

Radiographic CT Measures Protocol for Cam FAI

Participants

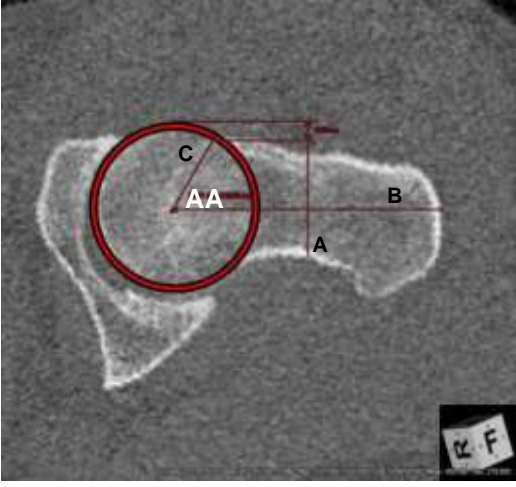
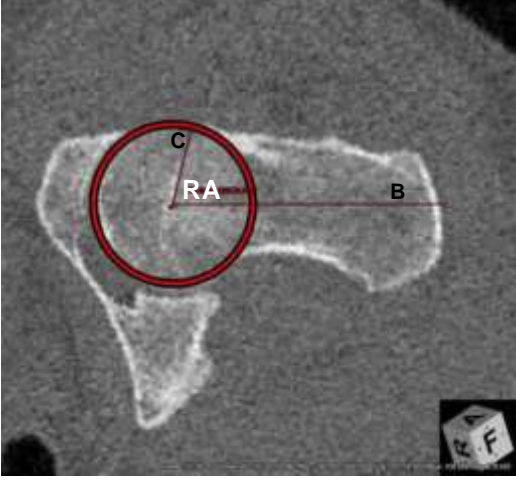
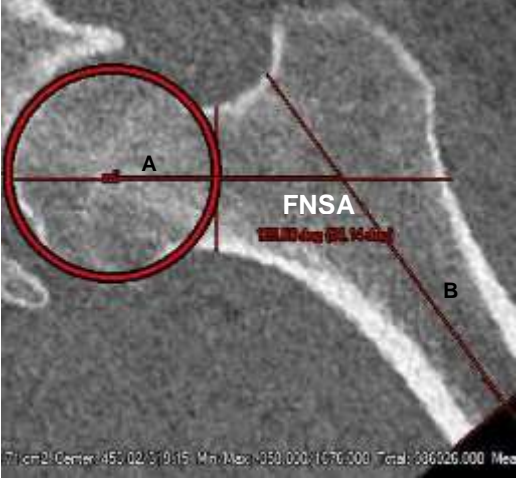
- Patients and participants first classified according to presence of cam deformity, symptoms, clinical signs
- Cam deformity defined by an elevated alpha angle in the oblique-axial or radial plane
 - Symptomatic femoroacetabular impingement (sFAI) – cam deformity, clinical signs
 - Asymptomatic femoroacetabular deformity (aFAD) – cam deformity, no clinical signs
 - Control (CON) – no cam deformity, no clinical signs

GROUP	ALPHA ANGLE (axial > 50.5° or radial > 60°)	CLINICAL SIGNS AND SYMPTOMS	NUMBER
sFAI	Yes	Yes	15
aFAD	Yes	No	19
CON	No	No	16
		TOTAL	50

Measures

- Subject-specific CT data are blinded, randomized, then evaluated
 - Blinded – CTs and filenames are renamed to “HJC XX” (where “XX” denotes a two-digit number); patient information removed from filenames to eliminate identification
 - Randomized – CTs are reassigned random number for “XX” and then randomly reordered
 - Evaluated – perform all measurements of the left hip, then right hip, for each patient in the reordered list
- Observations are recorded in a spreadsheet, that will indicate “HJC XX” and the parameters to be measured for the left and right hip
- Complete all measures for all patients within a two-day period
- Reading sequence for “HJC XX” will be randomized and reordered for second evaluation
- Second intra-rater evaluation, to start two weeks after completion of first evaluation, on a new spreadsheet (previous intra-rater evaluations are not to be seen)
- Previous inter-rater evaluations are not to be discussed, to eliminate bias

