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Anatomy

MEASUREMENT OF DIAMETER OF ACETABULUM - A MORPHOMETRIC STUDY

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ABSTRACT

Background: As total hip replacement is a common surgery performed now a days, 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 diameter of acetabulum in both the sexes.

Materials and Methods: Material of the study consisted of 110 human hip bones (60 males and 50 females). Diameter of Acetabulum (i.e. Transverse Diameter of Acetabulum-TDA and Anteroposterior Diameter of Acetabulum-APDA) was measured on these hip bones on both the sides.

Results: The mean diameter of acetabulum in male was TDA-50.55 mm, APDA-50.09 mm and in female was TDA- 45.46 mm, APDA-45.42mm. The mean diameter of acetabulum on right side was TDA-48.01 mm, APDA-47.96 mm and on left side was TDA-48.44 mm, APDA-47.98 mm.

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

KEYWORDS : Acetabulum, Diameter, Reconstruction, Hip replacement

INTRODUCTION

The acetabulum is a cup shaped cavity present on the lateral aspect of the hip bone. It faces laterally, forward and downward. The acetabulum is formed by the contribution from three parts of the hip bone i.e. ilium , ischium and pubis. 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.[1] The fibrocartilaginous acetabular labrum (L.labrum- lip) attaches to the acetabular rim, increasing the acetabular articular area by nearly 10 %. The transverse acetabular ligament, a continuation of the acetabular labrum, bridges the acetabular notch. Centrally a deep non-articular part, called the acetabular fossa, is formed mainly by the ischium .This fossa is thin walled (often transluscent) and continous inferiorly with the acetabular notch. Acetabulum is large in males and small in females.[2]

The male acetabulum is absolutely larger, and its diameter is approximately equal to the distance between its anterior rim and symphysis pubis. In females, acetabular diameter is usually less than this distance, not only because it is absolutely smaller but also because the anterolateral wall of the cavity is comparatively and often absolutely wider.[3]

The anatomy of the hip must be taken into account in order to ensure primary stability of cementless acetabular implants.[4] In the surgical procedure of the acetabulum, especially in the total hip arthroplasty, it is necessary to evaluate the diameter of the acetabulum as a step in the preoperative planning.[5]

Reconstruction of the acetabulum in patients with significant acetabular bone deficiency remains a major challenge in revision total hip arthroplasty. In many cases of acetabular revisions, the socket has a prevalent superior migration with large superior segmental bone deficiencies. In these large superior segmental bone deficiencies, the acetabulum presents with a longitudinal diameter that is greater than its transverse diameter.[6]

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 with the aim to study the morphometric measurement of diameter of acetabulum in both the sexes.

MATERIALS AND METHODS

The present study was conducted in the Department of Anatomy, 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. Diameter 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 diameter of acetabulum:

1) Anteroposterior Diameter of Acetabulum (APDA) - Maximum anteroposterior diameter of the acetabulum was measured by a line drawn from anterior superior iliac spine to the ischial tuberosity passing through the centre of the acetabulum.
2) Transverse Diameter of Acetabulum (TDA) - Maximum transverse diameter of the acetabulum was measured by a line passing perpendicular to the anteroposterior diameter mentioned above.

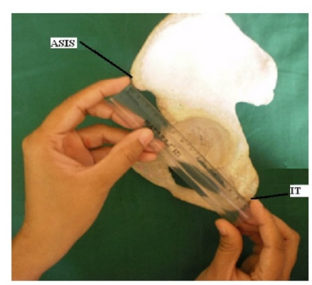

Figure1: Measurement of Anteroposterior Diameter of Acetabulum-APDA. (ASIS: anterior superior iliac spine; IT: ischial tuberosity).

Figure2: Measurement of Transverse Diameter of Acetabulum-TDA.

Figure 3 : Measurement of Transverse Diameter of Acetabulum-TDA with dial caliper.

