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ESTIMATION OF MEAN VALUES OF FEMORAL ANTEVERSION, ACETABULAR ANTEVERSION, COMBINED ANTEVERSION AND ANTEVERSION RATIO IN NORMAL INDIAN POPULATION: AN MRI BASED STUDY

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Abstract

Background: The purpose of this study to estimate mean values of femoral anteversion, acetabular anteversion, combined anteversion and anteversion ratio in normal Indian population.

Methods: It is a prospective study conducted between october 2019 to May 2023 in R.D.Gardi Medical College, Ujjain, M.P.188 normal Indian adults (376 hips), of which 96 were males and 92 were females, fulfilling the inclusion and exclusion criteria selected on a random basis were included in the study.

Results: The mean FA in our study was found to be 16.02° , with a mean value of 16.56° on the right side and a mean value of 15.49° on the left side. The mean AA in our study was found to be 16.11° , with a mean value of 17.05° on the right side and a mean value of 15.18° on the left side. The mean CA in our study was found to be 32.14° , with a mean value of 33.61° on the right side and a mean value of 30.67° on the left side. Mean anteversion ratio in the total population was found to be 1.11, with a mean of 1.07 on the right side while on the left side it was 1.16.

Conclusion: The correct estimation of FA, AA, CA and AR in a given population depends on the appropriate method along with a proper technique. MRI was found to be better and safer than CT scan, as oblique images of the femoral neck can be obtained without the use of ionizing radiation.

Keywords: Hip joint, femoral neck anteversion, acetabulum anteversion, combined anteversion angle, anteversion ratio.

INTRODUCTION

The erect posture of the humans is demanding on the hip joint because of the anteversion of both the femur and the acetabulum. ^[1-4]

The femoral neck anteversion (FA) is the inclination of the femoral neck axis with reference to the knee axis projected on a plane perpendicular to the shaft axis.

Acetabular anteversion (AA) is the angle between the line joining the most prominent anterior and posterior edges of the acetabulum, on axial section, with the perpendicular.

Combined anteversion {CA} in the hip means the sum of the anteversion of the acetabulum and the femur.

Anteversion Ratio {AR} means the ratio of the anteversion of the femur upon the acetabulum.

Abnormal femoral anteversion and/ or acetabular anteversion has been associated with several orthopaedics conditions such as Osteoarthritis of hip, Hip labral tears, Patellofemoral pain, Developmental dysplasia of hip, Impingement, In toeing and out toeing, Instability and wear in Total hip Replacement surgeries.^[1-13]

Racial and geographic variations do exist in femoral anteversion and acetabular anteversion.^[14,15] In India, data on femoral anteversion and acetabular anteversion being used is from western population as few studies are available on Indian population.^[16,17,18]

The purpose of this study is estimation of mean values of femoral anteversion, Acetabular anteversion, combined anteversion and Anteversion ratio in normal Indian population.

M.R.I. has been chosen as imaging modality in the study as the clinical methods are inaccurate in correct estimation of the femoral anteversion. M.R.I. does not use ionizing radiations, thereby causing no radiation hazard to the person and also visualization of femoral neck axis is improved with the M.R.I. ^[19]

METHODS

188 normal Indian adults (376 hips), of which 96 were males and 92 were females, fulfilling the inclusion and exclusion criteria selected on a random basis were included in the study.

Inclusion Criteria

- 1) Age: 20 80 years
- 2) Sex: either sex

Exclusion Criteria:

1) Adult with obvious bony deformity of the pelvis or femur.

- 2) Adult with obvious hip pathologies evident by abnormal gait / restriction of hip joint movements.
- 3) Previously operated hips.
- 4) Known hip, knee or spine diseases.
- 5) Adult with established metabolic bone disease.

MRI was done on a 3T GE Healthcare super conducting unit. A Fast Spin Echo sequence, T1 weighted images, with T.R. 300-900 ms, T.E. 12.0-14.0 ms and slice thickness of 3 mm were used. Femoral anteversion was analysed by the method described by Tomezak et al.^[21]. Axial image that showed the centre of the longest femoral neck was obtained.

The alpha angle is the angle between the neck axis and a horizontal reference line. (Fig. 1)

Estimation Of Mean Values Of Femoral Anteversion, Acetabular Anteversion, Combined Anteversion And Anteversion Ratio In Normal Indian Population: An MRI Based Study



The beta angle between the posterior tangent to the femoral condyles and a horizontal reference line was determined. (Fig. 2)



Due to external rotation, femoral anteversion was calculated by subtraction of the beta angle from the alpha angle. ^[22]

Measurement of the acetabular anteversion was done by the method as described by Reikeras et al ^[23] on a scan through the centre of acetabulum, a line drawn between anterior and posterior edges of acetabulum on an axial image and the angle between this line and a vertical line was measured as acetabular anteversion.

