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Prevalence of Cam and Pincer Type of Femoroacetabular Impingement on Computed Tomography in Asymptomatic Population: A Study in Tertiary Care Hospital

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ABSTRACT:

Objective
The fundamental goal of was the determination of the presence of cam and pincer morphology and the alpha angle ranges in patients without any symptoms or prior femoroacetabular impingement.
Material and methods
Our retrospective cross-sectional study was performed in tertiary care hospital. Abdominal computed tomography (CT) was performed on a total of 78 persons for non-hip-related causes. Patients who had femoroacetabular impingement were disqualified for the study. Additionally, the femoral head-neck offset was measured, as well as the center-edge angle, the angle of the acetabular version, and an estimation of the acetabular crossover sign. The alpha angle measurement was superior femoral head-neck junction at the anterior aspect using AN as well as AR images.
Results
Cam (an increase of alpha angle, reduced femoral head-neck offset) and pincer type of morphology were detected in a total of 20.0%, 26.8%, 25.8%, 10.2%, and 11.7% of hips, respectively (increased center-edge angle and decreased acetabular version and presence of acetabular crossover sign). The mean AR was between 40.32° ±4.34°SD and 49.11° ±4.57°SD and AN was 41.22° ±4.66°SD. Statistically, a significant difference was assessed between the AR and AN values ($P < 0.001$). The largest AR values were seen at the femoral head-neck intersection, at the anterosuperior aspect.
Conclusion
Alpha angles were larger in asymptomatic participants, at the femoral head-neck junction, anterosuperior aspect in comparison to axial oblique CT images in the anterosuperior area. The morphological pattern of pincer and cam-type can also be assessed using measurements that are outside the normal range for the general population.

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INTRODUCTION

Osteoarthritis of the hip can be caused by femoroacetabular impingement (FAI), a frequent source of pain in active and young people [1, 2] and terms of impingement, the cam, pincer, and combined types can be separated.[3] The pure cam form denotes the bone or cartilaginous excess at the anterosuperior aspect of the femoral head however pincer type signifies the over coverage of the femoral head with the acetabulum.[4] Number of reports have postulated malformations specific to FAI which are causes of this impingement and OA of the hip.[1] Having an aspherical intersection of the femoral head and neck reduces the equalization of the same because of its aspherical constituent.[5]

Hip asymmetry is diagnosed using a combination of symptoms; these anomalies can be spotted through a clinical examination and imaging tests. Diagnoses of FAI can be made using imaging symptoms such as an elevated alpha angle (AA), reduced offset of femoral head-neck, aberrant center edge angle (CEA), retroversion of the acetabulum (coxaprofunda), and protruding acetabuli (femoral anterior instability).[6]An abnormally deep (coxaprofunda) or retrovertedacetabular socket may cause pincer impingement. FAI results in irreversible chondral damage and degeneration of the labral tissue.[4]Femoroacetabular impingement can worsen and lead to hip joint degeneration if the root cause is not addressed.[1]The conceptualization of osteoarthritis denotes more on motion than on axial loading of the hip. The surgical treatment of femoroacetabular impingement is based on an idea to improve clearance for hip motion.[1]

Significant changes in the proximal femoral head and acetabulum have been studied by the researchers, morphological distinctions, and metrics that reflect these changes. Measurement of focal epiphyseal overgrowth in the femur, which indicates an inadequate anterolateral head-neck offset and femoral head asphericity, is the alpha angle (AA).[4]For decades; the AA measurement has been used for quantitative assessment of the osseous disproportion at the femoral head and femoral neck junction.[7]There is however some debate about the clinical validity of the AA measurements based on repeated measurements based on the interobserver difference.[3]

A very useful tool in the diagnosis and surgical planning of FAI is Computed tomography.[8] As part of this investigation, we surveyed patients without any prior history or symptoms of impingement and determined the prevalence of cam and pincer morphological assessment, as well as the AA value range in CT scans, and compared the AA values acquired from two distinct measurement procedures.