The data obtained for diameter 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 diameter 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.7 Statistical analysis was done using SPSS (Statistical Package for the Social Sciences) version 11 and Microsoft Excel 2007.

RESULTS

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

Table 1: Comparison of TDA and APDA in Male and Female.

Parameter		Sex		P Value
		Male (n=60)	Female(n=50)	
TDA (mm)	Mean SD	50.55 3.99	45.46 2.77	<0.0001
	Range	43.02 – 60.5	40.56 – 52.26	
APDA (mm)	Mean SD	50.09 3.55	45.42 2.71	<0.0001
	Range	41.38 – 57.22	40.18 – 52.44	

The mean TDA and APDA in Male > Female. The difference is statistically significant (P < 0.0001).

Table 2: Comparison of TDA and APDA on Right and Left side.

Parameter		Side		P Value
		Right (n=51)	Left (n=59)	
TDA (mm)	Mean SD	48.01 4.17	48.44 4.45	>0.05
	Range	40.56 – 58.62	41.28-60.5	
APDA (mm)	Mean SD	47.96 4.02	47.98 3.92	>0.05
	Range	40.18 – 57.22	40.2-56.9	

The mean TDA and APDA on Left > Right. The difference is statistically non- significant.(P>0.05) .

Table 3: Comparison of TDA in Male and Female with respect to side.

TDA in mm				
	Male (Right)	Female(Right)	Male(Left)	Female(Left)
Mean ±SD	50.77 3.49	45.13 2.58	50.39 4.38	45.79 2.96
Range	45.18 – 58.62	40.56 – 51.14	43.02-60.5	41.28 – 52.26

Table 4: Comparison of APDA in Male and Female with respect to side.

APDA in mm				
	Male (Right)	Female(Right)	Male(Left)	Female(Left)
Mean ±SD	50.73 3.16	45.08 2.49	49.6 3.79	45.77 2.93
Range	42.4 – 57.22	40.18 – 51.12	41.38-56.9	40.2 – 52.44

In case of male, the mean TDA and APDA on Right > Left. The difference is statistically non- significant (P>0.05) In case of female, the mean TDA and APDA on Left > Right. The difference is statistically non- significant (P>0.05) The mean TDA and APDA in Male Right > Female Right. The difference is statistically significant (P < 0.0001). The mean TDA and APDA in Male Left > Female Left. The difference is statistically significant (P < 0.0001).

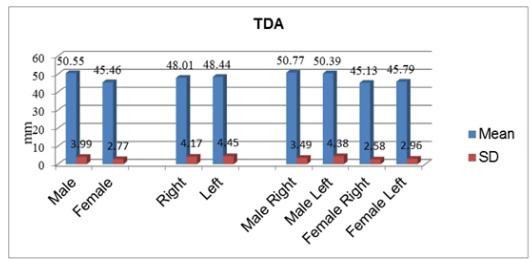

Figure 4: Comparison of TDA with respect to sex and side in total and subtotal sample.

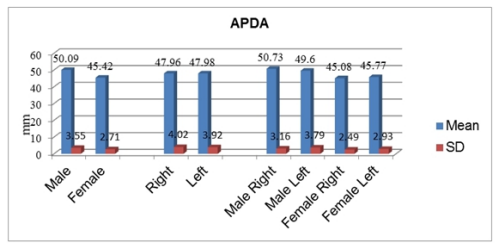

Figure 5: Comparison of APDA with respect to sex and side in total and subtotal sample.

