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Morphometry of Acetabulum in Adult Bangladeshi Population on Radiographs

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Morphomery, acetabulum, center edge angle, acetabular angle of Sharp, Tonnis angle

Abstract:

Background*: Morphometry of acetabulum has important clinical implications as it is crucial to the orthopaedic surgeons for surgical planning before acetabulum surgery and acetabular cupplacement during total hip arthroplasty and help the clinicians to assess hip dysplasia and hip osteoarthritis. It is also useful to the prosthetists for designing better prosthesis of hip joint. Gender differences in the morphometric parameters of acetabulum assist the forensic experts in determination of sex. The present study was designed to evaluate center edge angle, acetabular angle of Sharp and Tonnis Angle in adult Bangladeshi population, determine gender differences and compare findings of the present study with the studies on other* ***Methods:*** *This was a cross sectional analytical study conducted on the Department of Anatomy, Sir Salimullah Medical College, Dhaka from July 2020 to June 2021.Standardized plain anteroposterior pelvic radiographs of seventy adult Bangladeshi population age ranging from 25- 45 years were collected to measure center edge angle, acetabular angle of Sharp and Tonnis angle unilaterally on the radiographs with MB ruler software. Comparisons between male and female parameters were done with unpaired t-test. Statistical analyses were performed using SPSS 24 software.* ***Results:*** *In the present study, the total mean center edge angle was 34.29°±5.66°,the mean center edge angle of male and female were33.95°±5.64° and 35.03°±5.53° respectively. The mean acetabular angle of Sharp was 39.33°±3.29°.The mean value of male and female were 39.53°±3.82° and 39.39°±3.21°respectively. The mean Tonnis angle was 6.74°±4.26°. In male itwas 6.85°±4.05°, while in female it was 6.62°±4.51°. The present study showed no statistically significant gender difference in mean center edge angle, acetabular angle of Sharp and Tonnis anglein adult Bangladeshi population.* ***Conclusion:*** *In the present study center edge angle, acetabular angle of Sharp and Tonnis angle showed no significant gender difference in adult Bangladeshi population.*

Introduction:

Acetabulum is a hollow cavity present on the lateral aspect of the hip bone which articulates with the head of the femur to form the hip joint andthe deepness of acetabular socket is one of the important determinant of the stability of hip joint.[1]

Morphological abnormalities of the acetabulum lead to various diseases of hip joint such as acetabular dysplasia and pincer femoro-acetabular impingement.[2] In acetabular dysplasia the acetabulum becomes shallow and there isdeficient anterior, superior or lateral coverage of femoral head, whereas in pincerfemoro-acetabular impingement there isanterior and lateral over-coverage of the femoral head.[3]However acetabular dysplasia isone of the important cause of secondary osteoarthritis of the hip joint.[4] Morphometry of acetabulum in normal population is essential to the clinicians to diagnose hip diseases.

Morphometry of acetabulum is crucial to the orthopaedic surgeons for planning before

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acetabulum osteotomy and properpositioning of acetabular component during total hip arthroplasty.[5]Amalpositioned acetabular component during total hip arthroplasty can lead to dislocation, limited range of motion and pelvic osteolysis.[6]Morphometryof acetabulumin normal population is essential to avoid these complications. Biomedical engineersneed it for the designing ofproper prosthesis. It has also medicolegal importance as sexual dimorphism in the morphometric parameters of acetabulum helps the forensic experts in determination of sexin case of unidentified human remains.

Morphometry of acetabulum was studied on different population by many researchers and showed that it was influenced by age, sex, gender, profession, race, ethnicity and social custom of a population. As there was not much published article on the morphometry of acetabulum in our country, the present study was designed to measure center edge angle, acetabular angle of Sharp and Tonnis angle in adult Bangladeshi population, to determine gender difference in these parameters and to compare findings of the present study with the studies on other population.

Methods:

The present study was a cross sectional analytical study conducted in the Department of Anatomy, Sir Salimullah Medical College, Dhaka , Bangladesh from July 2020 to June 2021. The study population was adult Bangladeshi population age ranging from 25-45 years who were referred to the Radiology and Imaging Department of the hospital to have a plain digital radiograph of pelvis. Patients with existing hip disease or deformity, previous history of operation on hip joint and pregnant woman were excluded from the study. Informed written consent was obtained from the patients who were eager to participate in the study. The antero posterior radiographs of pelvis of the patients were taken in supine position on the x-ray table with both lower extremities orientated in 15° internal rotation to maximise the length of the femoral neck. The distance between x-ray tube and film was 120cm, while the tube was orientated perpendicular to the table. The crosshairs of the beam was centred on the point midway between the superior border of the pubic symphysis and a line drawn connecting the anterior superior iliac spines.[8] Radiographs of the pelvis in which the hip joints were reported as normal were collected. Soft copy of the images were collected via a pendrive and transferred to a computer. The sample was collected by a convenient sampling method.

