A Study of Depth of Acetabulum from Adult Human Hip Bones - A Cross Sectional Study

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Abstract

Background: Most of the studies described anatomical parameters on X-ray. Here the measurements were carried out on adult human cadavers. This study will essentially help orthopedicians to make suitable hip joint prosthesis, also help forensic expert in disputed sex and help to understand biomechanics of hip joint. These parameters help us to understand etiopathogenesis of disease like osteo-arthritis of hip joint.

Methodology: A total 60 hip joints were studied in 20 male and 10 female cadavers. Measurements taken with soft tissue in situ for depth of acetabulum. These measurements were taken using vernier caliper and a steel scale. Mean values of measurements were recorded and compared between males and females. The mean values also compared with right and left side for males and females.

Results: The mean depth of acetabulum was found to be 31.78 mm in males and 29.70 mm in females.

The mean values of parameter were found to be greater in males than in females.The mean values of parameters was found to be greater on right side in both males and females.

Conclusions: The mean values of depth of acetabulum were found to be significantly greater in males than in females. The parameters of hip joint are immense importance to orthopaedicians, radiologists, and prosthetists. These values are useful to identify the fragment of bone for sex determination sent to forensic expert.The acetabulum was relatively deeper in this study compared to other similar study. This explains why congenital subluxation is rare in Indians. These parameters will help the orthopaedicians, prosthetist to design suitable hip prosthesis.

Key words: Acetabulum, Femoral head, Diameter, Vernier caliper, Adult cadaver

Introduction

To understand hip joint mechanics, knowledge of anatomy of proximal femur is a pre-requisite. Knowledge of the bony component of hip joint will not only help the radiologists but will also be of immense importance to orthopaedicians and prosthetists[1]. These parameters help in designing patient specific implants and can be utilized to understand etiopathogenesis of osteoarthritis[2].Race, climate, heredity, and geographical areas also have strong influence over anthropometric parameters of bone. Acetabulum is hemispherical cavity, central on the lateral aspect of the hip bone facing anteroinferiorly. It is valuable to know diameter and depth of acetabulum for surgical treatment of acetabular fractures. Anterior acetabular ridge morphology is important in total hip arthroplasty[3]. Acetabular depth is a very important parameter in diagnosis of the frequency of acetabular dysplasia and normal hip joint morphometry in adults. Sixty hip joints were dissected in department of anatomy, Koppal institute of medical sciences Koppal. All the measurements were taken with vernier calipers and data obtained was analysed and interpreted. B.Mukhopadhaya and B. Barooah found that depth of acetabulum will be always more than the radius of head of femur. These findings shows that head will be perfectly fitted into acetabular cavity and no mechanical fault. Due to this osteoarthritis of hip joint is rare in Indians as compared with Western Population[4]. Antunsalamon et al. found that depth

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of acetabulum was in the range of 21mm to 38mm with mean value of 30mm. The mean diameter of acetabulum was 51.60mm. This is important for load transmission and mobility of prosthesis in hip joint replacement. This will prevent the endoprosthesis failure and development of complications[5].Kordelle et al. found that mean diameter of acetabulum was 53.00 mm and mean depth of acetabulum was 23.00 mm. They also concluded that patients with slipped capital femoral epiphysis generally do well if the slip is mild because good congruity between femoral head and the acetabulum remains. [6]. Lloyd Roberts GC observed that minor anatomical variation in between the articular surface of femoral head and acetabulum was the cause of osteoarthritis. He also noted that in more than fifty percent cases the etiology was unknown, among the idiopathic cases shallow acetabulum was the most common cause of osteoarthritis[7]. John Emmett, studied 148 acetabulum in adult human cadavers of age group 30-50 years, in New York University's Medical School. Average depth of acetabulum was 25.40 mm in males and 23.81 mm in females. He concluded that the parameters were more in males than females[8].

Although various dimensions of acetabulum have been measured by several studies and all such studies were conducted either on dry specimens or on X-rays. This study is unique because we are measuring hip joint parameters with soft tissues in situ. The measurements of normal parameter of acetabulum are very important which to give population specific data for acetabular parameters reconstruction of hip joint prosthesis.