DISCUSSION

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

Kim YS et al studied thirty acetabula that had been obtained from the cadavera of fifteen men and fifteen women. The mean diameter of acetabulum was 58 mm.[8] Varodompun N et al conducted a study on dried cadaveric pelvic bones to determine the relation between acetabular diameter and thickness of the acetabular wall in Thais. The diameters of the acetabulum were measured for 152 pelvic bones The average acetabular diameter was found to be 51.82 mm for all the acetabuli.[9]

In a study done by Wutthipiriyaangkool S et al in 10 cadavers ; 5 males and 5 females with the mean age of 69.7 years (range 42-86 years) the mean diameter of the acetabulum measured directly from the cadaver was 44.18 mm. ± 4.44mm.[5]

Genser-Strobl B et al performed a morphometric analysis of the human hip joint using, for the first time, the P40 plastination procedure. The mean diameter of acetabulum found was 48.94mm.[10] Govsa F et al studied the morphologic features of the acetabulum on 226 dry adult normal coxal bones of Turkish origin. They found that acetabular diameter in total group was 56.15 ± 3.95 mm (45.28-70).11 The mean diameter of acetabulum recorded by Vandenbussche E et al was 48.5 mm.[12] The mean transverse and anteroposterior diameter recorded by Kordelle J et al was 53 mm and 56.7 mm respectively.[13]

In the present study, the mean TDA and APDA is 48.24 mm (40.56-60.50) and 47.97mm (40.18-57.22) respectively. Comparision with other studies indicates that the mean diameter of the present study almost coincides with the study of Gensor-stroble B et al and Vandenbussche E et al.[10,12] (Table 5)

Table 5: Comparision of diameter of acetabulum with other studies.

Sr. No.	Author	Sample Size	Diameter		
			Mean	S.D.	Range
1.	Kim YS et al[8]	30	58	-	-
2.	Varodompun N et al[9]	152	51.82	-	-
3.	Wutthipiriyaangkool S et al[5]	20	44.18	4.44	-
4.	Gensor-strobleBet al[10]	42	48.94	2.74	-
5.	Govsa F et al[11]	226	56.15	3.95	45.28-70
6.	Vandenbussche E et al[12]	200	48.5	4.4	40.0-59.5
7.	Kordelle J et al[13]	44	T-53.0 AP-56.7	T-2.1 AP-2.1	T-44.6-64.6 AP-47.4-64.8
8.	Present study	110	T-48.24 AP-47.97	T-4.31 AP-3.95	T-40.56-60.50 AP-40.18-57.22

Note:

T- Transverse, AP – Anteroposterior

Derry DE measured the diameter of the acetabulum in 50 male and 50 female hip bones. The average diameter of acetabulum in male and female was 52 (45-57.5) mm and 46.8 (43-52) mm respectively.[14] According to Lang C, a series of mostly unorthodox measurements on a sample of 45 (19 females and 26 males) dry hip bones were studied. The mean acetabular height in males and females was 55.22 mm (SD= 3.05) and 48.20 mm (SD= 2.91) respectively.[15]

Kim YH measured the equatorial and meridian diameter of acetabulum in 655 Korean adult cadavers and 172 Korean fetuses. The mean equatorial acetabular diameter in males and females was 49.3 mm and 43.7 mm respectively. The mean vertical acetabular diameter in males and females was 49.5 mm and 43.6 mm respectively.[16] Arsuaga JL et al studied 34 linear variables and 10 non metrical (morphological) characters in a series of 418 adult hip bones of known sex(227 males and 191 females) born in the Beira Litoral region of Portugal between 1820 and 1920. The mean transverse acetabular diameter in males and females was 54.3 mm and 49.0 mm respectively. The mean vertical acetabular diameter in males and females was 55.2 mm and 49.9 mm respectively.[17]

Takahashi H studied hip bones (right side) of 165 Japanese adults (104 males and 61 females). The mean of maximum diameter of the acetabulum in males was 51.06 mm (43.64-57.79) and in females was 46.36 mm(39.40-54.66).[18]

