

# Pelvic Fractures: Imaging and Classification

Jon A. Jacobson, MD FACR

Professor of Radiology  
Section Chief, Musculoskeletal Imaging



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## Disclosures

- Consultant: Bioclinica
- Book Royalties: Elsevier
- Contractor: POCUS PRO
- Advisory Board: Philips
- Not relevant to this talk

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## Objectives

- To list the mechanisms of pelvic injury
- To recognize the common acetabular fracture patterns
- To follow the proposed imaging algorithm to classify acetabular fractures

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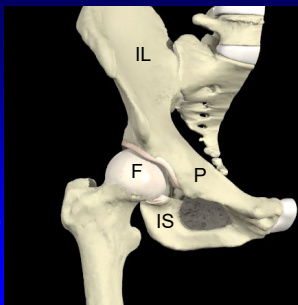
## Outline:

- Anatomy
- Mechanisms of injury
- Acetabular fractures
- Other pelvic fractures
- Approach to radiographs

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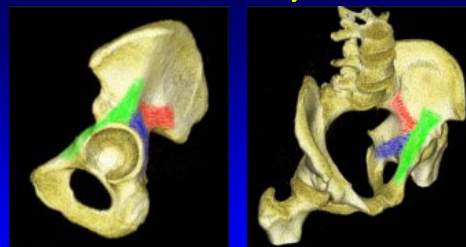
## Anatomy:

- Ilium (IL)
- Ischium (IS)
- Pubis (P)
- Femoral head (F)



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## Anatomy



Anterior column (green)  
Posterior column (blue)  
Sciatic buttress (red)

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**Outline:**

- Anatomy
- **Mechanisms of injury**
- Acetabular fractures
- Other pelvic fractures
- Approach to radiographs

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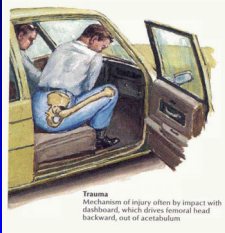
**Mechanisms of Injury:**

- Acetabular fracture
  - Femoral head impacted into pelvis
- Pelvic fracture
  - Lateral compression
  - Anteroposterior compression
  - Vertical shear
  - Complex

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**Mechanism of Injury: Acetabulum Fracture**

- Motor vehicle crash
- Knee against dashboard
- Pelvic fracture
- Hip dislocation





Trauma  
Mechanism of injury often by impact with dashboard, which drives femoral head backward, out of acetabulum.

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**Mechanism of Injury: Pelvic Fracture**

1. **Lateral Compression**

- Internal rotation of hemipelvis
- Rami fractures
- Sacrum compression fracture

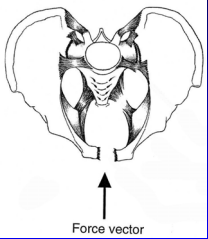
Hunter et al. Radiol Clin North Am 1997; 35:559

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**Mechanism of Injury: Pelvic Fracture**

2. **Anteroposterior Compression**

- External rotation of hemipelvis
- Pubic symphysis diastasis
- SI joint diastasis
- Possible rami fractures



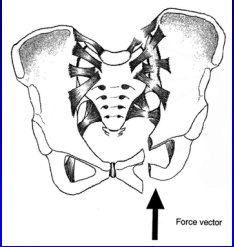
Hunter et al. Radiol Clin North Am 1997; 35:559

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**Mechanism of Injury: Pelvic Fracture**

3. **Vertical Shear**

- Hemipelvis dissociation
- Superior displacement of hemipelvis
- Possible rami and sacrum fractures



Hunter et al. Radiol Clin North Am 1997; 35:559

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**Mechanism of Injury:**  
**Pelvic Fracture**

**4. Complex Forces**

- Combinations of lateral compression, anteroposterior compression, and vertical shear



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**Outline:**

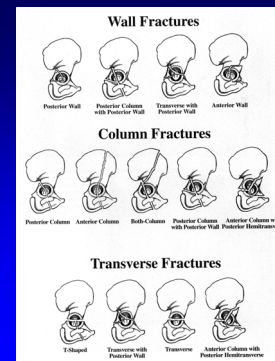
- Anatomy
- Mechanisms of injury
- **Acetabular fractures**
- Other pelvic fractures
- Approach to radiographs

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**Acetabular Fracture Classification:**

- 10 types
- Determines treatment
- Relies on radiographic views:
  - Anteroposterior
  - Inlet (caudal), outlet (cranial angulation)
  - Judet (obliques)