METHODOLOGY:

After approval of this cross-sectional study from the hospital's ethical review committee, our tertiary care center retrospectively identified the patients who presented between Nov 2019 and Mar 2020 and underwent abdominopelvic CT scans for reasons not related to hip abnormalities. A 16-MDCT scanner was used for all of the scans. When using 120kVp, dose modulation and images were obtained with section thicknesses of 5mm. A subset of 78 patients was selected at random from a pool of 120 patients for the study. Consent was obtained from patients. The participants in our study had to be free of hip-joint symptoms. The goal was achieved by computerized hospital records. Hip and pelvic imaging was performed on two patients previously, and orthopedic surgeons were consulted by them. Due to poor image quality or an insufficient area of interest, missing lesser trochanters, or presence of intramedullary nails on CT scout images, those 42 patients who did not meet the criteria of the study were excluded

Helical CT data was imported into a workstation and multiplanar reconstructions using a bone and soft tissue algorithm were generated. There were 100 hip joints studied, of 78 selected patients for the presence of FAI. To correct the patient's posture, oblique tools were employed on the workstation. Other hip joints were excluded because of not having desired quality of images needed for measurements. The images were interpreted by two radiologists who had 5 and 6 years of experience.

IMAGE INTERPRETATION

There were two measurements made: one for AA and one for FHNO. A cam lesion was defined as one with a femoral head-neck offset less than 8 millimeters and an alpha angle larger than 55 degrees [9](Fig.1)

In four different planes, the measurement of alpha angle was made at 30° intervals at the femoral head and femoral neck intersection in the anterosuperior aspect (Fig. 2). The narrowest part of the femoral neck and the femoral head's center was used to determine the femoral neck's axis. The alpha angle of more than 55 degrees was deemed abnormal in this research [9]

After reformatting the image so that it was orthogonal to a tangent that ran through both of its posterior corners, we calculated the acetabular version angle between the linear dimension connecting the edges of the anterior and posterior aspect of the acetabulum and its 90 degrees dimension (Fig. 3). Cross-referencing images obtained in the coronal plane were used to determine the acetabular cup's deepest angle. The presence of acetabular retroversion was defined as an angle less than 15°.[10]

The acetabular index (-0°) was chosen to depict the acetabulum's over-coverage of the femoral head. [9] Following is an illustration (Fig. 4A). Acetabulum's over-coverage of the femoral head of larger than 40 degrees was chosen as center edge angle.[11] (Fig 4B)

Pincer-like morphological characteristics of the acetabulum are an indicator of retroversion of the acetabulum. There is a positive cross-over sign when the posterior wall of the acetabulum is more medial concerning the superior acetabular rim than the anterior acetabulum wall. (Fig 5) Sphericity at the intersection of the femoral head and femoral neck is indicated by a pistol-grip deformity. It has a cam-like morphology. The acetabulum covers the back of the femoral head, by a prominent posterior wall sign.[9]

Statistical Analysis

Plotting the variance in the AN/AR (Axial oblique alpha angle / Radial alpha angle) mean and the intra- and interobserver variability were done using the paired-sample t-test and Pearson's coefficient of correlation, respectively. The AA (Alpha angle) or FHNO (femoral head-neck offset) showed no significant difference between the male and female populations. All calculations were carried out utilizing the SPSS statistical package for social sciences (version 25.0)

RESULTS:

A total of 78 patients (48 male population and 30 female population) were incorporated in the study, with an average age of 33.9 years ±7.30SD.

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Measuring the alpha angle

In AR (A1–A7), the calculated mean (range) was 40.32° ±4.34° SD to 49.11° ±4.57 ° SD, while in AN, it was 41.22° ±4.66° SD. AR (A2–A7) and AN (P < 0.001) showed a statistically significant difference (AR values were greater than AN), with P 0.001. Anterosuperior segments of the junction of femoral head-neck (A4–A6) were found to be most affected by AR values (Table 1). There Statistically significant difference was found in mean A5 and A6 values between males and females, with the males reporting values of 48.23° ±4.9° SD and the females reporting the value of 46.87° ±4.0° SD (P <0.001). Gender differences were not found in any other locations.

AR values were greater than or equal to 55° at 48 segments in 31 subjects of the study (41 hips). (See Table No. 2) 64.5 percent of the patients (20 men) and 35.4 percent of the patients (11 women) were found. Two or more patients had AR values of 55°, while nine patients had AR values of 55° only in one location. The AN of one patient was 55 degrees, but the AR was raised in several different places.