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Combined anteversion was determined by adding femoral anteversion and acetabular anteversion ${CA = FA + AA}$

Anteversion ratio $\{AR\}$ was determined by dividing femoral anteversion and acetabular anteversion. $\{Anteversion ratio = FA / AA\}$

RESULTS

The mean FA in our study was found to be 16.02° , with a mean value of 16.56° on the right side and a mean value of 15.49° on the left side.

The mean AA in our study was found to be 16.11° , with a mean value of 17.05° on the right side and a mean value of 15.18° on the left side.

The mean CA in our study was found to be 32.14° , with a mean value of 33.61° on the right side and a mean value of 30.67° on the left side.

The mean anteversion ratio in the total population was found to be 1.11, with a mean of 1.07 on the right side while on the left side it was 1.16.

Parameter	Side	Ν	Mean	Std. Deviation	Std. Error of Mean	Median	95% C.I.
AA	Right	188	17.05	5.22	0.38	17.00	16.31-17.79
	Left	188	15.18	4.98	0.36	15.30	14.47-15.89
FA	Right	188	16.56	10.05	0.73	16.70	15.13-17.99
	Left	188	15.49	10.30	0.75	14.20	14.02-16.96
CA	Right	188	33.61	11.59	0.84	34.05	31.96-35.26
	Left	188	30.67	11.76	0.86	31.20	28.98-32.36
Ratio	Right	188	1.07	0.81	0.06	0.93	0.95-1.19
	Left	188	1.16	1.02	0.07	0.96	1.02-1.30
Table 1: Anteversion values in total population							

Tuble 1. Anteversion values

DISCUSSION

The hip joint anatomy and morphology has been fascinating to orthopaedic surgeons since long time. Among various measurements of the hip joint, exact value and significance of the angle of femoral, acetabular and combined anteversion has not been clearly established. Different studies have reported different mean values of femoral and acetabular anteversion. There has been a wide range in the values related to different racial and geographic populations. The method of estimation

of the femoral and acetabular anteversion also contributes to the wide range in the values, both within and among different population and communities.

Among various methods used for the estimation of the femoral, acetabular and combined anteversion, such dry femora, x-ray, C.T. and M.R.I., C.T. has long been considered as the most accurate method. In the CT method, the centre of the greater trochanter is taken as one of the landmarks. Hence the values obtained do not represent the real anteversion but instead report the constantly higher, head-trochanter angle.^[22] A true profile of the entire neck can be visualized by placing cuts in an oblique axial plane with MRI while this is not feasible with CT.

Despite its questionable inferiority in demonstrating bony landmarks, MRI generates adequate information that is comparable to CT Also the M.R.I. estimation of the anteversion is safer in comparison to the C.T. scan method as there is no risk of irradiation to the person. Hence it is now suggested that MRI is not only as accurate as CT in the evaluation of FA but also a lot safer. ^[21,24-28] The mean FA in our study was found to be 16.02° , with a mean value of 16.56° on the right side and a mean value of 15.49° on the left side. This value is supported by the literature as shown by Schneider et al. ^[24]

The mean AA in our study was found to be 16.11° , with a mean value of 17.05° on the right side and a mean value of 15.18° on the left side. This value is supported by the literature as Tonnis^[1] and Mckibbin^[4] estimated that 15° to 20° is the normal range for acetabular anteversion. Reikeras^[29] in their study found a mean acetabular anteversion to be 17° .

The mean CA in our study was found to be 32.14° , with a mean value of 33.61° on the right side and a mean value of 30.67° on the left side. This value is supported by the literature as Mckibbin^[4] defined 30° to 40° combined anteversion as being normal. Tonnis^[1] estimated that 15° to 20° is the normal range for both femoral and acetabular anteversion and 30° to 40° is the normal range for the McKibbin instability index. Amuwa and Dorr suggested that the combined anteversion technique for acetabular component placement of total hip arthroplasty should provide a mean near 35° with a safe zone of 25° to 50° ³⁰.

The mean anteversion ratio in the total population was found to be 1.11, with a mean of 1.07 on the right side while on the left side it was 1.16.

The FA had a wide range from -9 0 to 47 0 in our study. This wide range is consistent with the literature as studies by various authors found it to range from -25° to +50° with the mean angle varying from 8° to 28°. ^[3, 17]

CONCLUSION

The correct estimation of FA, AA, CA and AR in a given population depends on the appropriate method along with a proper technique. MRI enables one to orientate the slice along the axis of the femoral neck, thus obtaining a single cross-section of the entire neck. MRI was found to be better and safer than CT scan, as oblique images of the femoral neck can be obtained without the use ionizing radiation. The mean FA in the total population was found to be 16.02^{0} . The mean AA in the total population was found to be 16.11^{0} . The mean CA in the total population was found to be 32.14^{0} . The mean anteversion ratio in the total population was found to be 1.11.

Limitation of the study

Small sample size is a limitation of the study. Further larger multicentric studies are required to verify the findings.

On behalf of all authors, the corresponding author states that there is no conflict of interestand patient consent is taken properly.

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