ORIGINAL ARTICLE

AN ANATOMICAL STUDY OF THE MORPHOMETRIC ANALYSIS OF ACETABULUM IN PAKISTANI POPULATION AND ITS CLINICAL CORRELATES

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ABSTRACT

Objectives: The leading objective of the current study was to gather data related to morphometry of acetabulum of hip bone. The gathered information supports the mechanism of the acetabulofemoral joint, enabling the planning of appropriate prostheses and various surgical techniques.

Methods: The study was conducted at the Department of Anatomy, Allama Iqbal Medical College, Lahore, utilizing one hundred hip bones from both sexes. Study included healthy and unbroken adult bones. Exclusion criteria included deformed, broken and worn specimens. Osteometric parameters, including the diameter and acetabular depth, as well as the acetabular notch and anterior acetabular ridge shape. Vernier calipers was used to take measurements.

Results: The acetabular depth was calculated to be 2.36 ± 0.48 cm on right sided bones and 1.99 ± 0.65 cm on bones of left side respectively. Acetabular diameter on the right and left side was calculated to be 5.27 ± 0.53 cm and 5.42 ± 0.80 cm respectively. The notch width on the right and left side was calculated to be 1.63 ± 0.39 cm and 1.90 ± 0.46 cm respectively. Most common type of anterior ridge was found to be of irregular type.

Conclusions: The study provides the average diameter and acetabular depth for the local population of Pakistan. The results will be valuable for orthopedic surgeons and prosthetists.

Keywords: Acetabulum, hip joint, prosthesis, acetabular diameters.

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INTRODUCTION

One of the most crucial and major weight-bearing joint of the body is the Hip Joint. It is classified as a ball and socket variety of synovial joint. The acetabulum, which resembles a deep cup, is located laterally on the bone and is formed by following bones: the ilium, ischium and pubis. This structure is bounded by an elevation known as the acetabular rim[1]. The non-articular area of the acetabulum is more rough than the articular area and it makes the central portion of the acetabulum, referred as the fossa of acetabulum. The articular portion is called the lunate surface. This surface is more wide at the top, where it facilitates the transmission of weight to the femur[2].

The proper formation of the acetabulum and its cavity is vital for the optimal biomechanics of the hip joint. Development of the acetabulum starts between the 4th and 6th weeks of intrauterine life. A pre-cartilaginous

structure is noticeable by the 7th week, with complete development occurring by the 8th week of fetal growth[1]. Displacement of the hip is among the most common congenital anomalies, characterized by the improper articulation of the femoral head within the shallow acetabular cavity. In such cases, early hip arthroscopy is often necessary[1]. The acetabulum is a crucial structure in the pelvic region for orthopedic procedures. Its morphology is significant in total hip arthroplasty, as accurate measurements of the acetabulum's bone structure are essential for ensuring the proper positioning and stability of the acetabulum[3]. The mean diameter and depth measurements of the acetabulum are important factors to consider when surgically treating acetabular fractures[3].

The morphometry of the acetabular fossa provides foundational data for designing acetabular prostheses in clinical settings. Orthopedics rely on acetabular measurements for surgical treatment. Among these parameters, acetabular depth and diameter are used to assess hip joint dysplasia and evaluate patient recovery[4]. Understanding these anatomical parameters is crucial for comprehending the complications and pathogenesis of conditions such as primary osteoarthritis of the hip joint[5]. Therefore, we measured the morphomety of the acetabulum and intended to show their clinical significance during surgeries involving hip replacement and dislocation with the help of this data.

METHOD

Study Design & Settings: This study was conducted at bone museum of Anatomy department, Allama Iqbal Medical College, Lahore. The protocol of this study and its methodology were approved by the Ethical review board of AIMC, Lahore.

Sample size. The study included a total of 100 unpaired and dried hip bones available in the Museum of Anatomy Department at, AIMC, Lahore. The bones were of unidentified sex and age. Sample included 51 bones of left side and 49 bones of right side.

Inclusion and exclusion criteria: All the selected hip bones for this study were intact, dry and showed normal anatomical features. Bones eitherbBroken or deformed were excluded from study as well the bones having osteoarthritic changes.

Study parameters: The study parameters included the following.

Total acetabular Diameter: the Antero-posterior diameter (maximum) of acetabulum was calculated by using the vernier caliper. An average of 2 reading was taken to ensure maximum accuracy.

Depth of the Acetabular cavity: it was measured by measuring the vertical distance (maximum) from the acetabular rim to the deepest part of the acetabulum. It was calculated by using a metal scale. The scale was positioned across the rim of the acetabular cavity and depth was calculated from this line to the deepest point.

Acetabular notch width: It is calculated as the distance between the two ends of the acetabular notch located in the articular part of the acetabulum.

Anterior ridge shape of the acetabulum: The shape of the anterior ridge of acetabulum was evaluated. It is into four types: irregular, curved, straight and angular[6]. Observation was recorded for each bone and frequency calculated.

All the above mentioned parameters were measured in each individual bone. Measurements were taken using the vernier caliper. The diameter and the depth of the acetabuar cavity were measured at two different points and average was calculated.

To eliminate observers biasness, all of the above mentioned parameters were measured twice. The data was tabularized and evaluated by the help of Microsoft Excel. For each parameter Arithmetic mean and standard deviation were calculated.

Figure 1: procedure of measurements of diameters and depth of the acetabulum

RESULTS

A total of 100 bones were analyzed, out of which 49 were right sided and 51 bones were of left side. All anatomical parameters of 100 hip bones were calculated in cm.

The mean value of acetabular Diameter, Acetabular Depth, and acetabular notch Width:

The calculated mean values of diameter on the right sided bones was 5.27 cm and 5.42 cm on the left sided bones. The mean depth of acetabular cavity was calculated to be 2.36 cm on right sided bones and 1.99 cm on left sided bones. On the right sided bones the notch width was 1.63 cm and it was calculated as 1.90 cm on the left side bones.