After proper magnification and resolution, center edge angle, acetabular angle of Sharp and Tonnis angle were measured unilaterally on the radiographs with MB ruler software. Comparisons of the angles between adult Bangladeshi male and female were done by unpaired student's t-test. Statistical analyses were performed with the statistical software SPSS 24.

Operational definition:

The center edge angle (CE) is formed at the femoral head centerby the intersection between two lines: (i) a line perpendicular to transverse pelvic axis passing through the center of the femoral head extending superiorly crossing the hip joint and (ii) a line joining the center of the femoral head to the lateral edge of acetabulum.[9] (Fig-1)

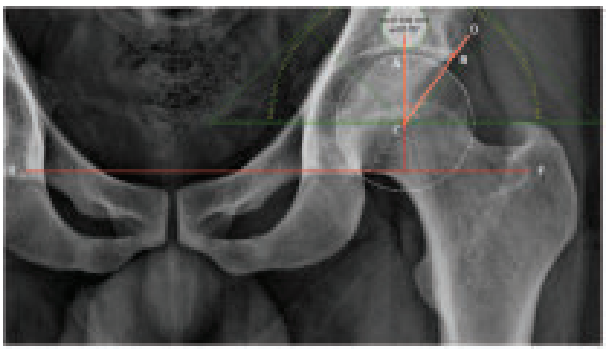

Fig-1: Plain digital radiograph of pelvis AP view showing measurement of center edge angle

The Acetabular angle of Sharp (SA)is formed at the inferior point of acetabular teardrop by the intersection of transverse pelvic axis and a line connecting the inferior point of the tear drop to the lateral edge of acetabulum.[10](Fig-2)

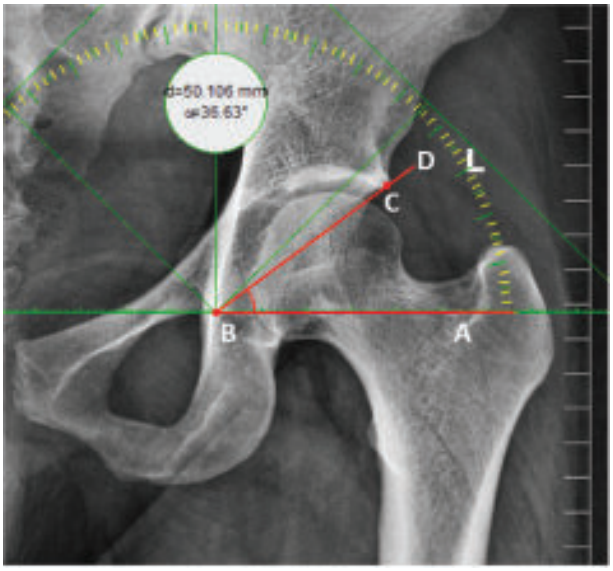

Fig-2: *Plain digital radiograph of pelvis AP view showing measurement of Acetabularangle of Sharp*

The Tonnis angle (TA) is formed at the most inferior point of the sclerotic sourcil by the intersection of (i) a horizontal line parallel to the transverse pelvic axis and (ii) the line joining the inferior and lateral point of the sclerotic sourcil.[9] (Fig-3)

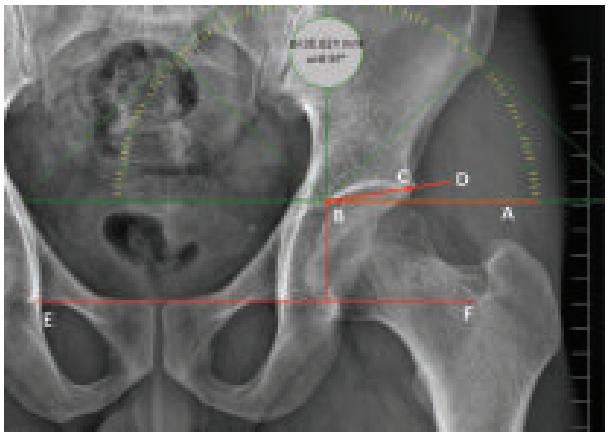

Fig-3: Plain digital radiograph of pelvis AP view showing measurement of Tonnis angle

