

# Black or White - Systematic Evaluation of Conventional Radiography

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3D to 2D

# Aim

This presentation aims to describe:

- > the technical properties of plain imaging affecting the anatomy of the hip on the X-Ray
- > summarize the different radiographic projections of the hip

# Overview

## Conventional x-Ray

### Acetabulum

- > depth
- > coverage
- > version
- > inclination

### Femur

- > Head-neck deformity
- > varus-valgus

## MRI

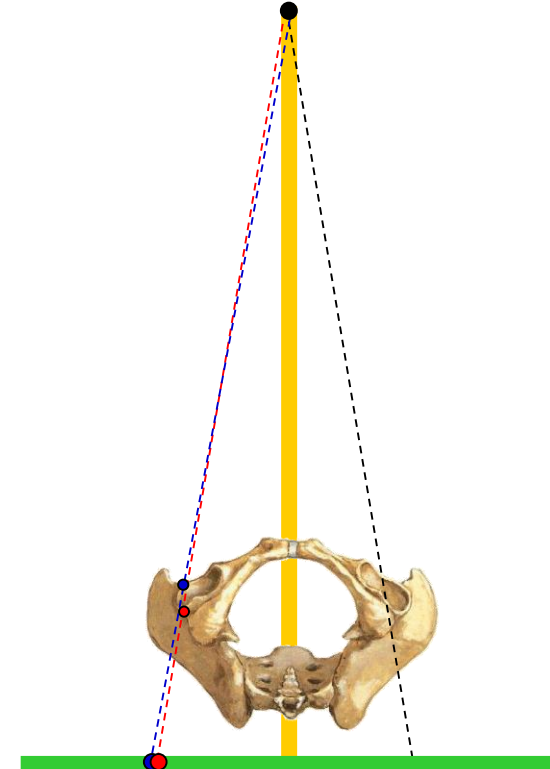
- > labrum
- > cartilage
- > asphericity
- > torsion

## CT

- > torsion
- > 3D-imaging
- > 3D-animation

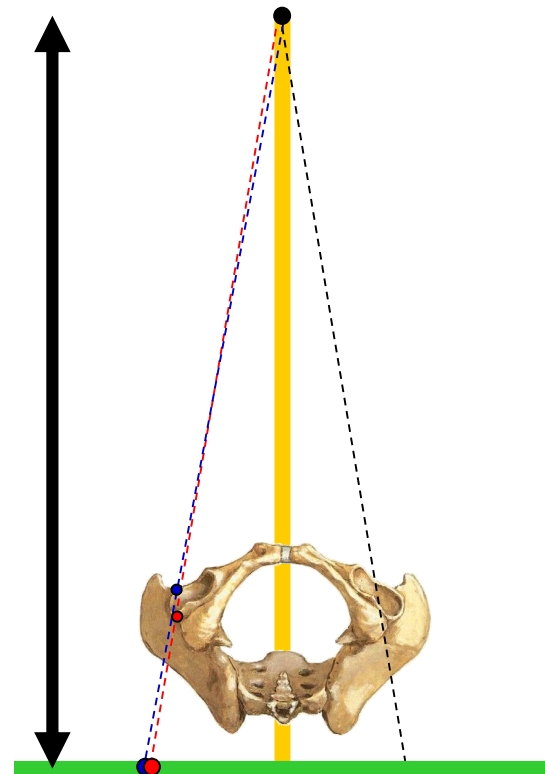
# Technical Principles of Radiographic Imaging

- > Film-Tube Distance
- > Patient-Film Distance
- > Centering and Direction of the X-Ray Beam
- > Conical Projection
- > Fluoroscopy



# Technical Principles of Radiographic Imaging

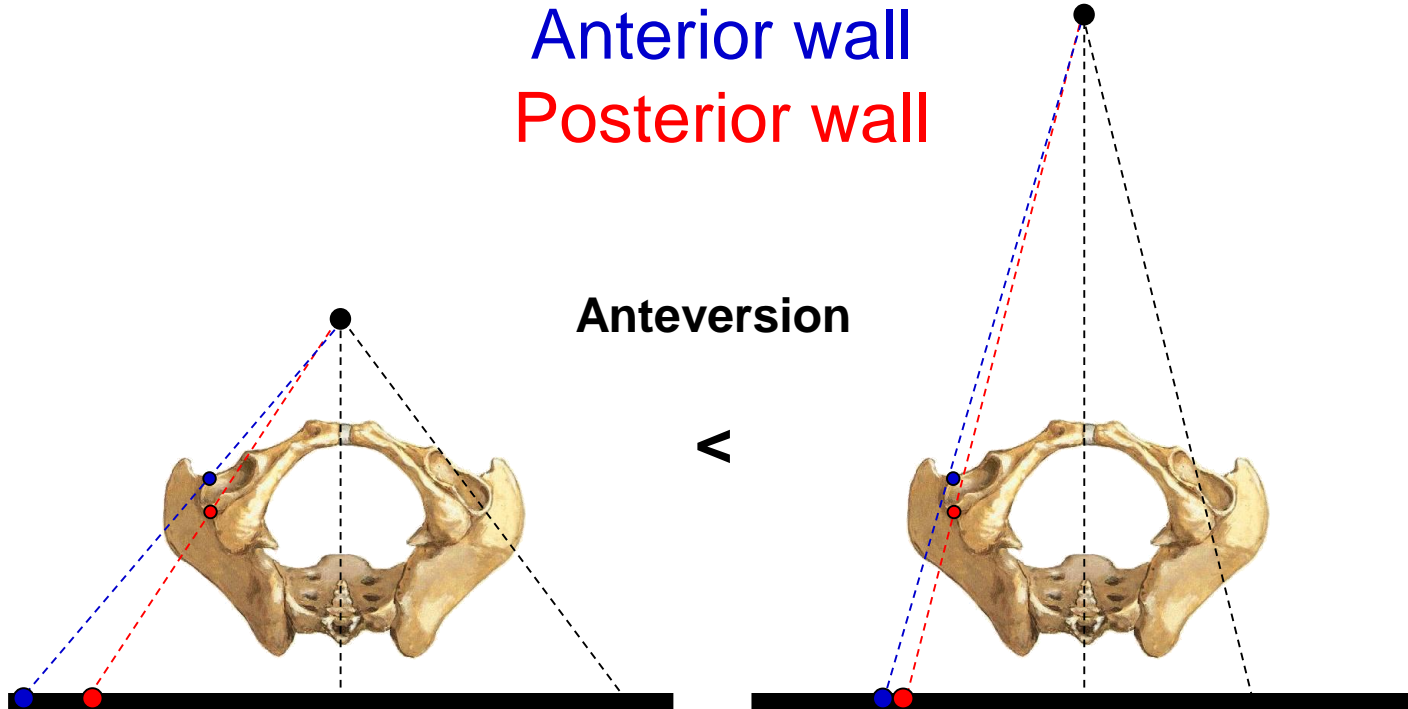
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# Film-Tube Distance