Table 1: Mean ± standard deviation of Acetabular Diameter, acetabular Depth, and Notch Width

	Side of bone	Mean	Standard deviation
Diameter of the acetabulum	Right	5.27 cm	0.53 cm
	Left	5.42 cm	0.80 cm
	Both sides	5.4 cm	0.67 cm
Depth of acetabulum	Right	2.36cm	0.48 cm
	Left	1.99 cm	0.65 cm
	Both sides	2.16 cm	0.59 cm
Width of acetabular notch	Right	1.63 cm	0.39 cm
	Left	1.90 cm	0.46 cm
	Both sides	1.77 cm	0.44 cm

The Shape of the acetabula's anterior ridge: Acetabula's anterior ridge shape was studied and it was observed that it can be of four distinct types, classified as irregular, curved, Straight and angular types. The frequency of irregular shaped anterior acetabular ridge was 53 % in right sided bones and 41 % in bones of left side. In the right sided bones 36% ridges were curved, 6 % angular and 4 % straight shaped. Whereas, in the left sided bones 41% ridges were curved, 19.6 % angular and 7.8 % straight shaped.

Table 2: Frequencies of different shapes of anterior acetabular ridge

Ridge type	Right	Left	Total
Straight	2(4.08%)	4(7.8%)	6(6%)
Curved	18(36.7%)	16(31%)	34(34%)
Angular	3(6%)	10(19%)	13(13%)
Irregular	26(53%)	21(41%)	47(47%)
Total	49	51	100

DISCUSSION

The hip joint is an important synovial joint of human body. The morphometric measurements of the acetabulum play a vital role in clinical applications of hip joint surgery, prosthetic implants and congenital deformities. These measurements are valuable for forensic experts in determining sex in ambiguous cases and help orthopedic surgeons in planning hip replacement procedures[7]. Primary objective of our study was to emphasize the significance of acetabular morphometric data. Such measurements assist orthopedic professionals in geometric modeling and the design of effective prosthetic implants. Additionally, the measurement of the depth and diameters of this bone are critical in the surgical management of hip joint fractures[3].

This information will be more helpful in our Pakistani population as most of the acetabular morphometric data we have is not on Pakistani population.

In this study when we compared the acetabular parameters from right to left, it showed that the mean diameter was calculated to be 5.47 cm and 5.24 cm on right and left sided bones respectively. The mean depth of bone cavity was 2.36 cm in right sided bones and 1.99 cm in the left sided bones. The mean width of the acetabular notch was 1.63 cm on right sided bones and 1.90 cm on the left sided bones. This is in accordance with the study conducted on South Asian population which also showed diameter to be 5.53 ± 0.37 and 4.41 ± 0.39 cm in the right and left sides respectively. They established bone depth to be 2.15 ± 0.33 cm on the right sided bones and on left sided bones it was calculated as 1.98 ± 0.2 cm[4].

Another study conducted on Indian population showed that the calculated mean diameter of right acetabulum was 4.70 cm and on left sided acetabulum it was 4.77 cm which is in contrast to our data. This study also showed that the depth of acetabular cavity was 2.71 cm in right sided bones and 2.63 cm in the left sided bones whereas the width of the notch was calculated as 1.92 cm and 1.86 cm respectively on right and the left sided bones[1]. Another research conducted on Turkish population showed diameter (transverse) of the acetabulum to be 50.99 ± 1.99 mm which is approximately similar to our data[3]. Moreover, the results of our study and those of above mentioned studies highlight that thediameters of the acetabulum do not differ significantly between left and right sides of the bones[8].

The above mentioned data suggests an ethnic and regional variation in the acetabular morphometric parameters, highlighting the need to establish this data for the local population to aid in the development of custom prosthetics.

Our study results, in terms of acetabular anterior margin shape, 47 out of 100 hip bones were classified as irregular type, 34 out of 100 bones (34 %) as curved type, 13 as angular shaped and 6 out of 100 as straight shaped. The most prevelant type was the irregular type observed in 47 bones. In contrast to our findings, study conducted by Yugesh[1] showed that curved type (39%) was the most

commonly found shape of anterior ridge whereas the irregular type was found in least number of specimen (15%).

Among other researches the studies performed on the Indian population, the curved type of the ridge was the most common type present in 37.5% of the sample[9]. In an African population study by Indurjeeth et al.,[10] the 41% of the sample were angular type and was considered most common type of anterior ridge.

In view of the fact that our study was performed on Pakistani population, it can be easily assumed that the irregular ridge type is relatively prevelant in our population.

Limitations: Our study was limited by the inability to differentiate between the bone gender.

CONCLUSION

The morphometric data of the acetabulum obtained in this study will be highly beneficial to orthopedic surgeons performing hip replacement and other related surgeries. These findings will contribute significantly to existing literature. The results are expected to support clinicians in the proper design and development of prosthetic implants, particularly tailored to the local population. In our study, the anterior ridge was most commonly observed to be irregular, a finding that contrasts with studies conducted in other countries. This information could prove valuable to orthopedic surgeons during total hip replacement procedures and assist prosthetists in creating more appropriate prostheses.

ETHICAL APPROVAL

Ethical approval was granted by the Institutional Review Board King Edward Medical University, Lahore vide reference No 639/RC/KEMU dated: 10/09/2020

CONFLICT OF INTEREST:

Authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTIONS

ND: Data collection and manuscript writing
MSA, SH: Data collection & analysis and critical review
SR: Data analysis and interpretation
AS, SK: Data collection & data analysis and manuscript writing
ALL AUTHORS: Approval of the final version of the manuscript to be published

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