Chauhan R et al carried out the dissections of fifty four cadaveric hip joints belonging to the age group of 50-70 years of both sexes. Maximum transverse diameter of the acetabulum was measured using vernier scale. Average diameter of acetabulum (in mm) on the right side and left side of male was 47.10 +- 2.90(40.0-52.3) and 47.48 +- 3.05(40.0-52.4) respectively. Similarly average diameter of acetabulum (in mm) on the right side and left side of female was 44.38 +- 3.01(39.0-48.0) and 46.0 +- 2.28(43.0-49.0) respectively. They found that diameter of acetabulum was greater in males than females. On the right side there was marginal stastically significant difference in the diameter of acetabulum between the two sexes (right $p = 0.049$, left $p = 0.22$).[19] Papaloucas C et al carried out the measurements of 200 hip bones within the Greek population. It was found that in males, in comparision to the females, the acetabulum diameter was larger.[20]

Table 6: Comparision of diameter of acetabulum in male and female with the other studies.

Sr. No.	Author	Sex								P value
		Male				Female				
		n	Mean	S.D.	Range	n	Mean	S.D.	Range	
1.	Derry DE[14]	50	52	-	45-57.5	50	46.8	-	43-52	-
2.	Lang C [15]	25	55.22	3.05	-	19	48.20	2.91	-	< 0.001
3.	Kim YH[16]	67	T-49.3 AP-49.5	-	T-44.3 -53.8 AP-44.3- 54	32	T-43.7 AP-43.6	-	T-43-44.3 AP-42.8-44.3	-
4.	Arsuaga JL et al[17]	207	T-54.3 AP-55.2	T-3.0 AP-2.8	-	181	T-49.0 AP-49.9	T-2.8 AP-2.7	-	<0.01
5.	Varodomp-un N et a[9]	118	52.38	-	-	18	49.54	-	-	-
6.	Govsa F et al[11]	116	56.39	3.94	45.28-70	110	53.50	3.04	49.06-63.0	-
7.	Takahashi H[18]	104	51.06	2.65	43.64-57.79	61	46.36	2.50	39.40-54.66	<0.0001
8.	Vandenbu-ssche E et al[12]	100	51.9	3.1	44.6-59.5	100	45.1	2.2	40.0-51.2	<0.0001
9.	Present study	60	T-50.55 AP-50.09	T-3.99 AP-3.55	T-43.02 -60.5 AP-41.38- 57.22	50	T-45.46 AP-45.42	T-2.77 AP-2.71	T-40.56-52.26 AP-40.18-52.44	<0.0001 <0.0001

Note:
T- Transverse, AP – Anteroposterior

In the present study the mean diameter of the acetabulum in Male > Female. Similar finding was observed in all other studies shown in Table 6. The mean diameter of male and female of the present study coincides with the study of Vandenbussche E et al and Takahashi H [12,18] In the present study a statistically significant difference was found when the mean diameter of acetabulum was compared between male and female.

Kim YH noted that in case of male acetabulum, the APDA was greater than TDA in 49.3 % ; whereas in case of female acetabulum, TDA was greater than APDA in 50 % and in the remaining 50%, both diameters were equal.[16] Kordelle J et al found mean APDA > TDA.[13] In the present study it was found that mean TDA > APDA. In case of male acetabulum, the TDA > APDA in 58.33 % ; whereas in case of female acetabulum, TDA > APDA in 52 %.

Chibber SR et al 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.[21] Chauhan R et al found that in both the genders left acetabulum had greater diameter than that of right side but of no statistical significance (male $p = 0.75$, female $p = 0.06$).[19]

In the present study also the mean TDA and APDA on Left > Right. In case of male, mean TDA and APDA on Right > Left, whereas in case of female, the mean TDA and APDA on Left > Right. The difference is statistically non-signficant.

CONCLUSION

The knowledge of acetabular diameter plays an important role in understanding occurence of primary osteoarthrosis. Total Hip arthroplasty requires more detailed knowledge, about the complex acetabular measurements. The diameter studied on acetabulum in the present study showed statistically significant differences between males and females. Studies based on both the diameters of acetabulum (i.e. transverse and anteroposterior) 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 provides valuable measurements of diameter of acetabulum which would help the radiologists, forensic experts, anthropoligists, orthopaedicians and prosthetists.

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