Material and Method

A total 60 hip joints were studied in 20 male and 10 female cadavers. Depth of acetabulum measured with soft tissue in situ. These measurements were taken using vernier caliper and a steel scale. Mean values of three parameters were recorded and compared between males and females. The mean values were compared with right and left side for males and females.

The material for study will be 30 adult human cadavers obtained during routine dissection from department of anatomy, KIMS Koppal. The study was carried on 30 cadavers, which included 20 male and 10 female cadavers of age group 18 to 85 years. This is cross-sectional study done for Six months. The study will be conducted on 30 adult cadavers that is on 60 hip joints. Sample size is based on probable number of cadavers that will be dissected during the study period.

Inclusion Criteria - All cadavers in the age group 18 to 85 years available during study period.

Exclusion Criteria - Cadavers with deformed or traumatized hip joint, pelvis and lower limb.

Method of collection of data

Permission was obtained from the head of department of anatomy and principal KIMS Koppal to conduct the study. The project was submitted to Independent Ethics Committee of KIMS Koppal. After getting approval letter from Independent Ethics Committee of KIMS Koppal, the study commenced.

The followings steps were carried out to dissect hip joint on both sides as given in the

Cunningham's Manual:

1. Femoral vessels and nerve were cut immediately inferior to inguinal ligament.
2. Sartorius and rectus femoris muscles were cut about 5 cm from their origins and turned downwards. Iliopsoas muscle was cut near its insertion and the two parts were turned upwards and downwards exposing the psoas bursa and capsule of hip joint. The bursa was removed and margins of thick iliofemoral ligament were identified.
3. Articular capsule was incised along the borders of iliofemoral ligament and all parts of capsule were removed.
4. Open the hip joint to disconnect the round ligament of femur or cutting the round ligament with scalpel.

The dissected hip joints were considered normal if:--

a. The acetabulum was spherical and cartilage lining was smooth and horse shoe shaped and ended abruptly at the inner margin forming the acetabulum as unbroken line.
b. The articular cartilage of femoral head was smooth and uniform with no evidence of marginal ossification.
c. Outer edge of cartilage and labrum of acetabulum blended without any distinct demarcation.
d. Acetabular fossa was filled with fibro fatty tissue and it had smooth surface.
e. Head of femur should form two third of the sphere, with round ligament attached in its centre. Deformed or any congenital deformity of head of femur was excluded from the study.

Using vernier caliper and metallic scale, depth of acetabulum have been calculated as follows:-

A thin metallic scale was placed across diameter of the acetabulum. Depth of acetabulum was measured

by using vernier caliper from centre of the acetabulum to metallic scale. Measurement was made more accurate as 1/10th of a millimeter by vernier caliper.

Intraobserver variation was avoided by measuring each reading three times by each of the three investigators and mean of the three readings were taken as final value and recorded.

