to develop congenital subluxation. [18] Werner Kohnlein et al. [19] reported width of the acetabular notch was 51±6 mm, which was wider in females than in males in Switzerland population. Igbigbi [20] reported the gender differences in the depth of the articular surface were characterized by the size of the fossa and width of the notch rather than by outer rim profile. The significant differences observed in the acetabular depth and angle may be due to the wider pelvis of women.

In present study, sex comparison which revealed depth of the acetabulum was greater in males (30.00±0.223 mm) than in females (21.45±0.22 mm). Diameter of acetabulum was greater in males (48.66±0.33 mm) and less in females (46.18±0.33 mm) but, statistically significant in both sexes. Notch width was greater in females (31.77±0.39 mm) when compared with males (30.47±0.7 mm) without any significance. When comparing with both sides depth of the acetabulum in both sides (Right & Left) were more or less same. Diameter of the acetabulum is same with small variation. Notch width of both right and left side was more or less same but none were statistically significant Werner Kohnlein et al. [21] reported the width of the acetabular notch was 51±6 mm, which was wider in females than in males in Switzerland population.

In present study notch width revealed 30.8±0.42 mm on the right side, 31.1±0.72 mm on the left side of acetabulum showed no difference between the two sides. In case of males, the notch width was found to be 30.47±0.70 mm and in females 31.77±0.39 mm which is not statistically significant. The gender differences in the depth of the articular surface were characterized by the size of the fossa and width of the notch rather than by outer rim profile.

CONCLUSION

A thorough knowledge of dimensions of acetabulum and femoral head in both sexes will assist the Biomedical Engineers to construct suitable prostheses. This gives the average values of various parameters to near normal situations as encountered in patients at the operation table. Knowledge of the anatomical parameters of bony components of the hip joint are also very much essential to get a better understanding of the etiopathogenesis of primary osteoarthritis and will help in early detection of disputed sex by Forensic experts. The various parameters of acetabulum observed in the present study can be used for Total Hip Replacement. It is necessary to evaluate the diameter of the acetabulum as a part of preoperative planning in order to estimate the size of the acetabular cup in surgical procedures which will help the orthopedic surgeons to identify the accurate diameter of the acetabulum.

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