Results:

The study was conducted on 70 adult Bangladeshi population among them 35 were adult male and 35 were adult female.The mean age of male and female were 33.97 ± 7.21 and 34.09 ± 9.01years respectively

Table-I shows morphometric parameters of acetabulum in total study population.In the present study, the total mean center edge angle, acetabular angle of Sharp and Tonnis angle were 34.29°±5.66°, 39.33°±3.29° and 6.74°±4.26°respectively.

Table-I. Morphometric parameters of acetabulumin total population (N = 70)

Variables	mean±SD	Range
Center edge angle(°)	34.29 ±5.66	23.08-46.37
Acetabular angle of Sharp(°)	39.33±3.29	31.47-45.89
Tonnis angle(°)	6.74±4.26	0.00-16.88

SD- Standard deviation

Table-II represents gender differences in the morphometric parameters of acetabulum in adult Bangladeshi population.

In male, mean±SDcenter edge angle (CE)was 33.95°±5.64° and therange was from 23.88° to 45.38°. In female, mean±SD of center edge angle (CE)was 35.03°±5.53° and therange was from 23.08° to 46.37°.No significant difference was found between meancenter edge angle of male and that of female (p=0.092).

In male, mean±SD of Acetabular angle of Sharp was 39.53°±3.82° and the range was 31.90°-49.44°.In female,mean±SD of Acetabular angle of Sharpwas 39.39°±3.21° and the range was 31.47° - 45.89°. No significant difference was demonstrated between mean Acetabular angle of Sharp of male and that of female (p=0.864).

Table II: Gender difference inmorphometric parameters of acetabulum (N = 70)

Variables (in degree)	Male (n = 35) Mean ± SD (range)	Female (n = 35) Mean ± SD (range)	P value
Center edge angle	33.95 ± 5.64 (23.88- 45.38)	35.03 ± 5.53 (23.08- 46.37)	0.092^{ns}
Acetabular angle of Sharp	39.53 ± 3.82 (31.90 - 49.44)	39.39 ± 3.21 (31.47 - 45.89)	0.864^{ns}
Tonnis angle	6.85 ± 4.05 (0.00 – 16.58)	6.62 ± 4.51 (0.00 - 15.98)	0.827^{ns}

Comparison between sexwas done by unpaired Student's t- test
^{ns}= Not Significant, P > 0.05 (2 tailed), N= Total sample size

Table-III: Comparison of the mean value of the present study with the findings of other studies

Studies	Population	CE(°)	SA(°)	TA(°)
Present	Bangladeshi	34.29±5.66	39.33±3.29	6.74±4.26
Baharuddin et al	Malay	31.69±5.48	42.35±3.24	4.27±4.03
Okoseimiema and Udoaka	South- South Nigerian population	34.98±5.66	36.69±3.86	-
Kim et al	Asian population	26.2±6.0	41.3±3.3	8.5±4.3
Zacharia and Fawas	Indian	35.9±7.2	26.5±3.4	4.1±2.4
Umer et al	Singaporean	31.25±7.98	39.46±6.04	7.86±6.55
Tallroth and Lepisto	Finland	41±7	-	3±4
Kondori et al	Tehran	32	37.1	-
Nekkanti et al	South Indian	-	37.50±3.57	-
Saika et al	Northeastern Indian	32.7	39.2	-
Sengodan et al	South Indian	-	35.5	-

CE- Center edge angle, SA- Acetabular angle of Sharp, TA- Tonnis angle

In male, mean±SD of Tonnis angle (TA)was 6.85°±4.05° and the range was 0.00°- 16.58°, while in female mean value of that was 6.62°±4.51° and therange was 0.00°- 15.98°. In the present study Tonnis angle showed no significant gender difference (p=0.827).

In Table-III demonstrated the comparison of present study with the studies on other populations.

Discussion:

In the present study center edge angle, acetabular angle of Sharp and Tonnis angle were measured on the standardized anteroposterior radiograph of pelvis of the adult Bangladeshi population, gender differences in these parameters were determined and study findings were compared with the findings on other populations.