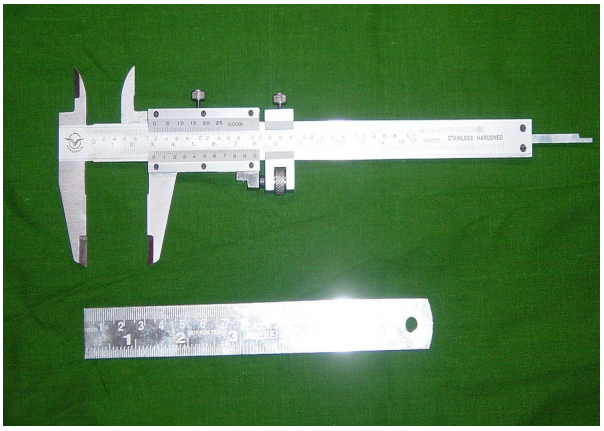

Fig 1: Materials Used for Study

Instruments Used: Vernier Caliper And Metallic Scale

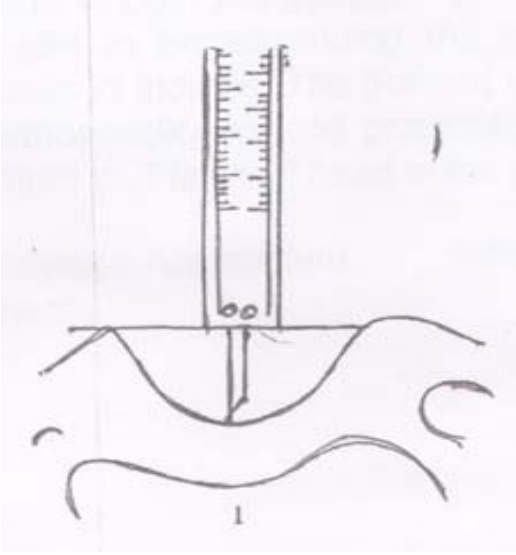

Fig 2: Method Used to Measure Depth of Acetabulum

Results

In this study parameter of 60 hip joints were measured using vernier caliper. In 60 hip joints of age group 18-85 years belonging to 40 male and 20 female,Depth of acetabulum measured.

All measurements were taken three times by three separate investigators. The mean of the three readings were considered as the final reading and recorded.

The data thus collected was analyzed and tabulated as follows:-

Table 1: Measurement taken in male hip bones (in mm)

Serial no	Cadaver number	Depth of acetabulum	
		Right	Left
1	1	32	33
2	3	30	32
3	4	25	26
4	6	33	31
5	7	30	30
6	9	36	34
7	10	34	32
8	12	33	32
9	14	32	31
10	16	30	31
11	17	31	32
12	19	30	30
13	20	36	36
14	21	34	33
15	22	32	31
16	23	35	34
17	25	30	31
18	26	30	31
19	28	32	31
20	29	33	32

Table 2: Measurements taken in female hip bones (in mm)

Serial no	Cadaver number	Depth of acetabulum	
		Right	Left
1	2	32	31
2	5	30	28
3	8	30	29
4	11	28	27
5	13	28	27
6	15	33	32
7	18	30	29
8	24	31	30
9	27	30	28
10	30	31	30

Measurements taken in sixty hip joints are given in table 1 and 2. This gives the mean values for depth of acetabulum of 40 males and 20 females hip joints

Table 3: Mean depth of acetabulum (in mm)

	Male (n = 40)		Female (n=20)	
	Right (20)	Left (20)	Right (10)	Left (10)
Minimum value	25	26	28	27
Maximum value	36	36	33	32
Mean	31.90	31.65	30.30	29.10
Standard deviation	2.57	1.98	1.55	1.66

In table 3, mean depth of acetabulum for 20 right and 20 left hip joints in males and 10 right and 10 left side hip joints in females are given

Table 4 : Average values depth of acetabulum

Gender		Depth of acetabulum
Males	n = 40	31.78
Females	n = 20	29.70
Mean		30.74

In table 4, average value of depth of acetabulum in males and females are given.

Table 5: Comparison of right side parameters with left side in males(in mm)

	Right			Left			
Parameters	N	Mean	SD	N	Mean	SD	P value
Depth of acetabulum	20	31.90	2.57	20	31.65	1.98	0.366 NS

In males, the mean values of depth of acetabulum on right side were compared with corresponding left side values

Table 6: Comparison of right side parameters with left side in females (in mm)

	Right			Left			
Parameters	N	Mean	SD	n	Mean	SD	P value
Depth of acetabulum	10	30.30	1.56	10	29.10	1.66	0.000008 S

In females the mean values of Depth of Acetabulum on right side were compared with corresponding left side values.

Table 7: Comparison of parameters (in mm) between males and females

Parameters		Male			Female			
	Side	N	Mean	S.D.	n	Mean	S.D.	P Value
Depth of acetabulum	Right	20	31.90	2.57	10	30.30	1.56	0.0830 NS
	Left	20	31.65	1.98	10	29.10	1.66	0.0016 S

The mean values of Depth of Acetabulum on right side in males were compared with corresponding values on right side in females.

The mean values of Depth of Acetabulum on left side in males were compared with corresponding values on left side in females.