Moderate to highly strong intraobserver correlation was assessed (r=0.66–0.94), and moderate to high interobserver correlation (r=0.54–0.86) for radial alpha angle and axial oblique alpha angle measurements; both were statistically significant (P<0.001).

Other Calculated Measures

Femoral head-neck offset was 9.02 ±1.66 mm on average (range 6–14 mm). For FHNO, no statistically significant gender difference was seen (P > 0.001). FHNO was less than 8 mm in 37 subjects.

The average center edge angle was 36.89° ±6.25° (range: 25°–56°), with a range of 26°–57°. For center edge angle, among male and female populations no statistically significant difference was appreciated (P > 0.001). CEA was greater than 40° in 33 patients.

The average acetabular version angle was 22.23° ±4.78° (range 12–39°). In terms of acetabular version angle, there was a statistically significant gender difference; females had higher values. The AV angle was 15° in 13 patients. There was an acetabular crossover sign in 15 patients.

Cam morphology (increased radial alpha angle, decreased femoral head-neck offset) morphology of pincer type (increased center edge angle, reduced acetabular angle, and presence of acetabular crossover sign) were found in 20.0%, 26.8%, 25.8%, 10.2%, and 11.7% of the hip joints, respectively.

DISCUSSION:

Many criteria and specific radiologic indications related to FAI can be identified using the current standard literature. Higher Radial alpha angle values (55°) were found in the population without any symptoms and no impingement test the maximum AR values (A4–A6) were 20 %. Femoral head-neck junctions were found in males and were more likely to have higher AR values than females. 20 percent, 26.8 percent, 10.2 percent, and 25.8 percent of the population, respectively, had cam and pincer morphologies, (there was the use of various parameters, as mentioned above and hence ranges are mentioned).

Cam-type deformities were initially quantified by measuring femoral head and neck, at the anterior aspect alpha angle method by MRI. Alpha angle was then assessed around the femur's entire circumference using radial plane images.[3]In recent years, the use of Alpha angle to evaluate cam-type deformities has become contentious. A study by Sutter et al, [3] found that if the Alpha angle threshold is the increased value from 55 degrees to 60 degrees that reduced the number of falsepositive results. More than half of the patients had an angle value of higher than 55 degrees. Our study found 20% of the subjects without any symptoms had Alpha angles larger than 55 degrees in at least one radial plane in our study. According to Sutter et al., [3] and Reichenbach et al., [12] the anterior superior aspect of the femoral head-neck intersection (i.e., the A4–A6 locations) had the highest Alpha angle values. [12]

Patients with higher Alpha angles than 55° were predominantly males, which is consistent with previous studies. Statistically, the significant difference is found in Alpha angle values between males and female populations found at A5 and A6, according to our research. Alpha angle assessment at the anterosuperior aspect of the femoral neck was found to be higher in the literature with suspected cam-type impingement, as well as in asymptomatic individuals. [3, 12,16] Of the 78 individuals studied, 74% of those who were not experiencing any symptoms had some degree of cam-type deformity in at least one plane of the CT scan reconstruction data set.

A study by Reichenbachet al.[12] found that, of 244 young asymptomatic males who underwent MRI with radial reconstructed images, 24% had definite cam-type deformities.

A 74% reduction in femoral head-neck offset was also discovered, with the majority occurring in the anterosuperior position

Interobserver and intraobserver variability/agreement in AA measurement has been the subject of numerous studies. For AA measurements, Nötzli and colleagues 7 found 2% intraobserver variability, while there was 30% of interobserver variability by Lohan et al[13]Interobserver agreement and reproducibility for AA measurements have been described as moderate to good in some studies, with intraclass coefficient constant values ranging from 0.50 to 0.712 in those same studies. [3, 12, 14]Both intra- and interobserver agreement (r=0.66–0.94), as well as intra- and interobserver agreement (r=0.54–0.86), were found to be moderate to strongly correlated. AA measurements on five additional subjects who weren't part of our study, as well as AA measurements from the same set of images, may have contributed to our findings of higher correlation levels than those found in previous studies. In the study of Kang and colleagues [15] who examined the prevalence of abnormalities associated with an impingement in those who were not experiencing any symptoms, as well as the AA measurement on images taken from an anteroposterior perspective. 33 percent of women and 52 percent of men were found to have at least one risk factor for FAI.