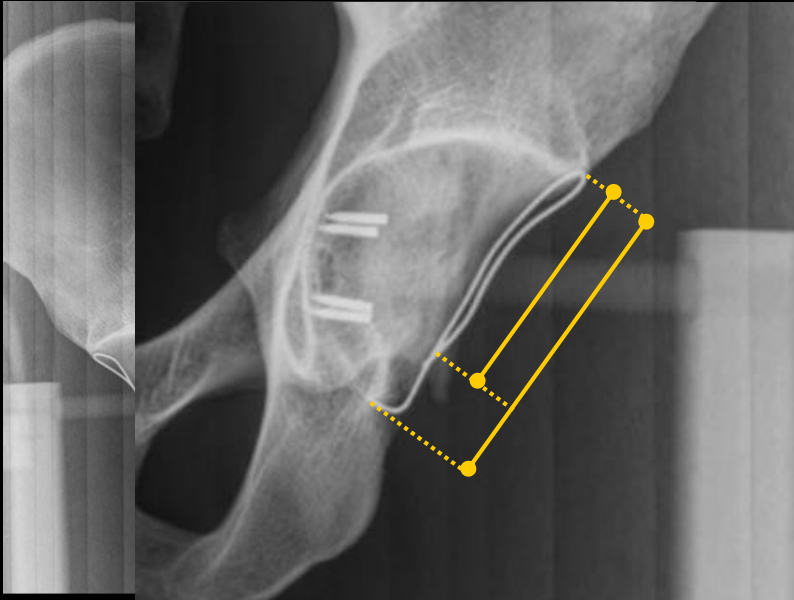
Anterior wall  
Posterior wall

Anteversion

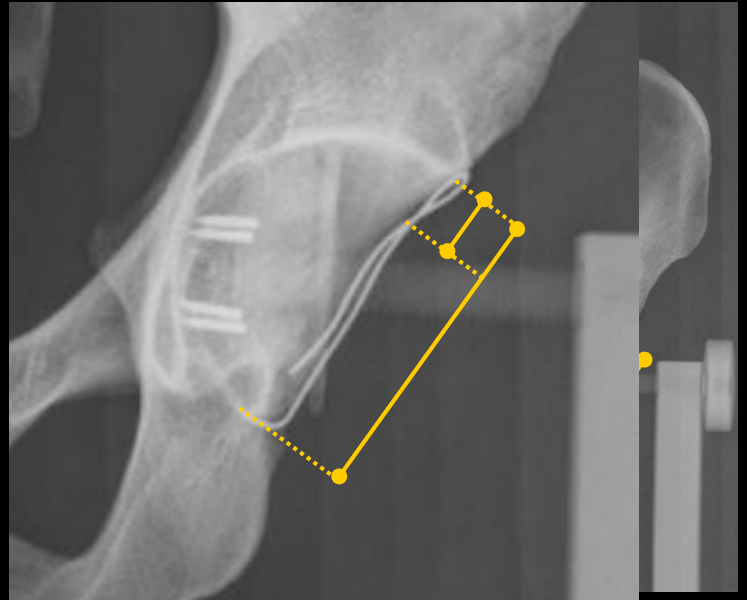


## Film-Tube Distance

80cm



120cm

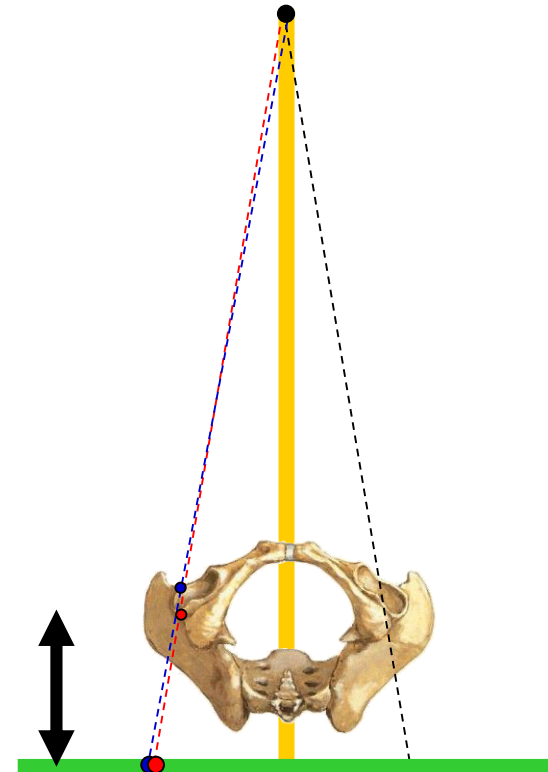


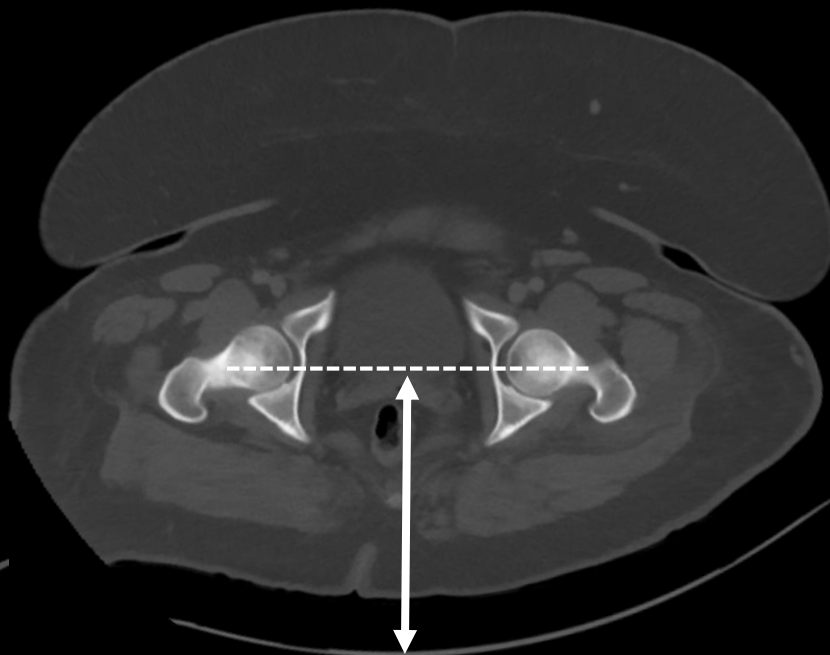
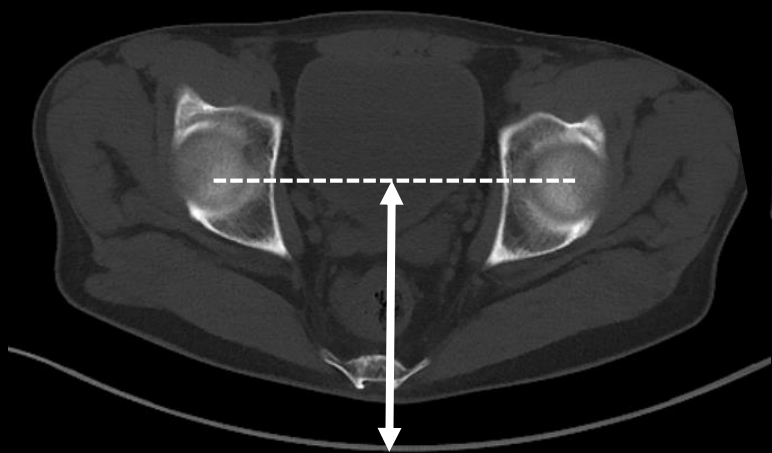
decreasing film-tube distance may mimicking a retroversion



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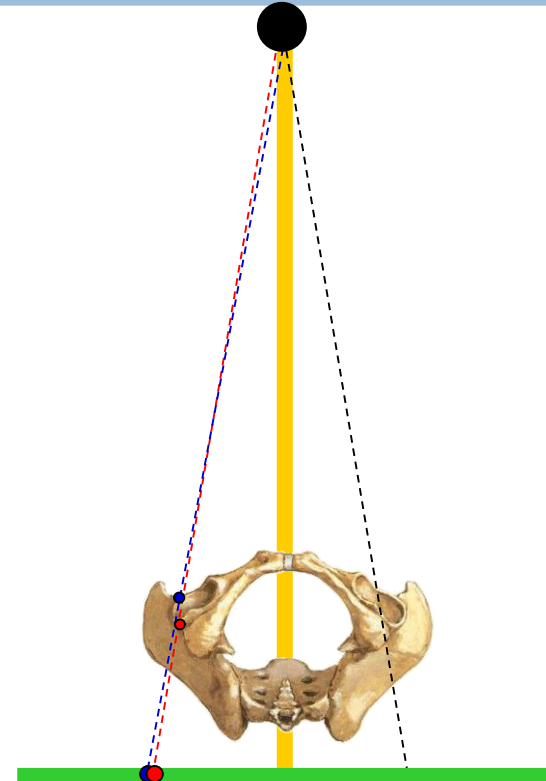


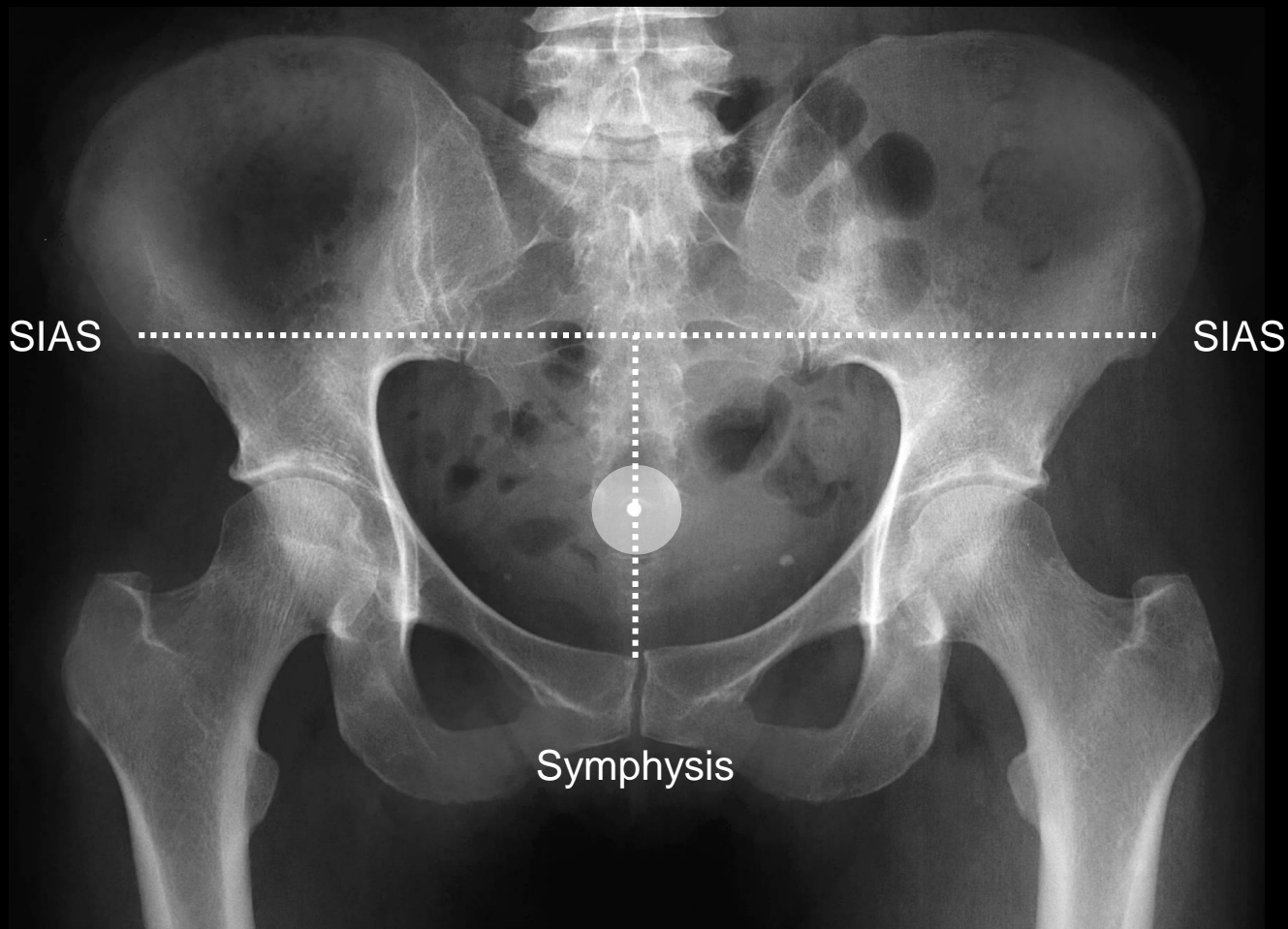


Irrelevant

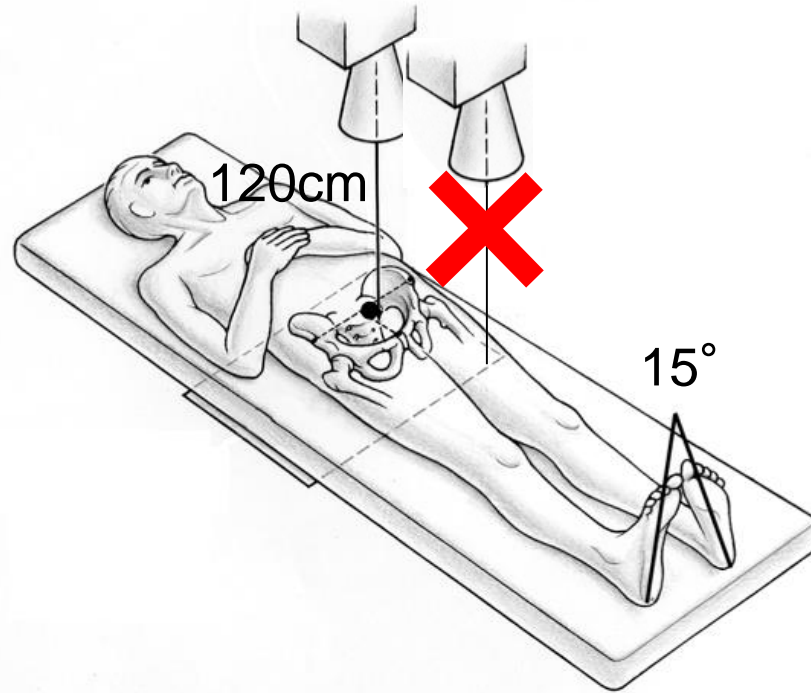
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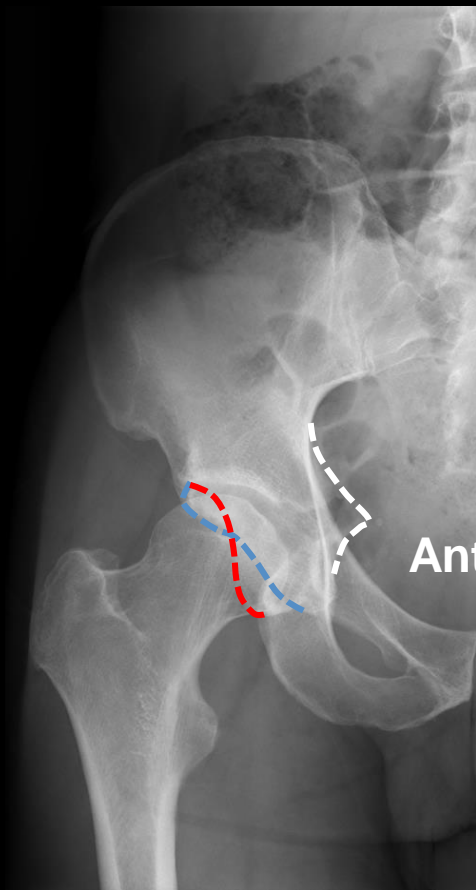