Observation

Males

The mean depth of acetabulum was 31.90 mm on right side and 31.65 mm on left side. Minimum value for right side is 25 mm and maximum value for right side is 36 mm. On left side minimum value is 26 mm and maximum value was 36 mm.

From above observation it was concluded that all the parameter are more on right side than left side. This is because most of the people are right sided and they use right limbs most of the time.

Females

(c) Mean depth of acetabulum on right side is 30.30 mm and 29.10 mm in left side. The minimum value for right side depth of acetabulum is 28 mm and left side it is 27 mm. The maximum value for right side is 33 mm and for left side it is 32 mm.

From the above obsevations it was noted that the values are higher on right hip joint than on left hip joint parameters in females.

From above data comparison was made for male and female hip joint parameters. It was noted that the parameters are more in males than females. The difference of values between males and females are statistically significant. The difference was significant for depth of acetabulum.

Discussion

Table 8: Comparative study of depth of acetabulum (in mm)

	Authors	Depth of acetabulum	
		Male	Female
1	FundaTastekinaksu et al. (2006) in Turkey	29.49mm	29.49mm
2	Jeong Min Park et al.(2011) in Korea	11.80 mm	11.40 mm
3	Chang-Dong Han et al. (1998) in Korea	11.50 mm	10.20 mm
4	D. Jeremic et al. (2011) in Serbia	12.50 mm	11.20 mm

5	K.C. Saikia et al. (2005) in India	25.00 mm	25.00 mm
6	B. GenserStroble et al. (2005) in USA	16.43 mm	16.43mm
7	Murray RO (1965) in USA	13.00 mm	12.00 mm
8	John Emmett (1967) in USA	25.40 mm	23.81 mm
9	M. P. Moon et al. (1998) in France	26.91 mm	24.77 mm
10	Chauhan R et al. (2002) in India	27.83 mm	25.19 mm
11	Present study	31.78 mm	29.70 mm

Table 9: Comparative study of depth of acetabulm (in mm)

	Authors	Right	Left
1	K.C. Saikia et al. (2008) in India	25.00 mm	25.00 mm
2	D.Jeremic et al. (2011) in Serbia	11.90 mm	11.90 mm
3	Chang Dong Han et al. (1998) in Korea	10.90 mm	10.90 mm
4	Jeong Ming park et al. (2011) in Korea	11.60 mm	11.60 mm
5	Mukhopadhaya and Barooah (1967) in India	24.65 mm	24.51 mm
6	Present study	31.10mm	30.37mm

Hip joint is one of the major joint of the body.It is a multiaxial, synovial ball and socket (spherical, cotyloid) type of joint. Menschik, described it as rotational conchoids.

Dimension of the acetabulum and head of femur help in the reconstruction of hip joint i.e. help in manufacturing of best suitable prosthesis for the given population. Normal dimensions of the hip joint also help in the treatment of the acetabular fracture, and total hip replacement. Anatomical parameters of hip joint by radiographic techniques may produce magnification errors. Soparameter obtained by present study are with soft tissues in situ. So these parameters are near to normal situation for a given population.

Jeong Min Park et al., in Goyang, Korean population reported that the depth of acetabulum was 11.80 mm in males and 11.40 mm in females[9].

D. Jeremic et al., studied the depth of acetabulum in Kragujevac, Serbia. They found that depth of acetabulum was 12.50 mm in males and 11.20 mm in females[10].

Murry RO, in London, UK, showed the average depth of acetabulum in males and in females were 13.00 mm and 12.00 mm respectively[11].

John Emmett, studiedon hip bones in New York, USA observed depth of acetabulum in males 25.40 mm and in females 23.81 mm.

M.P. Moon et al., on cadaveric study in Paris, France reported that the depth of acetabulum was 26.91 mm in males and 24.77 mm in females[12].

Chauhan R et al., in New Delhi, India, studied on North Indian population, found that the depth of acetabulum was 27.83 mm and 25.19 mm in males and in females respectively[1].

The present study showed the average depth of acetabulum was 31.78 mm in males and 29.70 mm in females. These values are nearer to the studies done by M.P. Moon et al., John Emmet et al., and Chauhan R et al.