Center edge angle is used to measure superolateral coverage of acetabulum. Acetabular angle of Sharp measures acetabular inclination, which is important to the orthopaedic surgeons for proper positioning of acetabular cup placement during total hip arthroplasty and Tonnis angle is used to measure weight bearing surface of acetabulum.[5] The normal value of these angles in a population help the clinicians to diagnose hip diseases from normal anatomical variation.

The center edge angle was first described by Wiberg. The normal range of center edge angle is 25°- 40°, when it is less than 20° it indicates acetabular dysplasia and if it is above 40°, it is considered as acetabular over-coverage.[8]In the present study mean CEwas 34.29°±5.66°. Studies were conducted by Saikaet al[10]on Northeastern Indian, while by Zachariaand Fawas[2]on Indian population and reported mean CE as 35.9°±7.2° and 32.7° respectively. The mean CE of the present study was higher than that of Malay,[5]Northeastern Indian,[10] Singaporean,[11] Asian[12] and Tehran population.[13] Our mean value was in accordance with that of Indian[2] and South- South Nigerian population.[14] The mean CE of the population of Finland[15] was 41°±7°, which was higher than that of the present study.

In present study, no statistically significant difference (P>0.05) was observed between meancenter edge angle of male and that of female. Similar observation was found in population of Tehran, Iran[13] and Malawi, Africa[16].However statistically significant difference between mean center edge angle of male and that of female was found in Singaporean[11], Asian[12],South- South Nigerian[14], Sudanese[17], Egyptian[18]and European Caucasian, American Caucasian, African American and Chinese population.[19]

The acetabular angle of Sharp was first described by Sharp and an important radiographic measurement to diagnose acetabular dysplasia. The normal value of acetabular angle of Sharpis33°-38°, the upper limit of normality is 39°-42° andabove 47°isconsidered as acetabular dysplasia.[20]The mean acetabular angle of Sharp of the present study was

39.33°±3.29°. Our mean value was higher than that of Indian[2], Tehran[13] and South-South Nigerian population[14], while lower than Malay[5]and Asian population.[12]The mean SA of North eastern population[10] andSingaporean[11] were comparable to that of the present study. However, mean SA of Malay[5] and Asian population[12] were higher than that of the present study.

No statistically significant difference (P>0.05) was observed between mean acetabular angle of Sharp of male and that of female. Similar observation was found inSingaporean[11],Tehran[13], South-South Nigerian[15] and South Indianpopulation.[21,22]In contrary to the present study, statistically significant gender difference in the mean acetabular angle of Sharp was observed in Asian[12],Malawians[16], Egyptian[18]and European Caucasian, American Caucasian, African American and Chinese population[19] and population of Southern Assam, India.[23]

The Tonnis angle is used to measure the weight bearing surface of acetabulum on AP view radiograph of pelvis. The normal value is 0°-10°.If it is above 10°,it is considered as a risk factor for acetabular dysplasia and when it is less than 0°, it is considered as a risk factor for pincer femoroacetabular impingement.[8]The mean Tonnis angle of the present study was 6.74°±4.26°. Our mean value was higher than Indian[2], Malay[5]and population of Finland[17] but lower than that of Singaporean [11] and Asian population.[12]

In the present study no statistically significant gender difference (P>0.05) was observed in mean Tonnis angle in adult Bangladeshi population. Similar finding was also found in Singapore anpopulation.[11] However, statistically significant (P<0.05) gender difference was demonstrated in the mean Tonnis angle of Asian population.[13]

Our study finding was comparable to the study finding of some researchers and differs from some others as morphometric parameters of acetabulum are influenced with age, sex, race, profession, ethnicity and social custom of a person. The differences was also due to the variation in the methods and materials being used by the researchers.

There were some limitations of the present study. It was a single center based study and sample size was small. The morphometric parameters of acetabulum were measured only on the AP view of the radiograph of the pelvis.

Conclusion:

In the present study no sexual dimorphism was observed in mean center edge angle, acetabular angle of Sharp and Tonnis angle in adult Bangladeshi population. Morphometry of acetabulum shows variation among the populations and the regions which would be helpful to the clinicians, orthopaedic surgeons, forensic experts and radiologists of our country.

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Conflict of Interest:

No author has any conflict of interest to disclose for this manuscript. The authors themselves are responsible for their ideas and views expressed in this article, which do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

Ethical Approval:

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Institutional Review Board of the Sir Salimullah Medical College. Written informed consent was taken from all the patients before taking part of the study.

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