## Centering and Direction of the X-Ray Beam

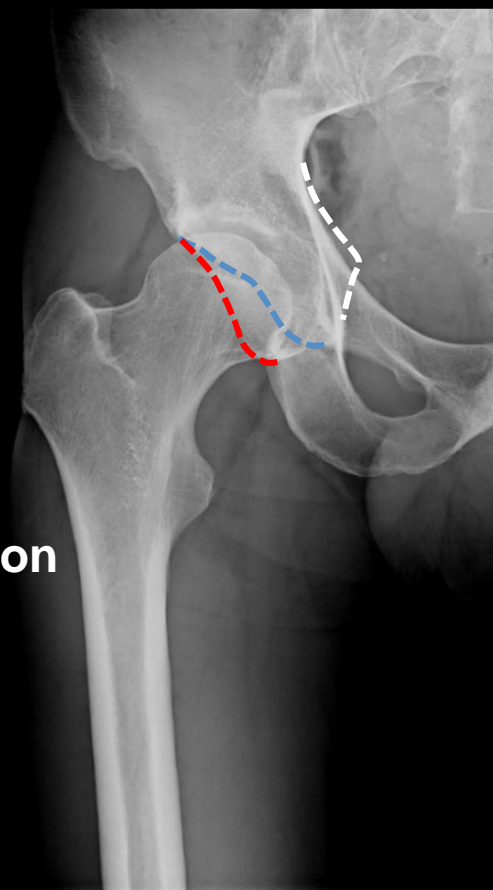


No deep-centered pelvic X-Rays for joint-preserving surgery



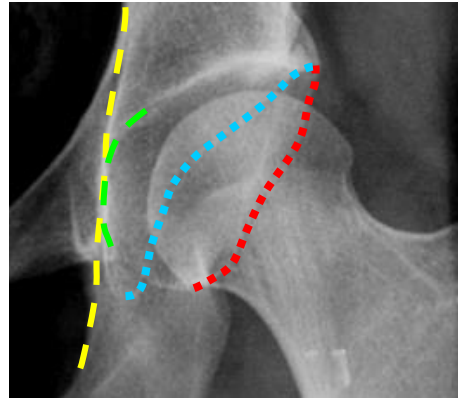
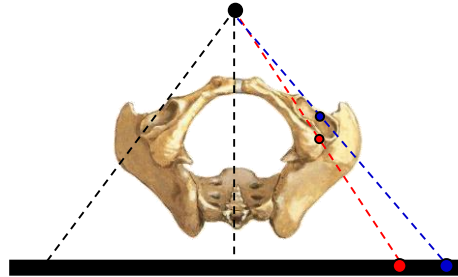
Pelvis ap

Anteversion

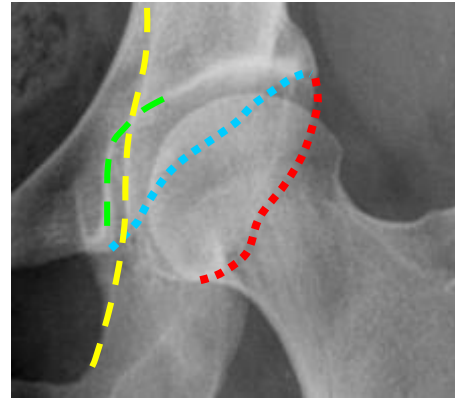
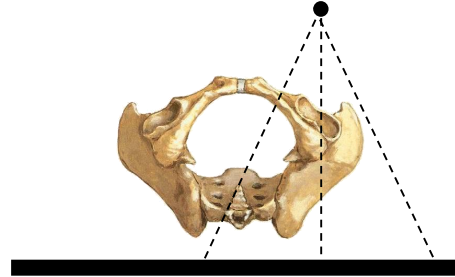


Deep-centered pelvis

# Centering and Direction of the X-Ray Beam

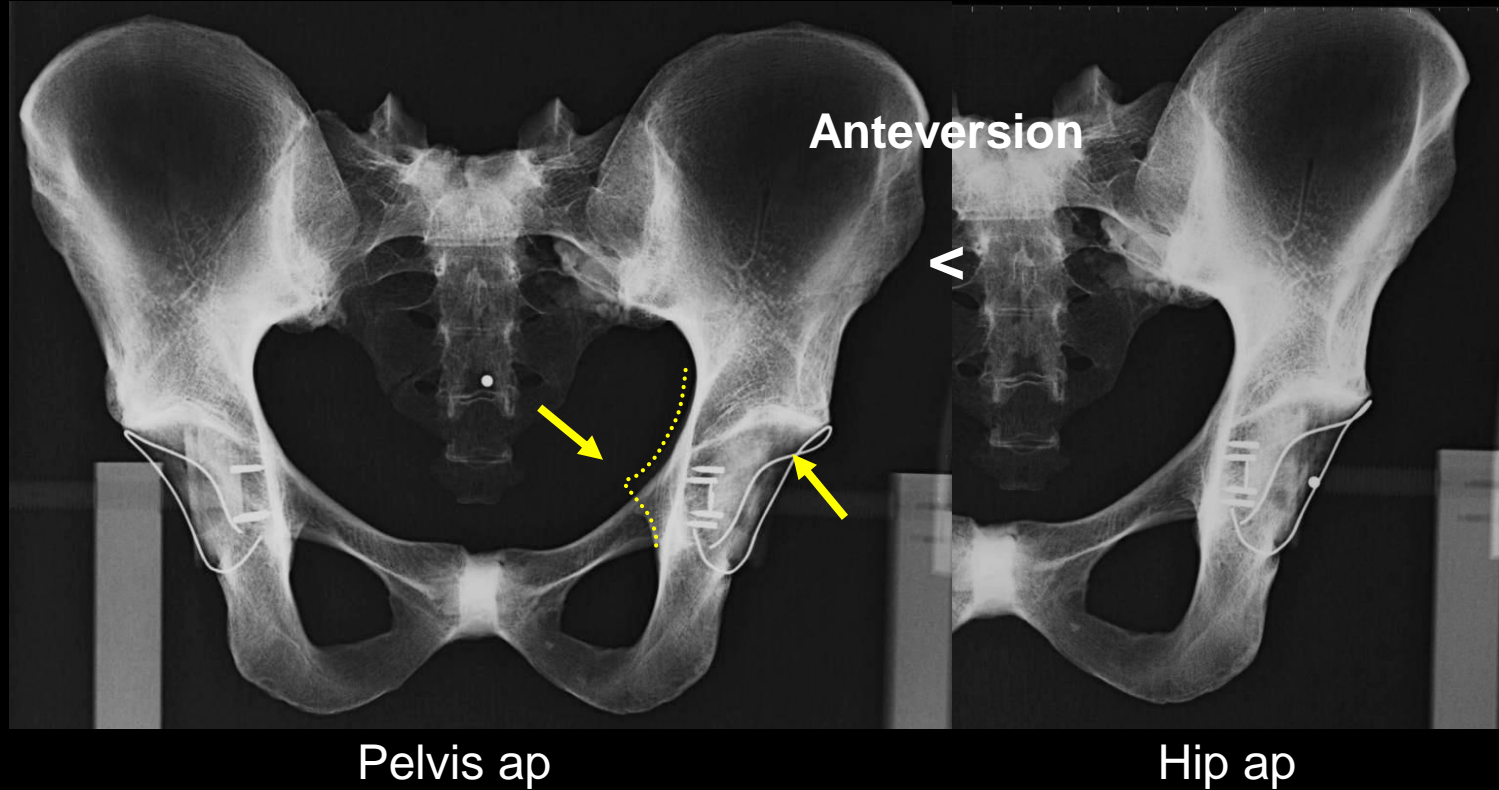


Pelvis ap



Hip ap

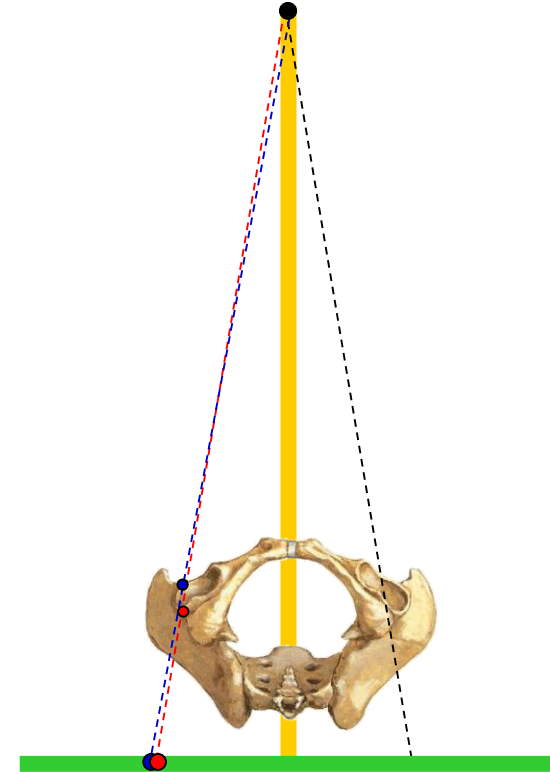
## Centering and Direction of the X-Ray Beam



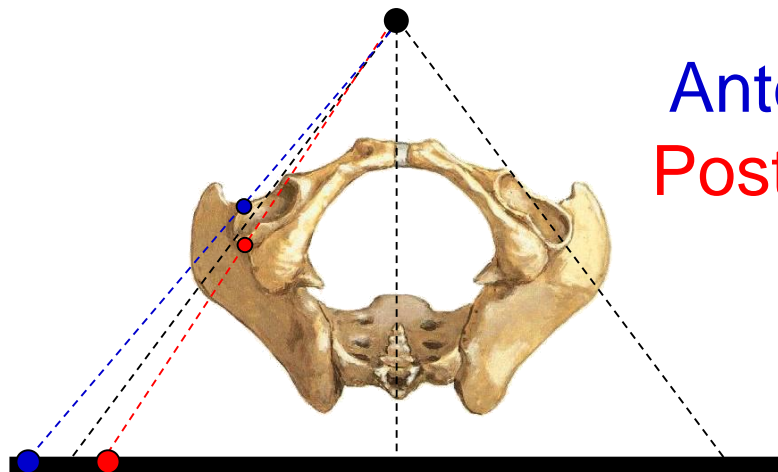


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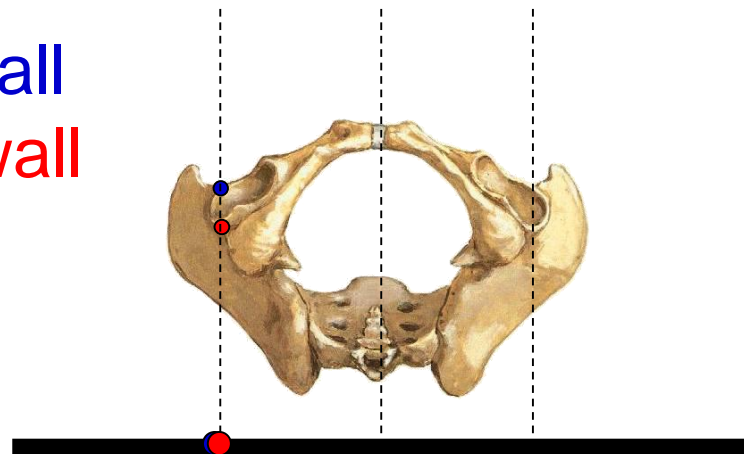