The present study shows the depth of acetabulum was more than the studies done by FundaTastekin Aksu et al., John Emmet et al., M.P. Moon et al., and K.C. Saikia et al. This is because in present study the acetabular labrum is intact while measuring the depth of acetabulum. On contrary John Emmet et al., FundaTastekin Aksu et al., and Moon et al., had measured on dry hip bones.

The values for depth of acetabulum in the present study are more than the studies done by Jeong Min Park et al, Chong Dong Han, D. Jeremic et al., Murry RO. This is because all the above said studies are radiological studies and present study has been done on cadavers keeping the acetabular labrum intact in situ which increases the depth of acetabulum.

If the mean acetabular depth was less than 9 mm, the persons are very prone to develop osteoarthritis. Shallow acetabulum was one of the causes for osteoarthritis. In the present study it was shown that acetabulum in Indian population has got adequate depth. So the incidence of osteoarthritis is less in Indian population as compared to Western population.

From the various studies and present study it was found that the depth of acetabulum was more in males than in females. In present study the depth of acetabulum was 31.78 mm in males and 29.70 mm in females which are very significant. From above values it reveals that the females have shallow acetabulum due to which they are more prone to develop osteoarthritis of hip joints.

The difference in values for the depth of acetabulum for right side and left side is not so significant. Both the sides have got similar values.

As we are unaware of the age of these cadavers we could not determine the age changes in parameters of acetabulum. Study by Jeong Min park et al., D.Jeremic, Murray RO, concluded that old age was

one of the causes of osteoarthritis. This was because as age advances depth of acetabulum decreases. This finding could not confirmed by present study.

FundaTastekin Aksu et al., inInciralti, Turkey, observed that the average depth of acetabulum was 29.49 mm. This value was less than that of present study because they studied on dry hip bones[4].

B. GenserStroble, studied radiographs in Vienna, Austria found that the average depth of acetabulum was 16.43 mm[13].

D.Jeremic, in Kragujevac, Serbia found that the mean depth of acetabulum was 11.9mm. This value was very less than the present study because study done by D.Jeremics was a radiological study.

In present study the mean value of depth of acetabulum was 30.74mm. Above said studies have got very less values as compared to present study. It was because above said studies are either radiological studies or carried on dry bones.

The depth and diameter from present study can be utilized for determining abnormal acetabulum. Abnormal acetabulum was one of the major causes of osteoarthritis. Any deviation from normal parameters of acetabulum can cause osteoarthritis. These parameters of acetabulum help in early diagnosis of osteoarthritis in North Karnataka population.

Abnormal anatomy of hip joint was the cause of osteoarthritis and acetabular dysplasia. To prevent further complication we need to restore the normal anatomy of hip joint. The parameters from present study can be utilized to restore normal anatomy in North Karnataka population. This will prevent the complications such as hip pain and disability in patients of this region.

We cannot compare the values obtained by above said studies for regional variations. This was because most of the studies either were done on the dry bones or they were radiological studies. So the values were very less as compared with present study. No other study was similar as this except the study done by Chauhan R et al. in North India. The values obtained by Chauhan R et al. are very near to present study.

Conclusion

The anatomical parameters of hip joint help the prosthetists and biomechanical engineers to design the best possible, population specific prosthesis for the hip replacement surgery in North Karnataka. This will prevent the complications arising from the mismatch of the prosthesis in total hip replacement surgeries in North Karnataka. It was found that most of the prosthetists will design the prosthesis keeping in mind the parameters available from the western countries. This study will give parameters which are very specific to North Karnataka population by which prosthetists can design more perfect prosthesis.

Present study provides valuable parameters which will help the forensic expert in early detection of disputed sex, race, and stature of a person. In this study it was found that the parameters vary from males to females and parameters also vary from right and left side.

The limitation of the present study was its small sample size. Further studies on larger population will redefine its results and various parameters values. Parameters of hip joint are specific to age, sex and race. Hence the present parameters can be applied only to the sex and race from which the sample has been drawn.

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Conflict of interest: Nil
Source of funding: Nil

Date received: Jun 23, 2022
Date accepted: Dec 20, 2022