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Morphometric analysis of acetabulum and its clinical correlation in south Indian population

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Abstract
Introduction: In modern world Orthopedic Surgeons and Biomedical Engineers are trying to make the best possible prostheses for planning the total hip management. Body proportions and absolute dimensions 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.
Materials and Methods: The study was conducted in the Department of Anatomy. Sixty hip bones of both sexes were used. The osteometric parameters such as Side, Sex, and Diameter of acetabulum, Depth of acetabulum, Notch Width and Lunate surface endings were measured using Vernier caliper, scale and thread. The data were analyzed statistically using SPSS software. In this study we included only healthy bones, deformed and eroded bones were excluded from the study.
Observation: The depth of acetabulum was found to be more in males (30±0.223 mm) than in females (21.45±0.22 mm). Diameter was found to be more in the males than in females (P<0.005). Notch width was found to be more in females than in the males. There is no significant difference between the right and left sides of acetabulum.
Conclusion: Morphometric measurements of acetabulum is essential for clinical correlation and it also helps the orthopedic surgeons to identify the accurate diameter of the acetabulum.

Keywords: Hip bone, Osteometric parameters, Acetabulum

1. Introduction
Acetabulum is a deep cup shaped cavity present in 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. This aperture is divided into articular & non-articular part, non-articular part is called as acetabular fossa covered by pad of fat & articular part is known as lunate surface articulating with head of femur forming the hip joint. The articular part of acetabular cavity is deficient inferiorly (acetabular notch) where it ends anteriorly as pointed and posteriorly as semilunar shaped. Development of normal acetabular cavity is essential for proper bio-mechanism 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 fetus.
Displacement of acetabulum is one of the commonest congenital disorders. Shallow cavity is seen in underdeveloped acetabular fossa in which the head of femur is not properly articulated inside the cavity of acetabulum. Also in this condition the roof is not well formed, congenitally where very small articular surface is seen. In such circumstance, during ambulatory activities heavy force is exerted on roof of the rim of cavity henceforth the early degeneration is observed in the roof of joint cavity. In this situation patient has to undergo hip arthroscopy at the earliest [1]. Morphometry of acetabular fossa serves as a baseline data for construction in prostheses of acetabulum in clinical practice [1-3].
Orthopedic surgeons use measurements of acetabular parameter for operative treatment [2], [4]. Acetabular and Center Edge (CE) angle amongst other parameters were used to evaluate hip dysplasia and to assess patient's recovery [3]. Direct damage to the hip can be caused by variations in size, shape and orientation of the proximal femur, acetabulum or in combination of both [5-7].

The posterior acetabular wall has been proposed to be hypo-plastic, for acetabular retroversion. Pre-operative planning has always been an integral part of total hip replacement [8]. For many years, human hip joint has been an object of investigation for morphologists and biomechanics etc. Load is transferred to the hip bone through sacroiliac joint and from the pelvis to the lower extremities through hip joint [4]. It is important to understand ethnic differences in the general morphology of hip joint that may contribute to the onset of osteoarthritis. Assessment of acetabular depth ratio to study the acetabular morphology helps the surgeons to diagnose the hip dysplasia [9]. Knowledge of the anatomical parameters in this area is very much essential, for better learning the complexity and etiopathogenesis of diseases like primary osteoarthritis of the hip joint etc.

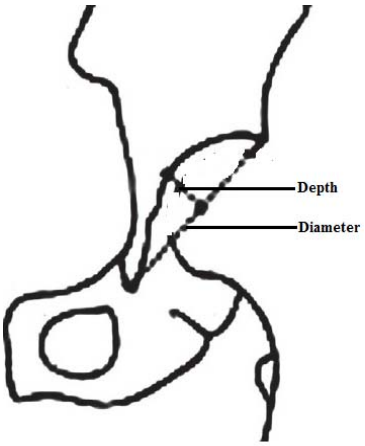

Fig 1.1: Measuring diameter & depth of acetabulum

2. Materials and Methods

Sixty hip bones of both sex were used. The osteometric parameters such as Side, Sex, Diameter, Depth, Notch Width and Lunate surface endings were measured using Vernier caliper, scale and analyzed statistically using SPSS software. In this study we included only healthy bones, eroded and deformed were excluded from the study.