The range of AA values in asymptomatic subjects has been examined in several studies [16, 17] but ours is unique in aspects that in our study, Seven distinct AAs were measured from the anterior quadrant to the superior femoral head and neck connection, and the cam-type deformity was detected using a semiquantitative method rather than a quantitative approach.

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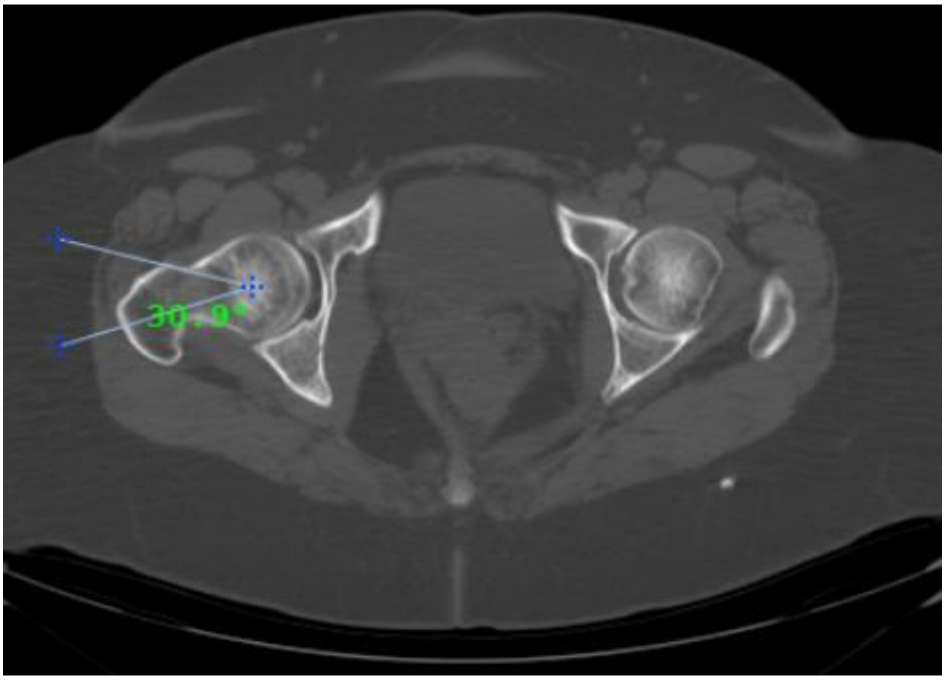
TABLE:1

Segments	Radial Alpha Angle	Axial Oblique Alpha Angle	P Value
A1	40.32 ±4.34	41.22 ±4.66	<0.001
A2	41.36 ±4.75	41.22 ±4.66	<0.001
A3	44.52 ±4.48	41.22 ±4.66	<0.001
A4	46.21 ±5.01	41.22 ±4.66	<0.001
A5	47.89 ±4.63	41.22 ±4.66	<0.001
A6	49.11 ±4.57	41.22 ±4.66	<0.001
A7	46.42 ±4.12	41.22 ±4.66	<0.001

Table 2: Radial alpha angle <55° at 48 locations

A1	A2	A3	A4	A5	A6	A7	Total
0	2	5	10	12	12	5	46

Measurement on axial oblique plane: Fig 1A



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Measurement on axial oblique plane: Fig: 1B