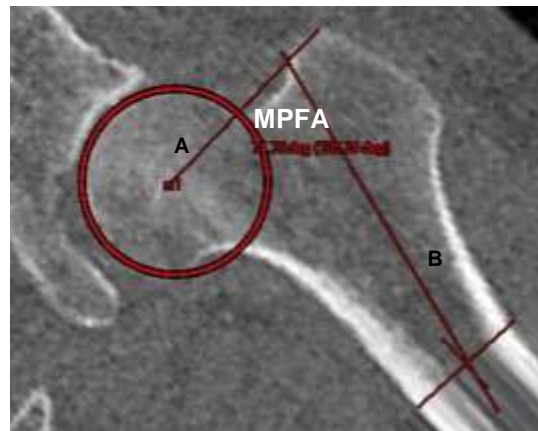
Parameters

<p>1. Alpha Angle – Axial 3:00 (AA)</p> <ul style="list-style-type: none"> • Axial plane found from cross-sectional view through centroid of femoral head and longitudinal femoral neck axis • Trace a circle around contour of femoral head, with centroid centred in the frontal, sagittal, and transverse planes • Using the axial view, find the narrowest part (width) of the femoral neck and draw a line (Line A) through its cross section • Draw a second line (Line B) through centre of the femoral neck (longitudinally) perpendicular to previous line • Draw best-fit circle, following the outer edge of the femoral head (compact bone) • Draw line (Line C) from centre of circle to the edge of the circle, where the femoral head exceeds the circle (head neck junction) • Alpha angle is the angle between the line B and C <p>Classification: cam deformity defined by axial alpha angle $> 50.5^\circ$</p>	
<p>2. Alpha Angle – Radial 1:30 (RA)</p> <ul style="list-style-type: none"> • Radial plane found from 45° rotation along the narrowest mid-sectional axis of the femoral neck, exposing the anterosuperior quadrant (1:30) of the femoral head • Trace a circle around contour of femoral head, with centroid centred in the frontal, sagittal, and transverse planes • Using the axial view, find the narrowest part (width) of the femoral neck and draw a line (Line A) through its cross section • Draw a second line (Line B) through the centre of the femoral neck (longitudinally) perpendicular to previous line • Then, draw best-fit circle, following the outer edge of the femoral head (compact bone) • Draw line (Line C) from centre of circle to the edge of the circle, where the femoral head exceeds the circle (head neck junction) • Alpha angle is the angle between the line B and C <p>Classification: cam deformity defined by radial alpha angle $> 60^\circ$</p>	
<p>3. Femoral Neck-Shaft Angle (FNSA)</p> <ul style="list-style-type: none"> • Axial plane found from cross-sectional view through centroid of femoral head and longitudinal femoral neck axis • From the frontal plane, trace a circle around and centred at femoral head • Make sure that the slice used exposes the widest/thickest portion of the femoral diaphysis • Draw a line going through both the centre of the femoral neck and femoral head (Line A) • Draw a second line (Line B) beginning at the edge of the piriformis fossa all the way down through the centre of the femur • Femoral neck-shaft angle is angle between lines A and B <p>Classification: normal neck-shaft, defined by angle between $124-136^\circ$; coxa vara, defined as $\leq 120^\circ$</p>	

4. Medial Proximal Femoral Angle (MPFA)

- Trace a circle around contour of femoral head, with head centroid centred in the frontal, sagittal, and transverse planes
- From the frontal view, ensure that the slice exposes the widest/thickest portion of the femoral diaphysis
- Draw a line (Line A) from the centre of the femoral head to the superior tip of the greater trochanter
- Draw a second line (Line B) beginning at the edge of the piriformis fossa all the way down through the centre of the femur
- Medial proximal femoral angle is angle between lines A and B

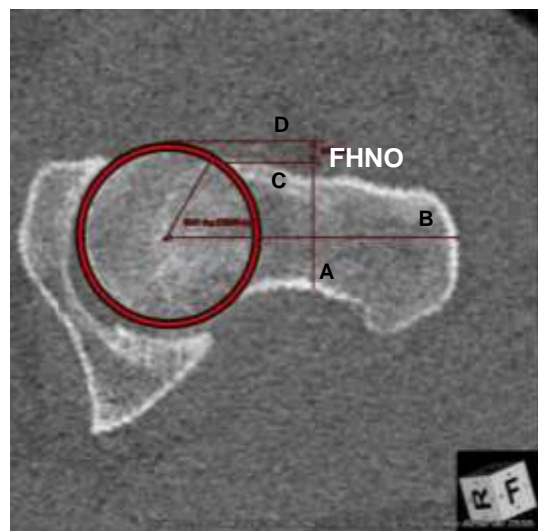
Classification: normal MPFA is between 84-89°