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Brandser et al.  
AJR 1998;  
171:1217

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**Acetabular Fractures:**

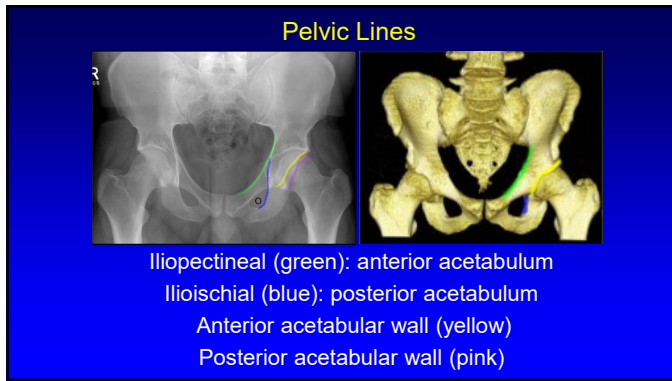
- Both column: 29%
  - Transverse + posterior wall: 19%
  - Posterior wall: 17%
  - T-shaped: 14%
  - Transverse: 10%
  - Posterior + posterior wall: 3%
  - Posterior column: 3%
  - Anterior column + posterior hemitransverse: 2%
  - Anterior wall: 2%
- } 89%

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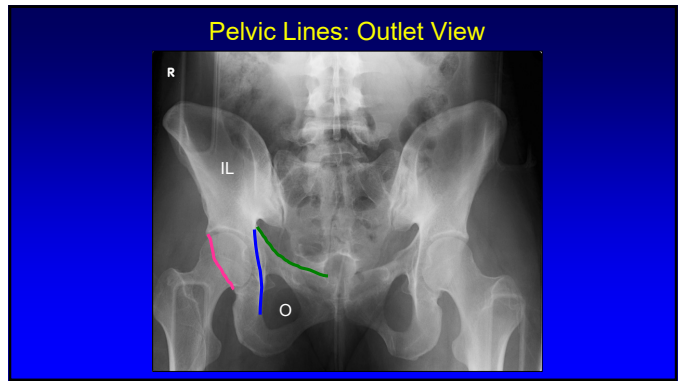
**Acetabular Fractures:**  
**Radiographic Assessment**

- Obturator ring fracture
- Iliopectineal (iliopubic) line disruption
- Ilioschial line disruption
- Posterior acetabular wall fracture
- Iliac wing fracture

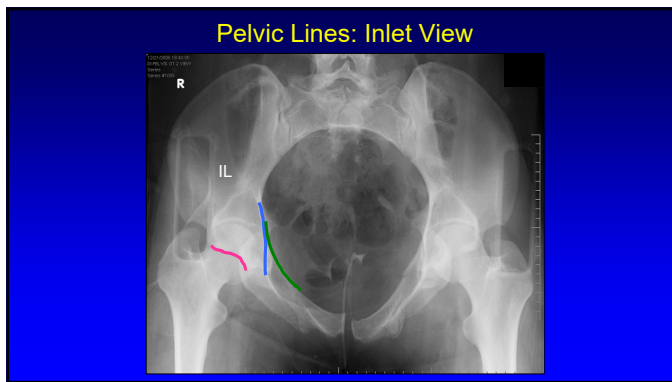
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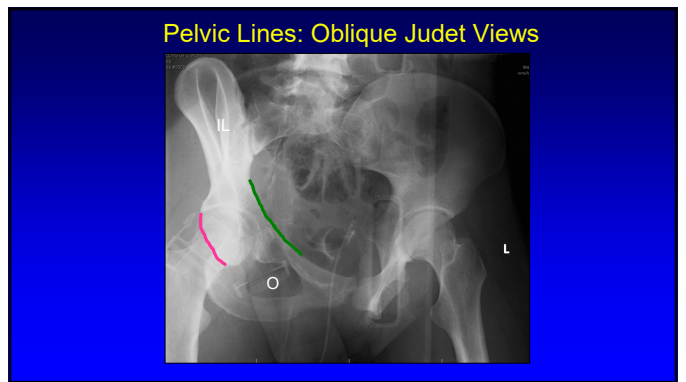
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### Acetabular Fractures: subset A

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2 types involve the obturator ring