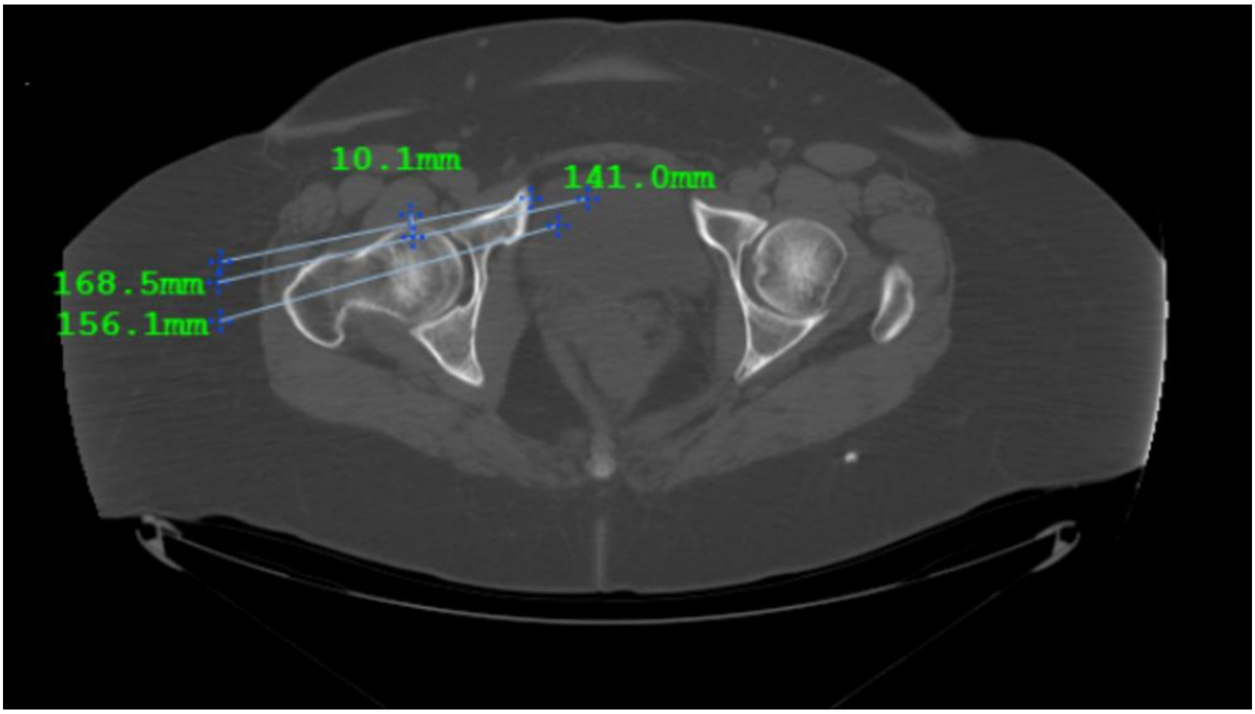

Fig 2: Alpha angle

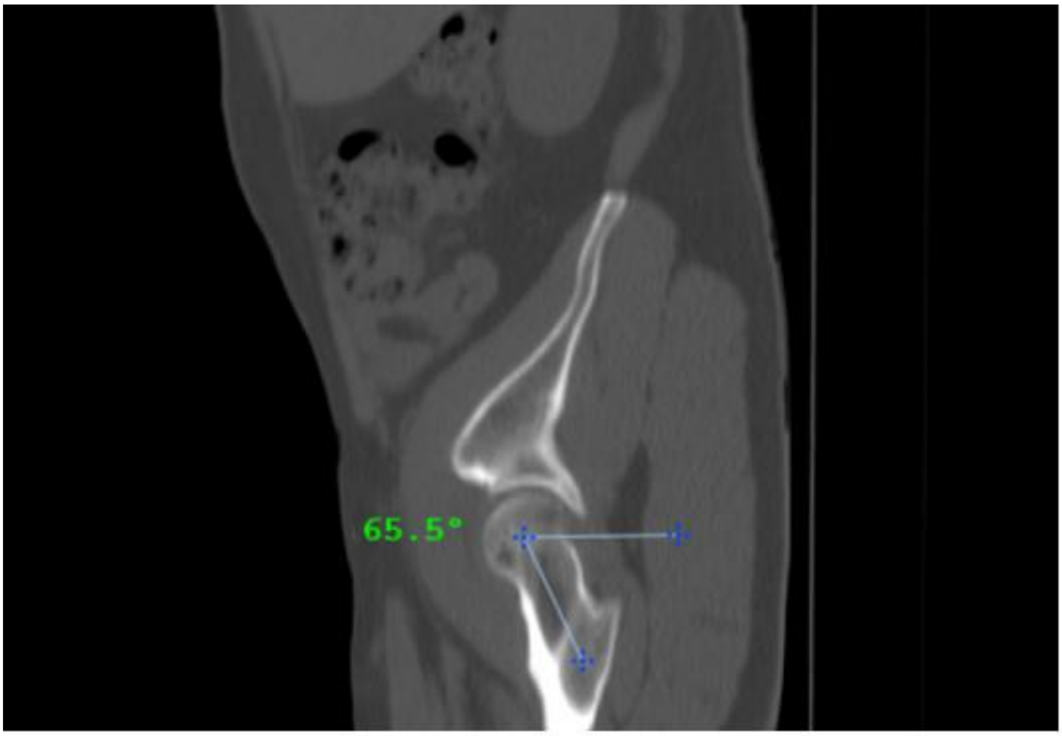

Fig 3: Acetabular retroversion angle