# Conical Projection



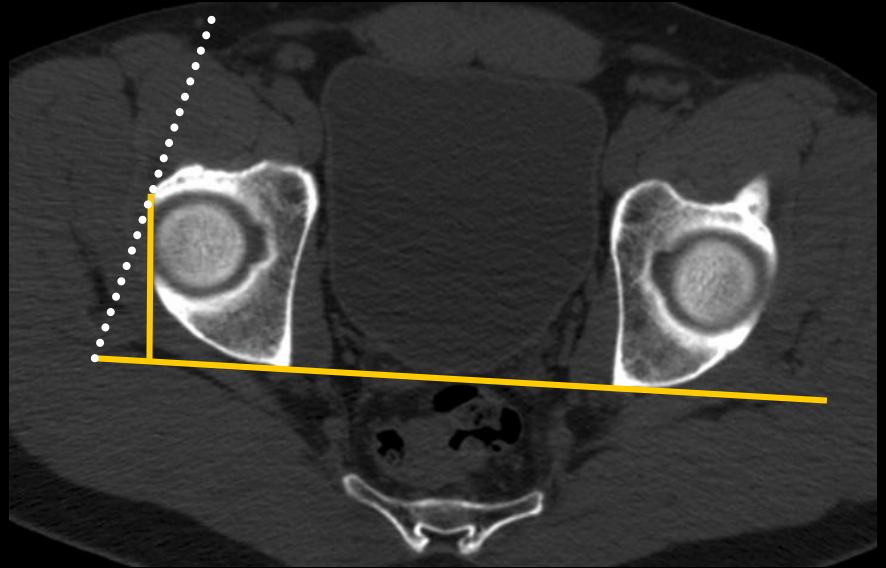
Anterior wall  
Posterior wall

X-Ray

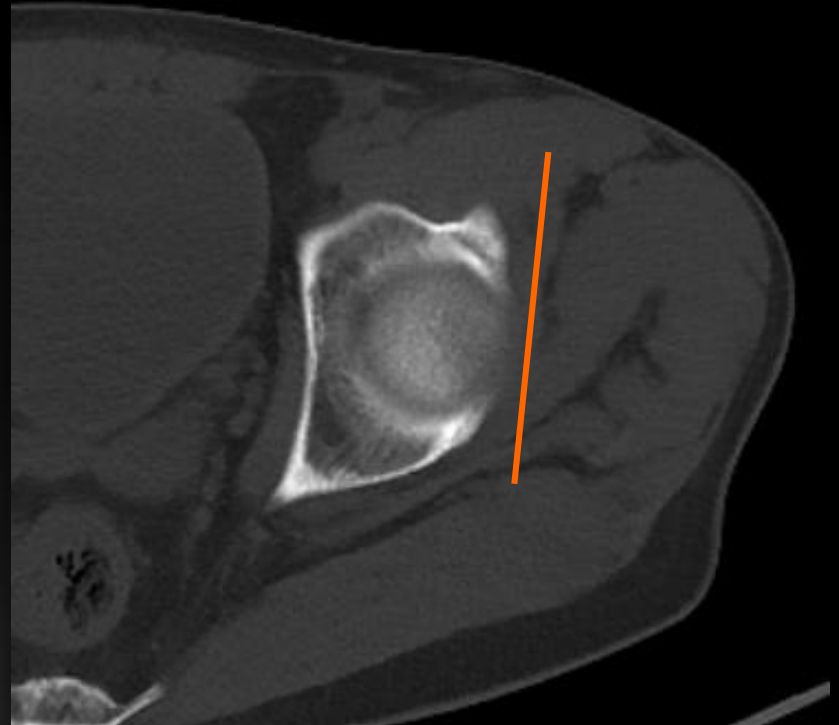
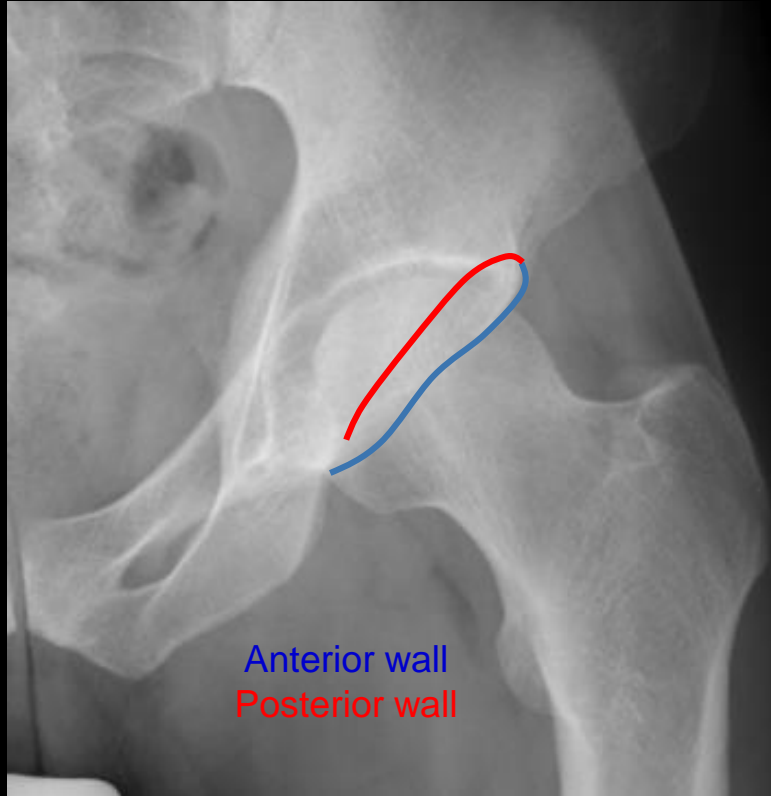