Diameter were measured from anterior to posterior part of the rim of the acetabulum, depth was measured by a line joining the aforesaid rim perpendicular to it in non-articular part is measured Fig. 1.1.

3. Results

3.1 The mean value of depth, diameter and notch width on male and female hip bone

Depth of the acetabulum was greater in males (30.00±0.223 mm) compared with females (21.4±0.22 mm). While diameter of acetabulum was greater in males (48.66±0.33 mm) and less in females (46.18±0.33 mm) where both the sexes showed statistically significant. Notch width was grater in females (31.77±0.39 mm) when compared with males (30.47±0.7 mm) which was not significant statistically. (Table –I).

Table I

Acetabulum	Sex	Mean (SD) in mm
Depth	Male	30.00±0.223
	Female	21.45±0.22
Diameter	Male	48.66±0.33*
	Female	46.18±0.24*
Notch Width	Male	30.47±0.70
	Female	31.77±0.39

*p<0.005

3.2 Ends of acetabular labrum

In majority of the bones (93.3%), the anterior end was pointed and the posterior end was lunate shaped (Fig. 3. A). While in 5% anterior and posterior end lunate in shape (Fig.3.B). In 1.7% cases the anterior and posterior ends were pointed (Fig. 3. C).

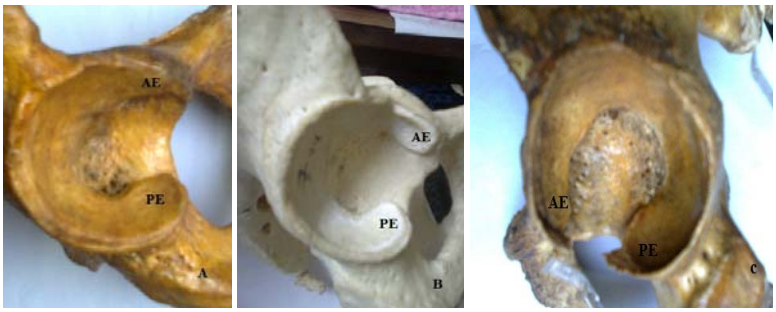

Fig 3: Comparison of acetabular labrum endings (AE - Anterior End; PE- Posterior End)

3.3 The mean depth, diameter and notch width of acetabular fossa on right and left side of hip bone

Depth of the acetabulum compared with both sides (Right - 29.9±0.21 mm & Left - 29.7±0.23 mm) were more or less same. Diameter of the acetabulum is same with small variation (Right side – 47.4±0.27 mm and Left side – 48.0±0.37 mm). Notch width of both right and left side (Right side - 30.8±0.42 mm; Left side – 31.1±0.72 mm) was more or less same but none were statistically significant TABLE - II.

Table II

Acetabulum	Side	MEAN (SD) in mm
Depth	Right	29.9±0.21
	LEFT	29.7±0.23
Diameter	Right	47.4±0.27
	LEFT	48.0±0.37
Notch Width	Right	30.8±0.42
	LEFT	31.1±0.72

4. Discussion

Hip joint is one of the major joint of the body described as ball and socket variety of synovial joint Williams *et al*. [10], Menschik [11]. Various parameters of the acetabulum viz., diameter of acetabulum and depth of acetabulum were carried out by Murray [12] Lane *et al*. [13] and Gonzale [14] 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*. [15] 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 [9] 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*. [6] 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*. [16] 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[3] reported that shallow acetabulum is more prone to develop congenital subluxation. Werner Kohnlein *et al*. [17] reported width of the acetabular notch was 51±6 mm, which was wider in females than in males in Switzerland population. Igbigbi and Kwatampora [18] 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 reveled 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 grater 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*. [17] 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.

5. 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 pre-operative 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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