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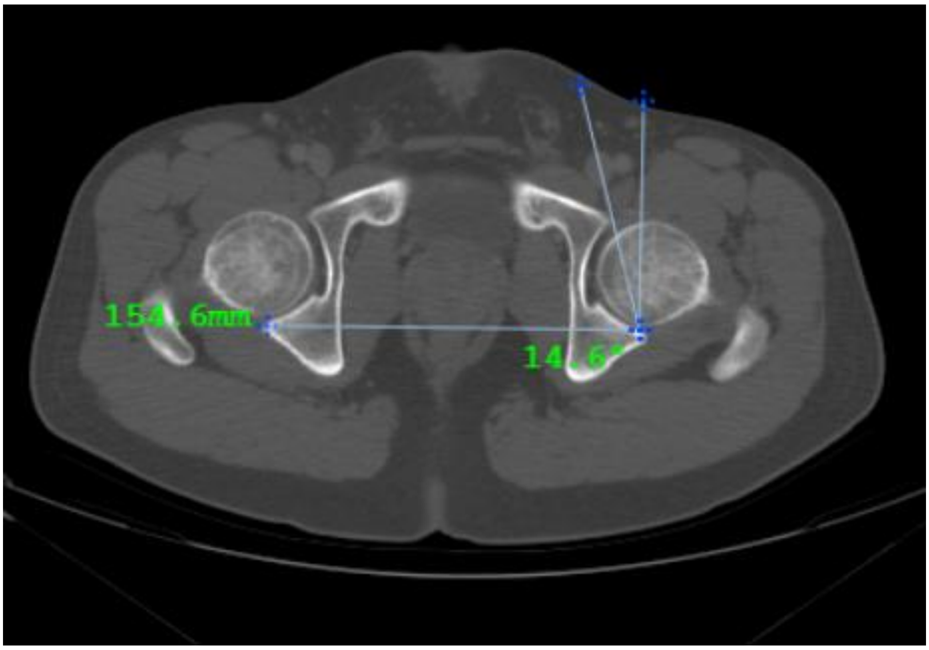
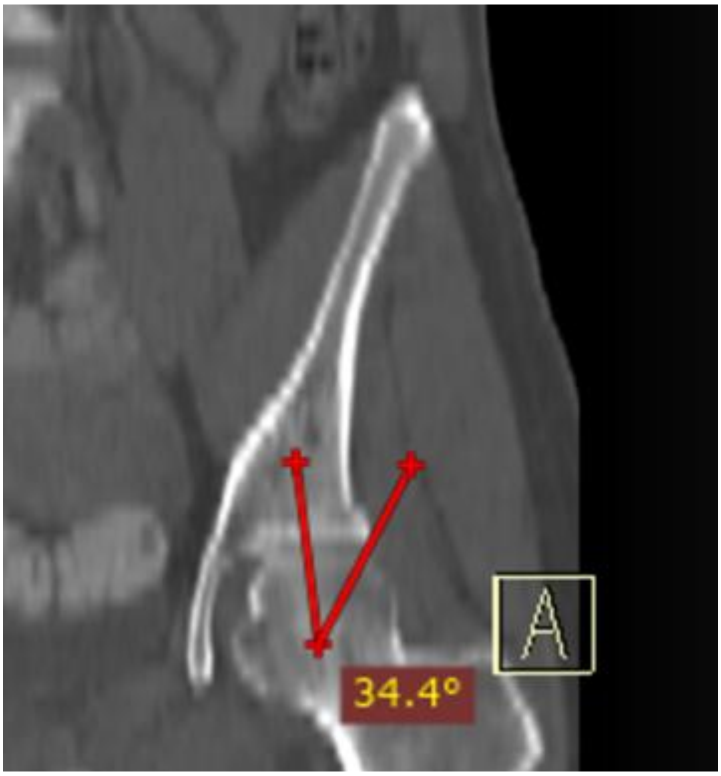