CT/MRI

# Conical Projection

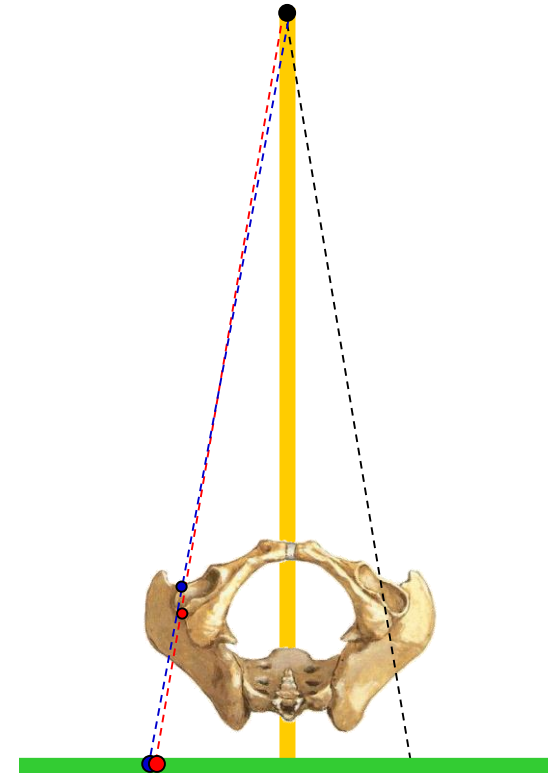


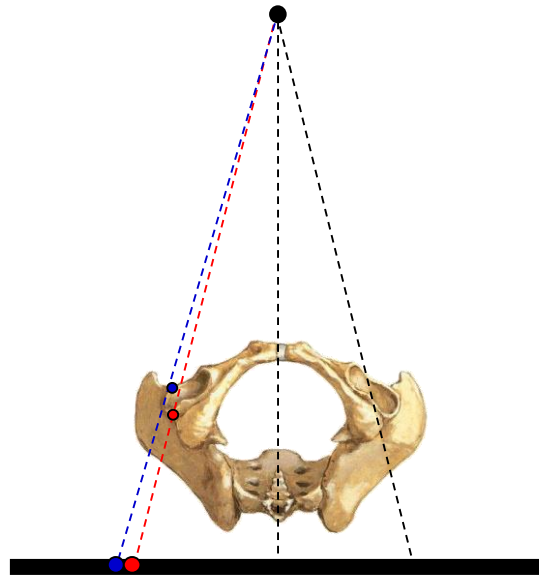
# Conical Projection



# Technical Principles of Radiographic Imaging

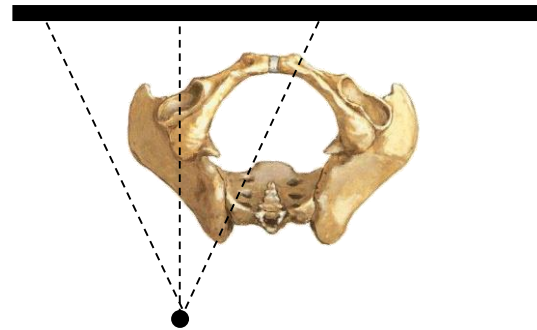
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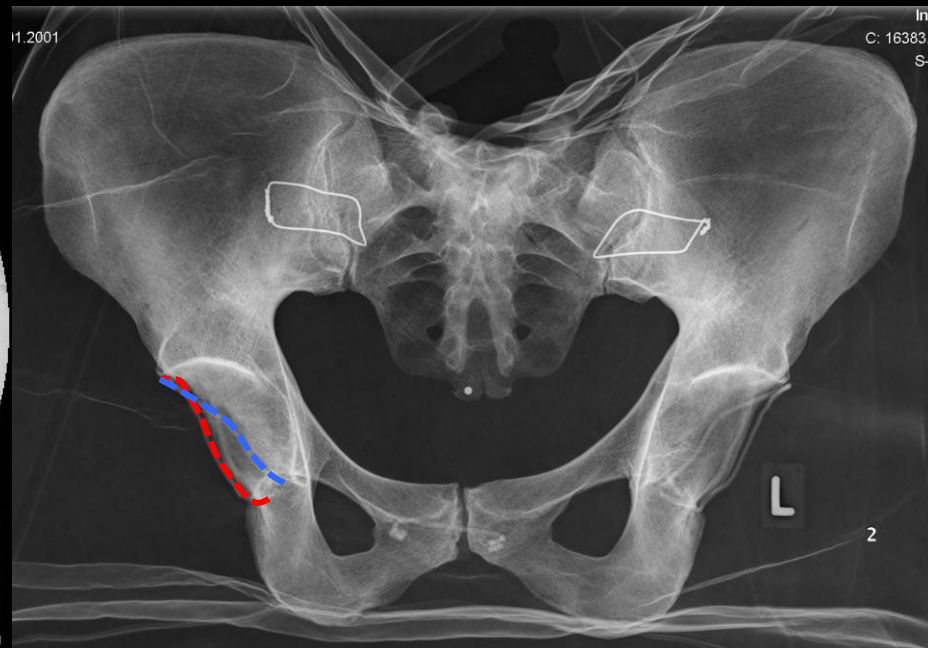
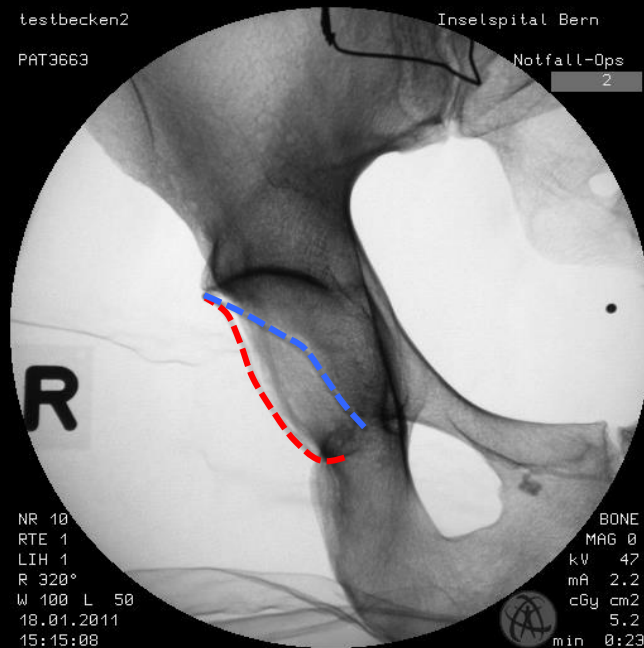
X-Ray

- Hip centered
- Posteroanterior projection
- Lower film-tube distance
- Changed patient-film distance



Fluoroscopy

# Fluoroscopy

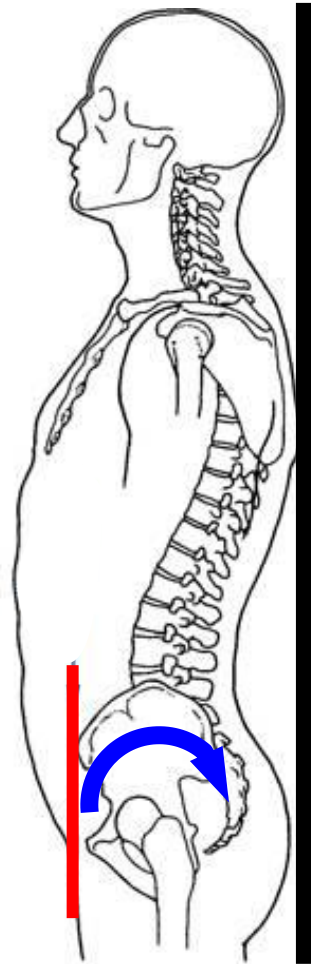
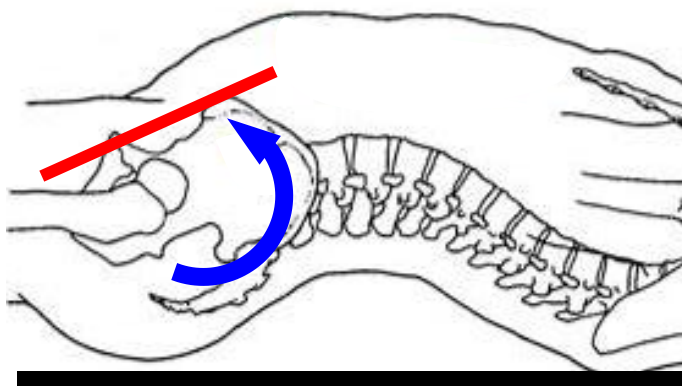


Increased anteversion, LCE unchanged

## Supine or standing X-Ray?

- > Unchanged joint space
- > Posterior pelvic tilt in standing position
- > supine = standard (Inselspital)
  - All major studies correlating acetabular retroversion with hip pain and osteoarthritis are based on supine imaging
  - Comparability to intraoperative imaging







supine

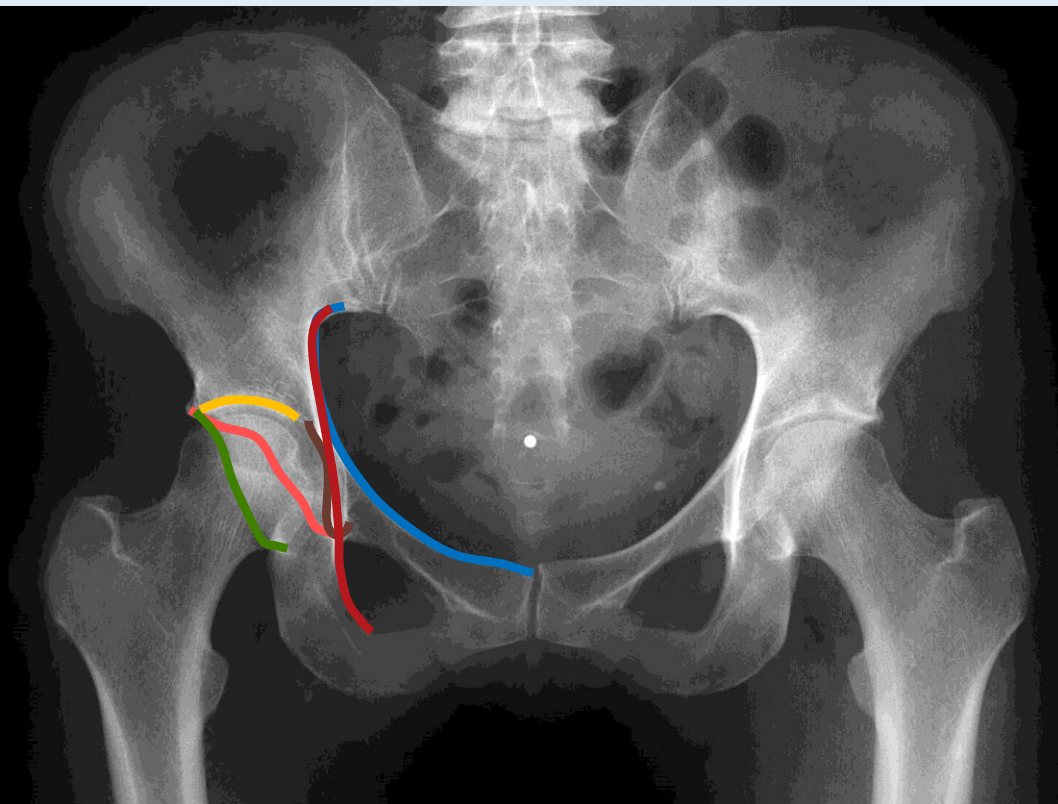








standing

## Summary: pelvis ap

- > Correct centering and direction of the X-ray beam
  - central beam is directed to the midpoint between the upper border of the symphysis and a line connecting both anterior superior iliac spines
  - supine
  - internal rotation of 15°
  
- > Patient-Film Distance
  - 120cm

## Six lines by Letournel

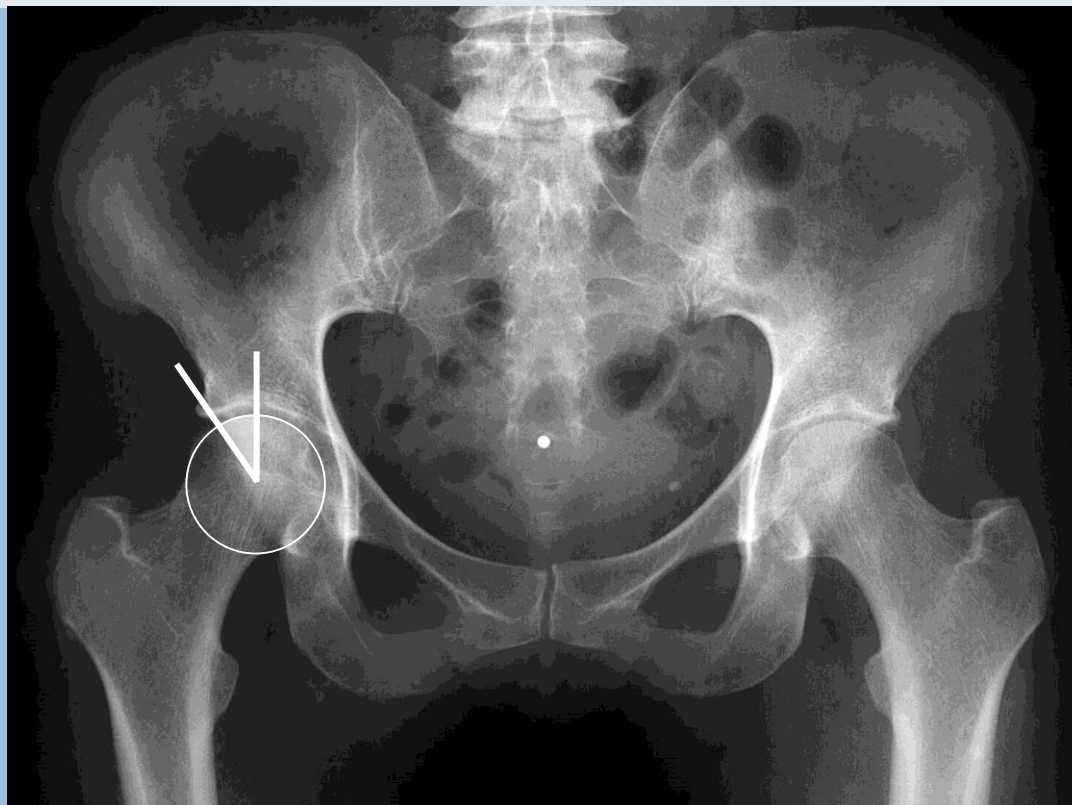


-  Anterior wall
-  Posterior wall
-  Acetabular roof
-  Tear drop
-  Iliopectineal line
-  Ilioischial line