- T-shaped
- Both column

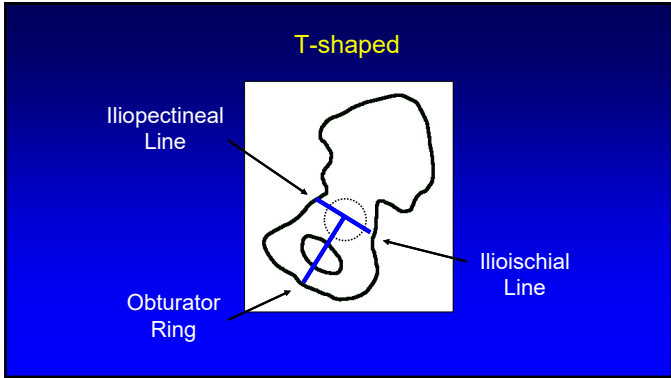
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### T-shaped:

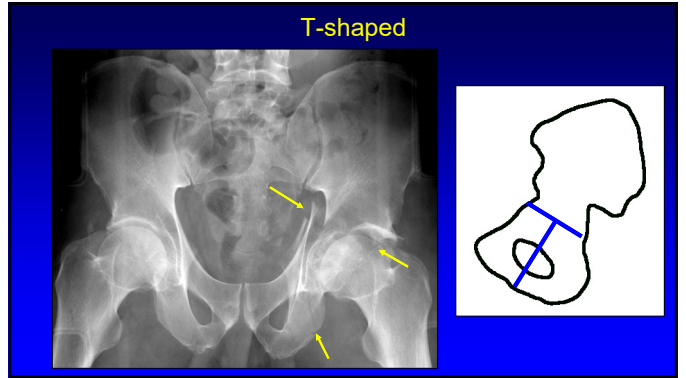
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- Obturator ring fracture
- Transverse fracture
  - Relative to acetabulum
  - Not transverse to body
  - Ilioischial and iliopectineal line disruption

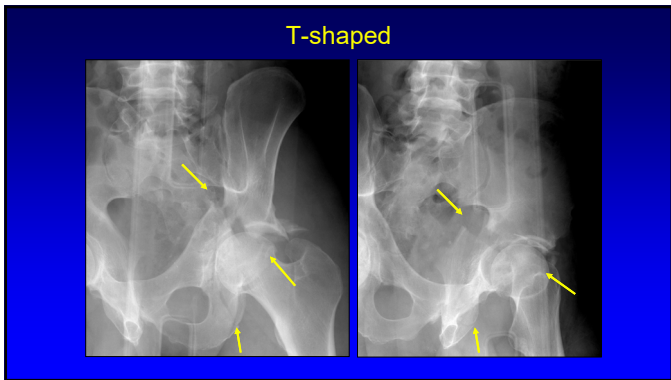
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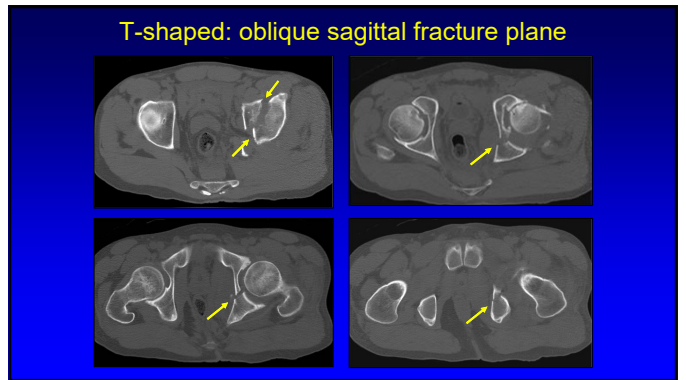
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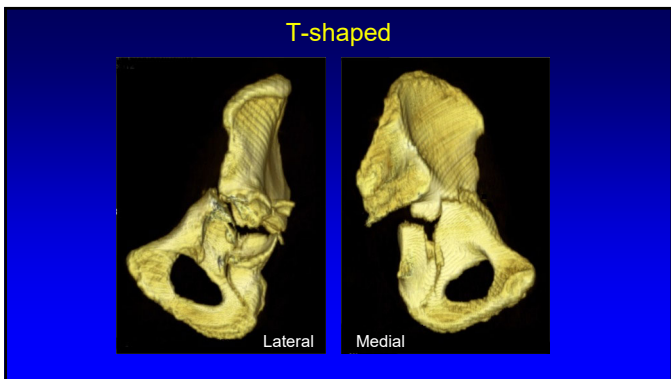
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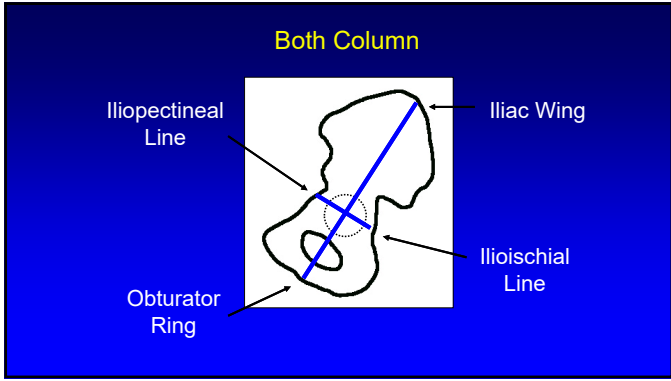