5. Femoral Head-Neck Offset (FHNO)

- Trace a circle around contour of femoral head, with head centroid centred in the frontal, sagittal, and transverse planes
- Using the axial view, find the narrowest part (width) of the femoral neck and draw a line (Line A) through its cross section
- Draw a line (Line B) through the centre of the femoral neck longitudinally and perpendicular to line A
- Draw a line (Line C) perpendicular to line A and parallel to line B, lining it up with the edge of the compact bone of the neck itself (anterior wall of femoral neck)
- Draw another line (Line D) parallel to line C, lining it up with the outer edge of the circle drawn around the femoral head.
- Femoral head-neck offset is the thickness of the femoral head that lies anterior to the line passing the anterior wall of the femoral neck, between line C and D

Classification: decreased femoral head-neck offset defined as < 8mm



6. Femoral Version (FV)

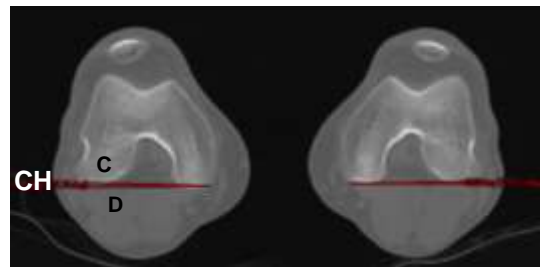
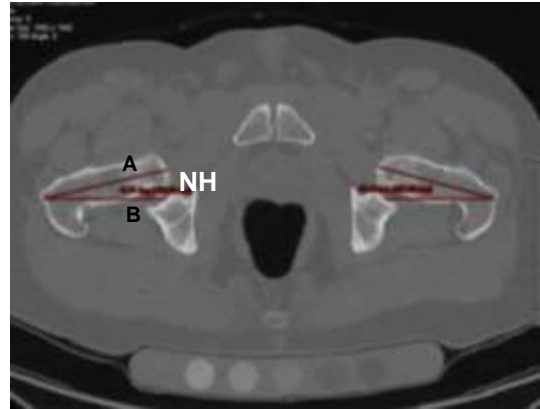
Neck Horizontal

- From the transverse plane, take the slice with the thickest cross section of femoral neck making sure that the lesser trochanter is not visible in the slice selected
- Draw the first line (Line A) through both the centre of the femoral head and longitudinally along the femoral neck axis
- The second line (Line B) is a straight horizontal line with respect to the image plane that intersects with line A
- Neck-horizontal angle is the angle between line A and B

Condyle Horizontal

- From the transverse plane, take the slice about the knee with both epicondyles in view
 - Draw the first line (Line C) tangential to the most posterior convexity of both epicondyles (can also use femoral condyles as reference point) and the second line (Line D) in the horizontal plane that intersects with line C
 - Condyle-horizontal angle is the angle between line C and D
- Femoral version (absolute anteversion or retroversion) obtained by subtracting the condyle-horizontal from the femoral neck-horizontal
 - If femoral epicondyles are internally rotated on the images, the angle is negative, therefore must be added to the angle of anteversion
 - If the femoral epicondyles are externally rotated on the images the angle of rotation must be subtracted to the angle of anteversion
 - Knees rotated inward when increased femoral anteversion and compensatory external tibial torsion
 - Rotated outward when decreased femoral anteversion and compensatory internal tibial torsion

Classification: femoral retroversion can be defined as $< 15^\circ$; anteversion $\geq 15^\circ$



7. Acetabular Version (AV)

- Correct for pelvic tilt, by aligning all left-right and anterior-posterior superior iliac spines on the transverse plane
- From the transverse plane, locate the slice where the acetabular cup is the deepest – where the medial wall of the acetabulum is most medial
- Draw a line (Line A) horizontally across both posterior edges of the acetabulum
- Draw a second line (Line B) perpendicularly to line A, crossing at the posterior edge of the acetabulum.
- Draw a third line (Line C) tangentially from the anterior to posterior margins of the acetabulum
- Acetabular version is the angle between line B and C

Classification: acetabular retroversion defined by an angle $< 15^\circ$; normal acetabular version is between $15-20^\circ$