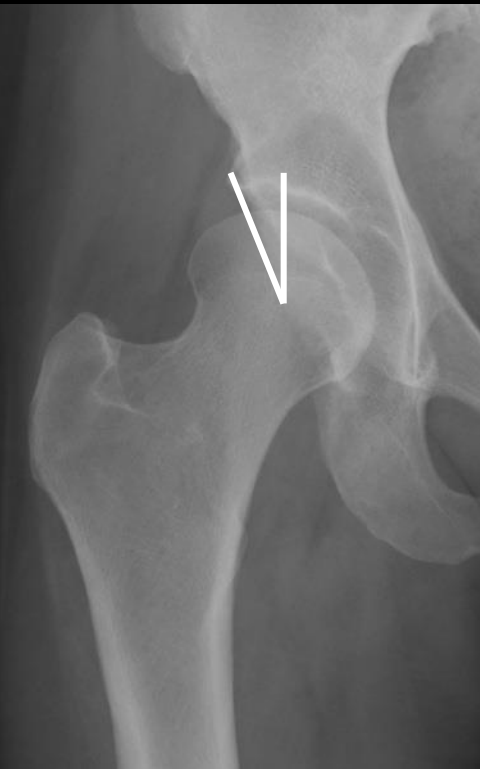
# Acetabular Coverage

- > Lateral Center-Edge angle (LCE)
- > Acetabular Index (AI)
- > Coxa profunda
- > Protrusio Acetabuli
- > Anterior Wall Index and Posterior Wall Index: rule of thirds