Fig: 4 Acetabular angle and Lateral centre edge angle

A



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B

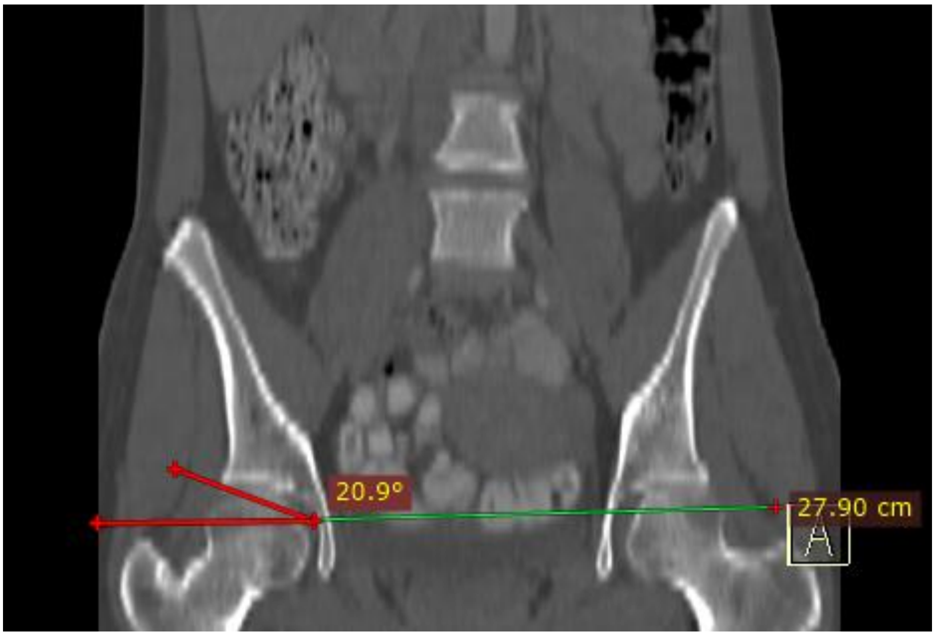
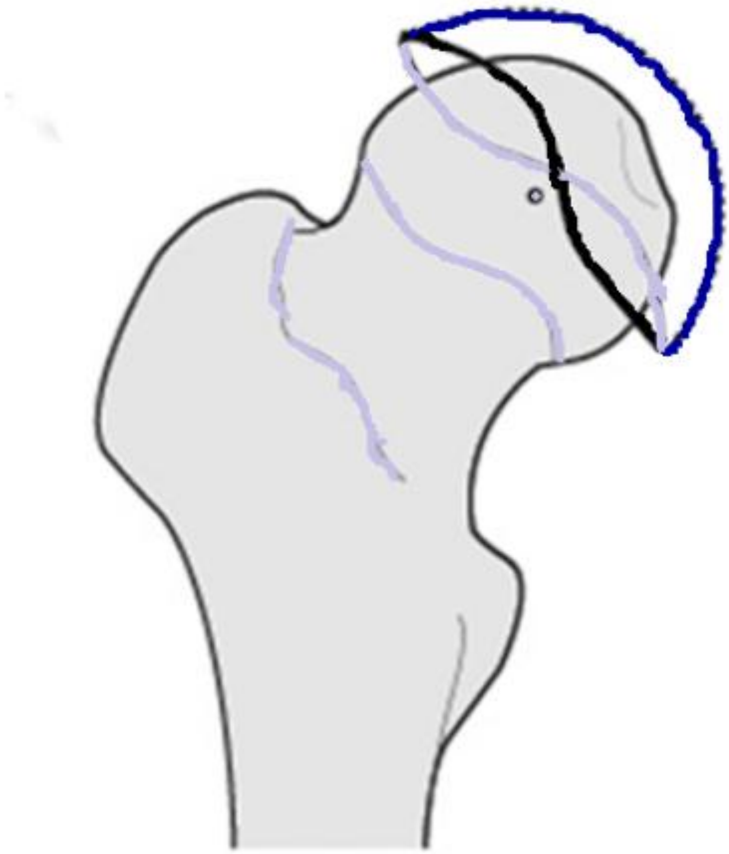


Fig: 5 Cross over sign



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