## Lateral Center-Edge angle (LCE)



Dysplasia



$<22^{\circ}$

Normal



$23-33^{\circ}$

Deep hip



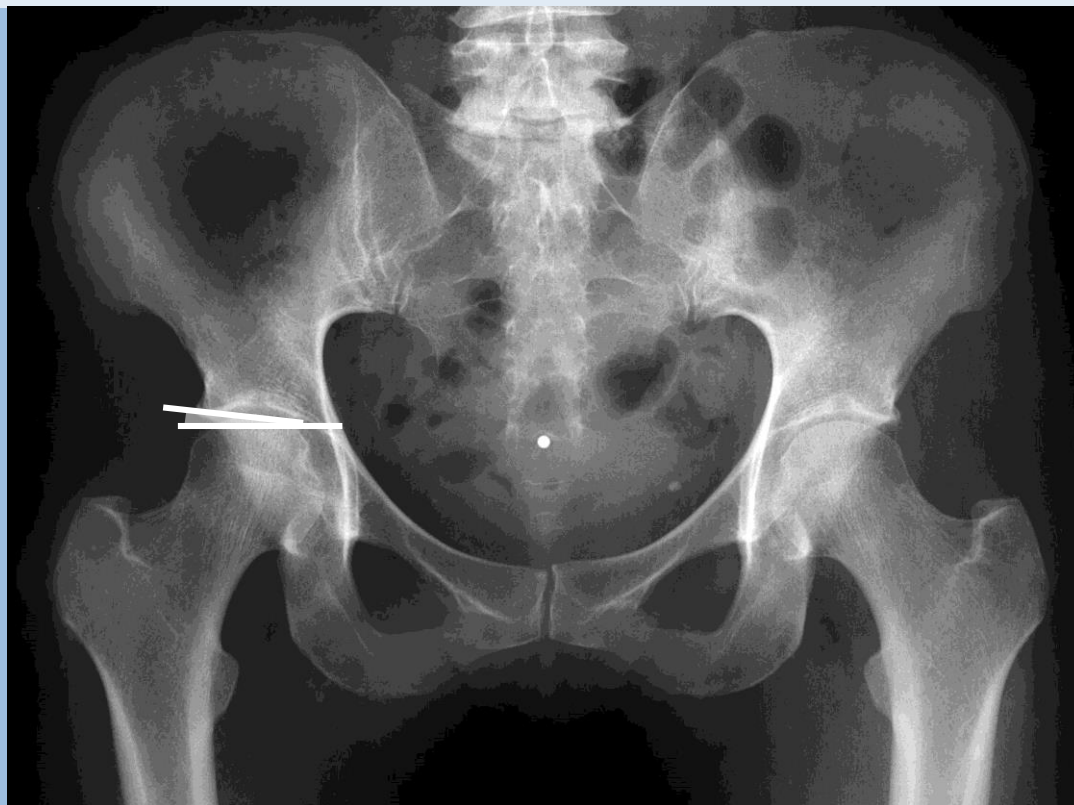
$34-39^{\circ}$

Protrusion



$>39^{\circ}$

# Acetabular Index (AI)





Dysplasia



$>14^{\circ}$

Normal



$3-13^{\circ}$

Deep hip



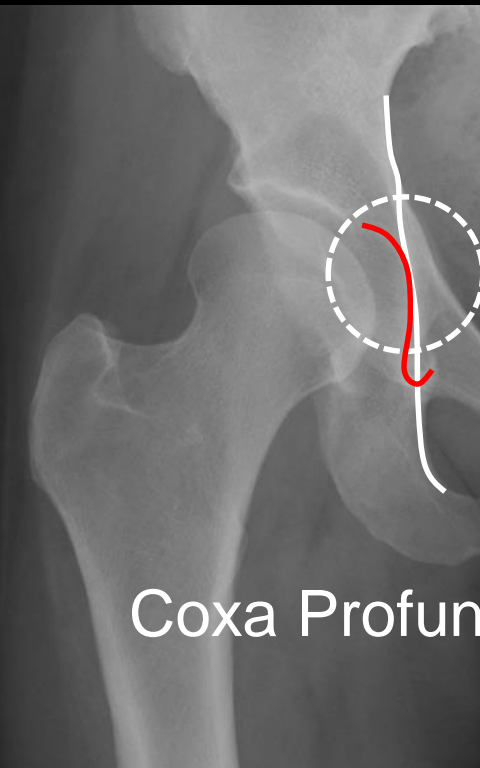
$-7-2^{\circ}$

Protrusion



$<-8^{\circ}$

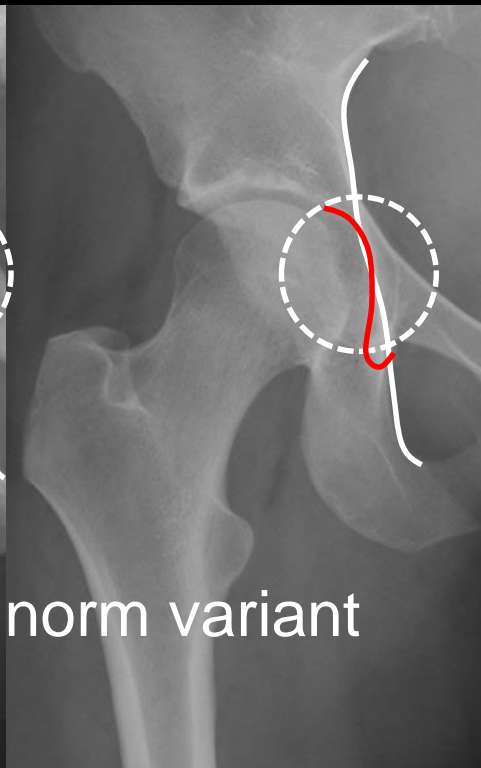
Dysplasia



Normal



Deep hip



Protrusion



Coxa Profunda = anatomical norm variant

Dysplasia



Normal



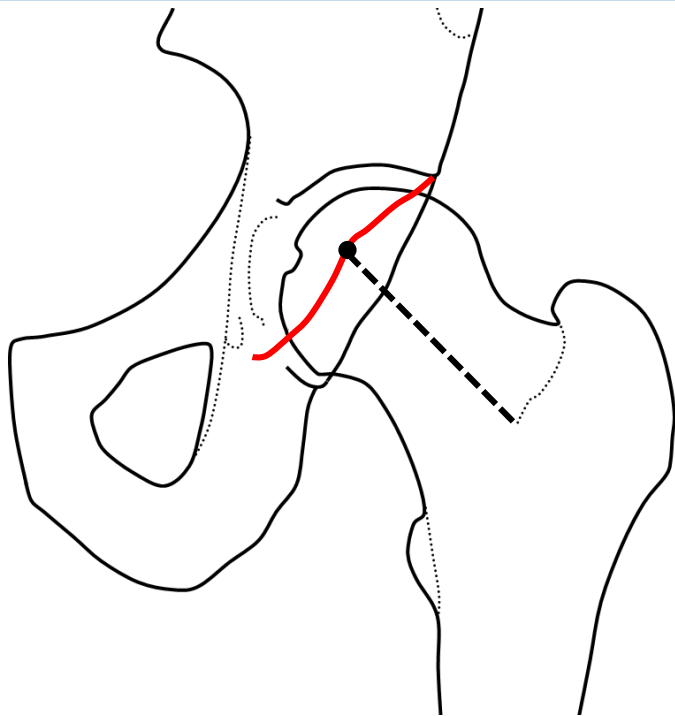
Deep hip



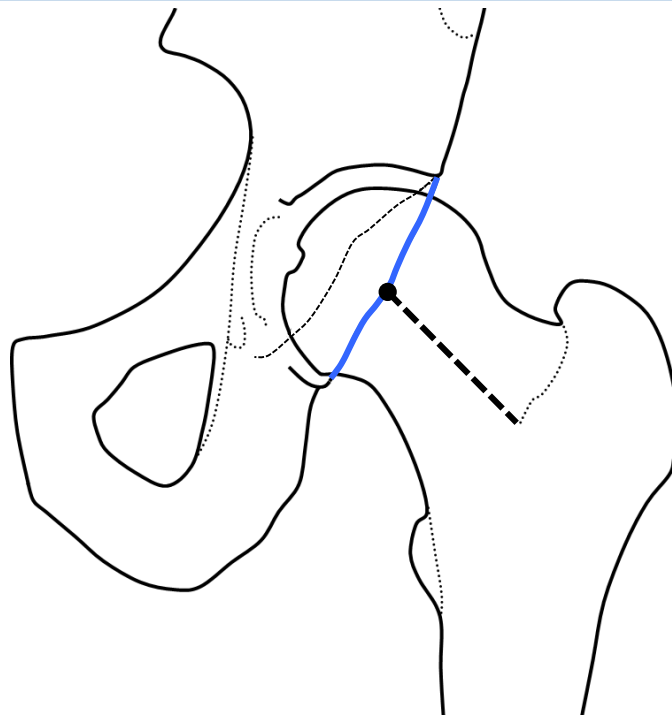
Protrusion



## Rule of Thirds (Acetabular Wall Index)

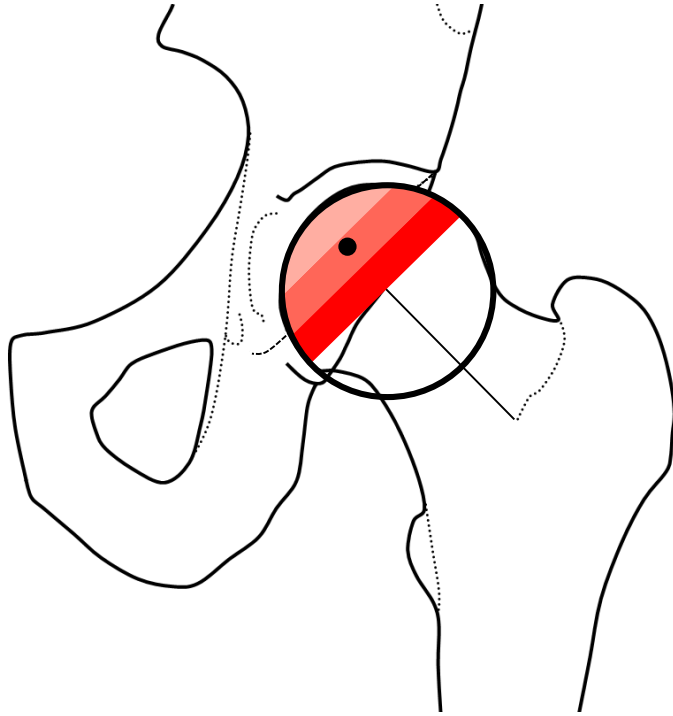


Anterior coverage

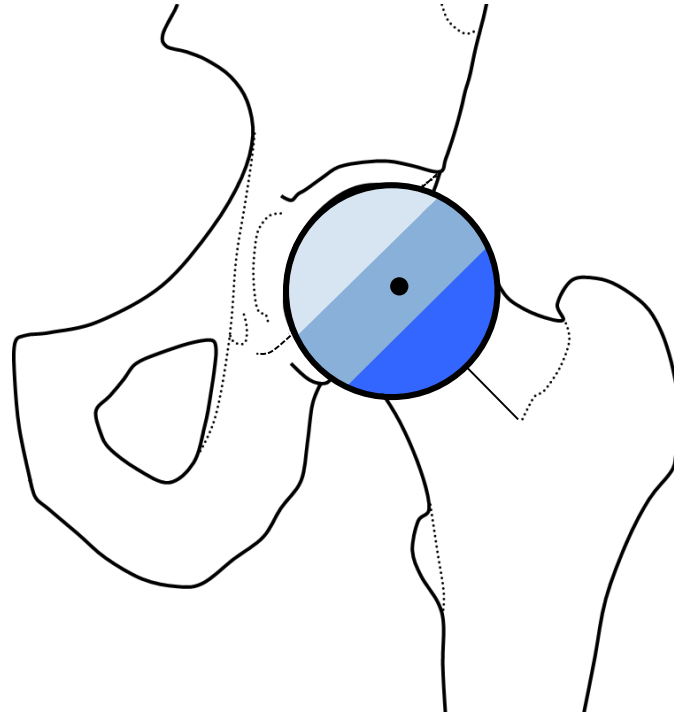


Posterior coverage

## Rule of Thirds (Acetabular Wall Index)

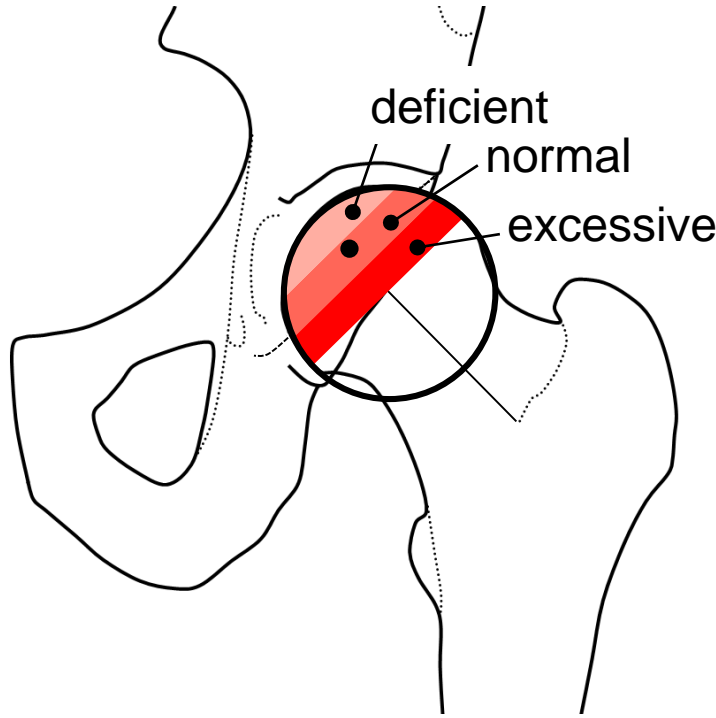


Anterior coverage

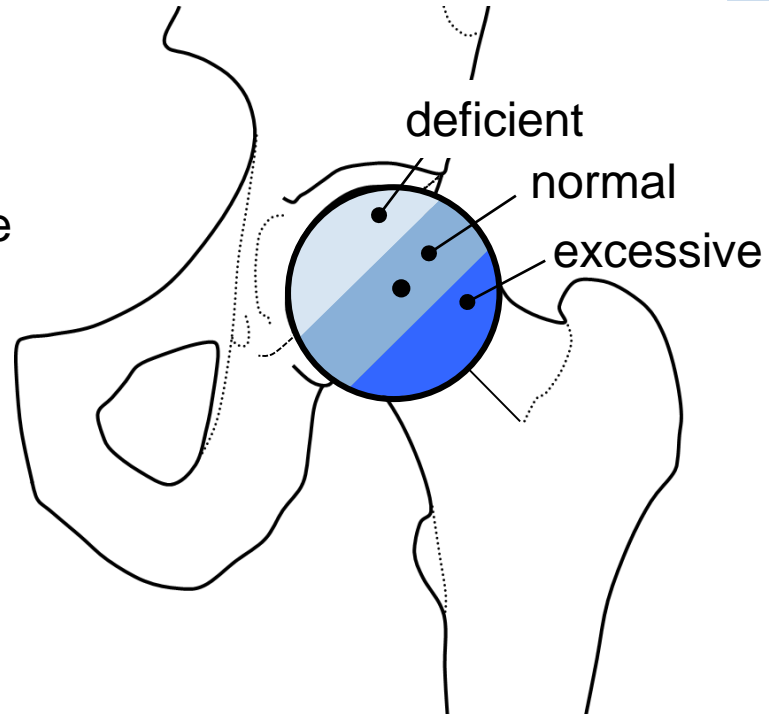


Posterior coverage

## Rule of Thirds (Acetabular Wall Index)

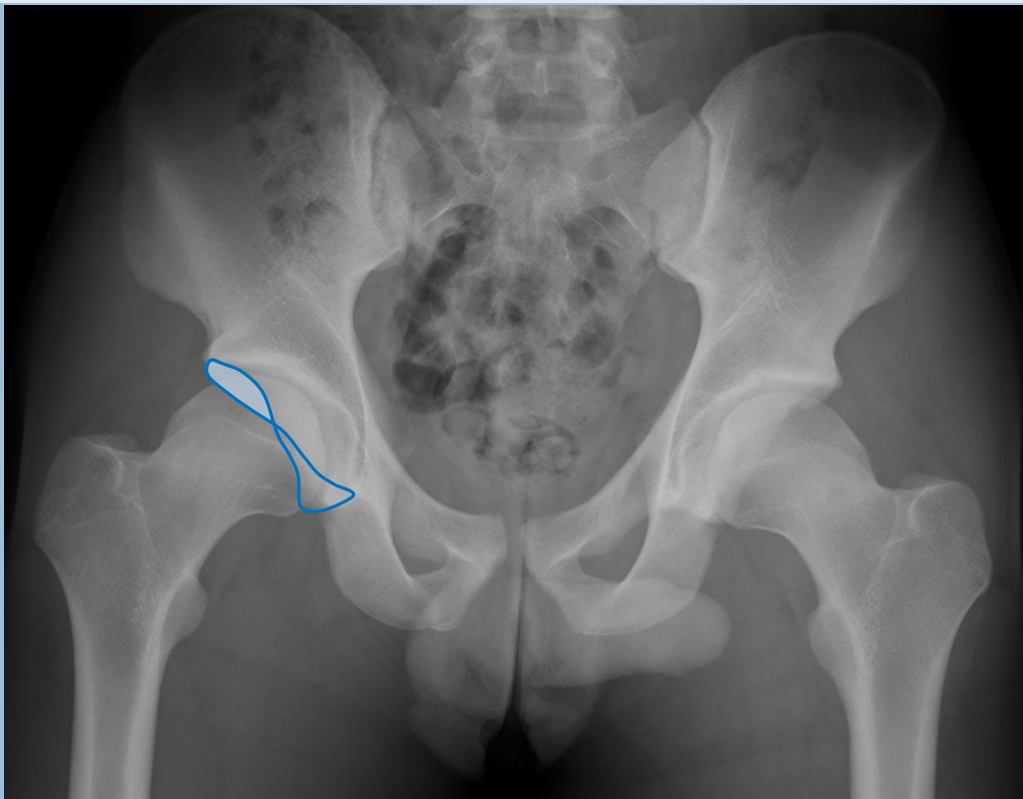


Anterior coverage



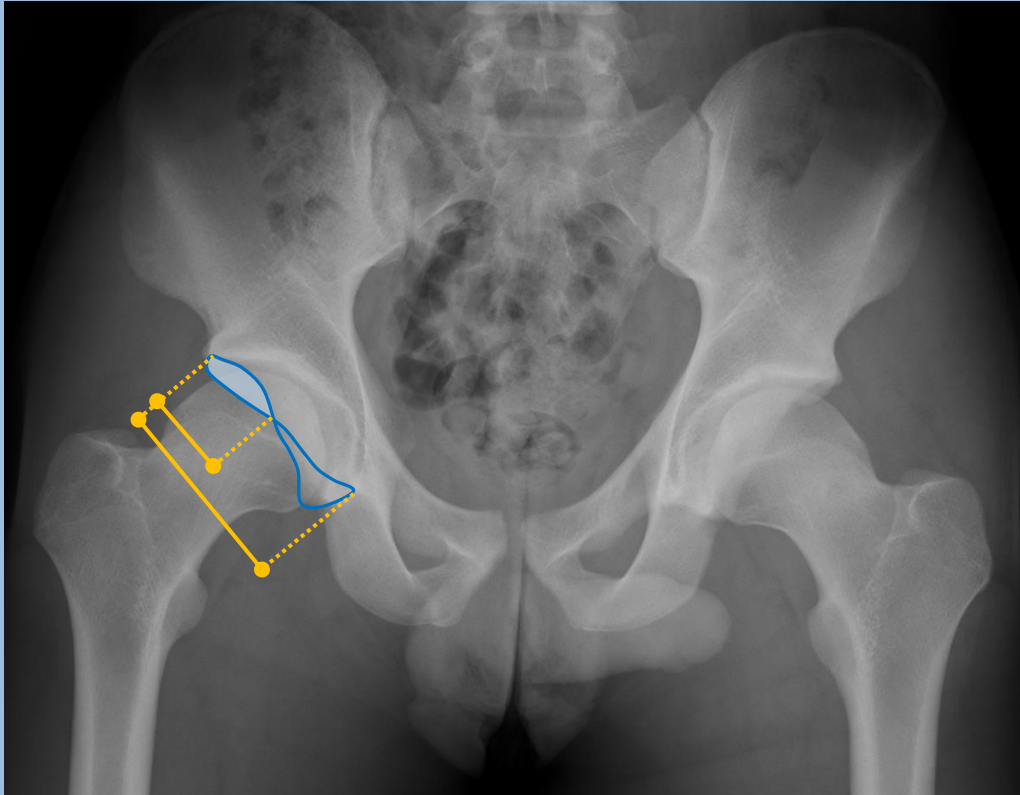
Posterior coverage

## Acetabular Orientation: signs for retroversion



■ Cross-over sign («figure of 8»)

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- Cross-over sign («figure of 8»)
- Retroversion-Index

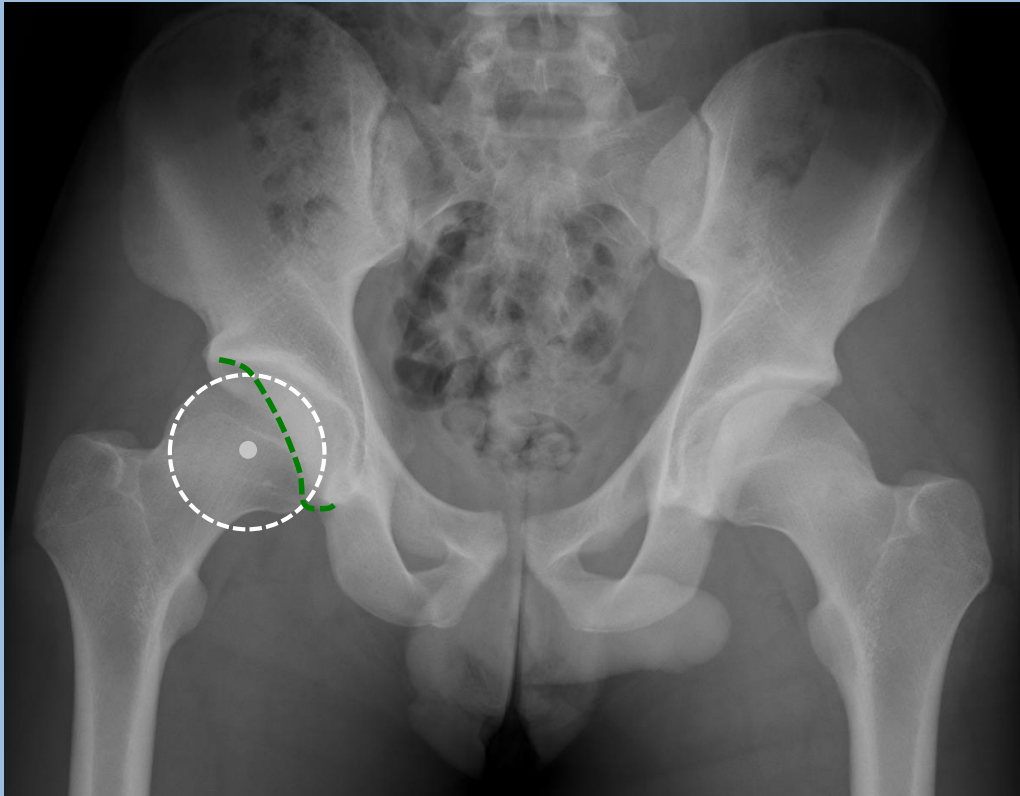


## Acetabular Orientation: signs for retroversion



- Cross-over sign («figure of 8»)
- Retroversion-Index
- Ischial-spine sign

## Acetabular Orientation: signs for retroversion



- Cross-over sign («figure of 8»)
- Retroversion-Index
- Ischial-spine sign
- Posterior wall sign

# Femoral Anatomy

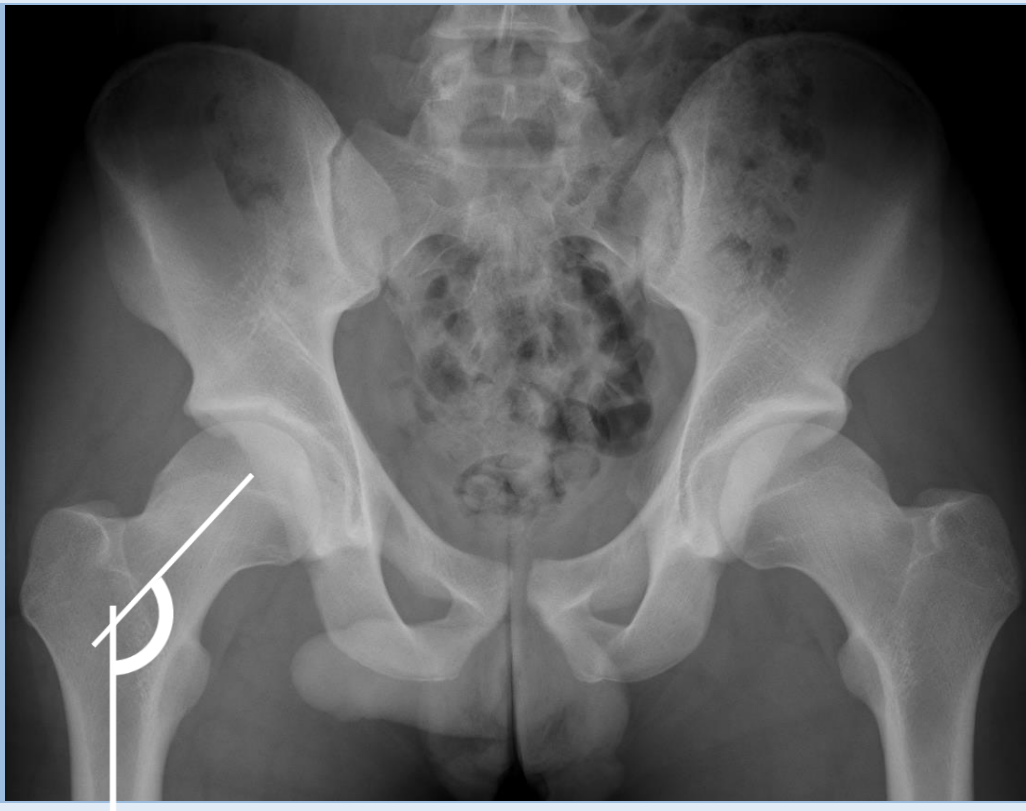
- > Pistol-grip deformity
- > CCD-angle
- > Alpha angle

# Femoral Anatomy



■ Pistol-grip deformity

## Femoral Anatomy: CCD



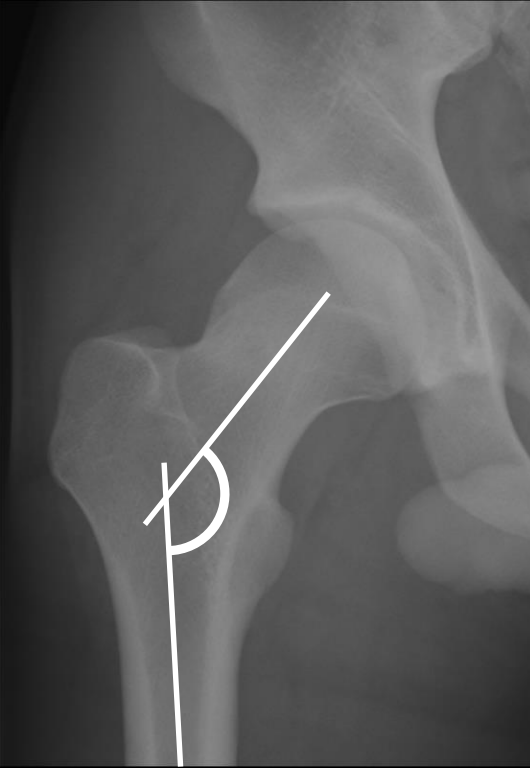
- Corpus-Collum Diaphysis Angle (CCD)

Coxa vara



$<120^\circ$

Normal



$120-135^\circ$

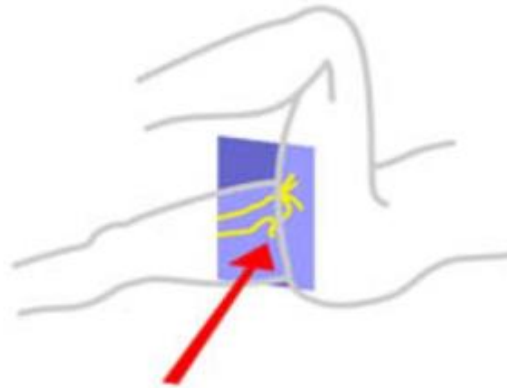
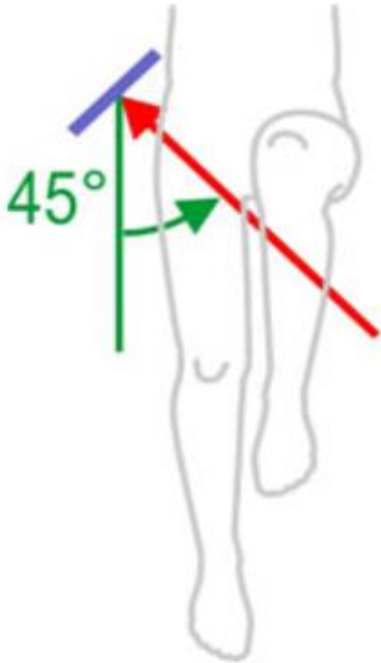
Coxa valga



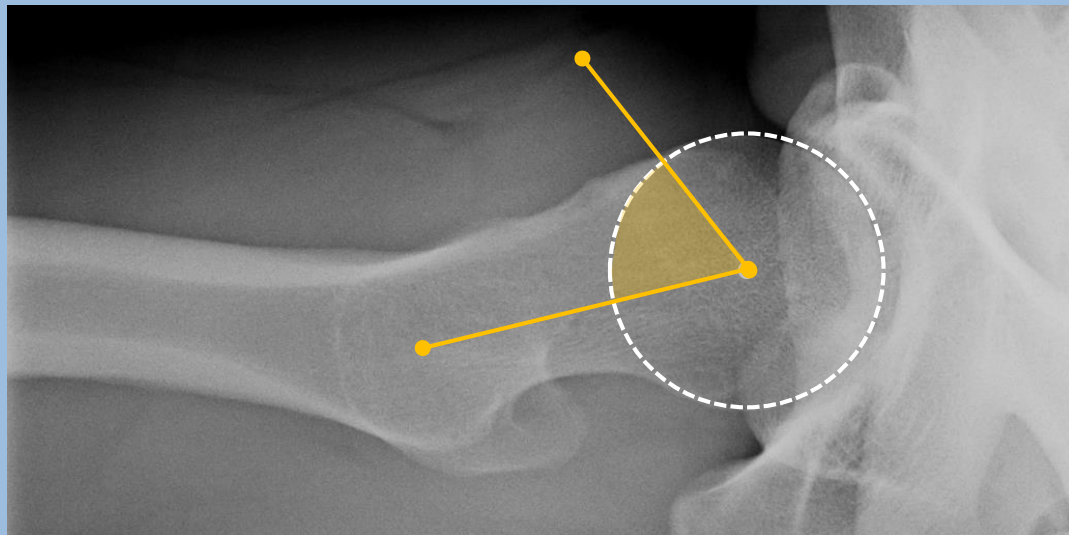
$>135^\circ$

# Femoral Anatomy

- > Cross-table view
  - 2<sup>nd</sup> standard projection
  - Hip in 15° internal rotation as compensation for femoral antetorsion



## Femoral Anatomy: Alpha Angle



Alpha angle

- Abnormal if  $>60^\circ$





bern