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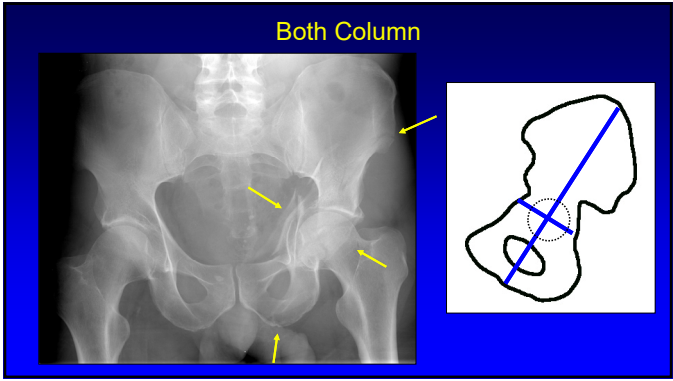
**Both Column:**

- Obturator ring fracture
- Transverse fracture
  - Ilioischial and iliopectineal line disruption
- Iliac wing extension

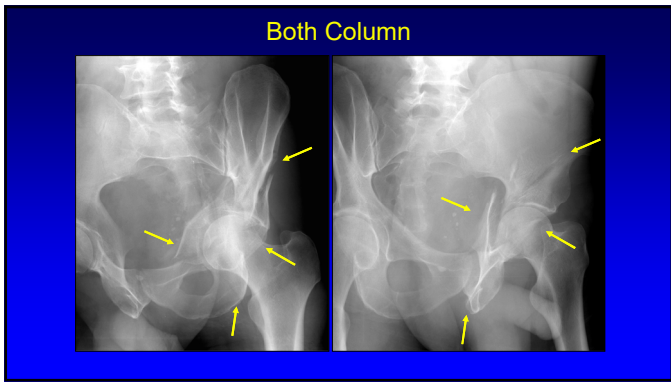
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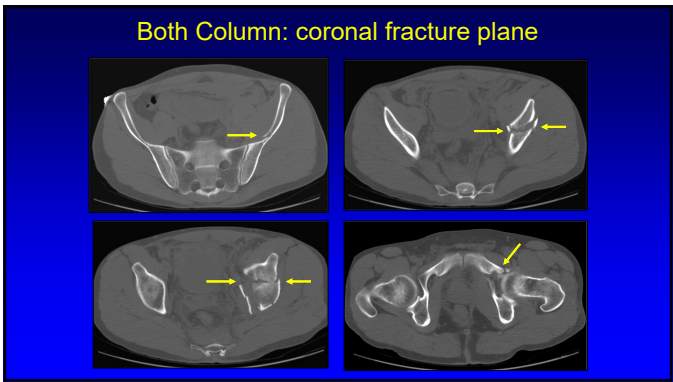
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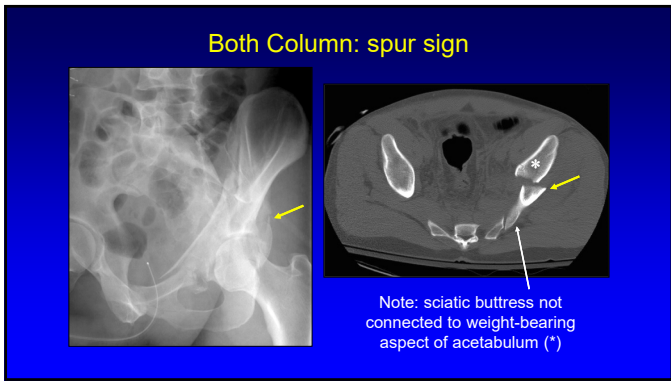
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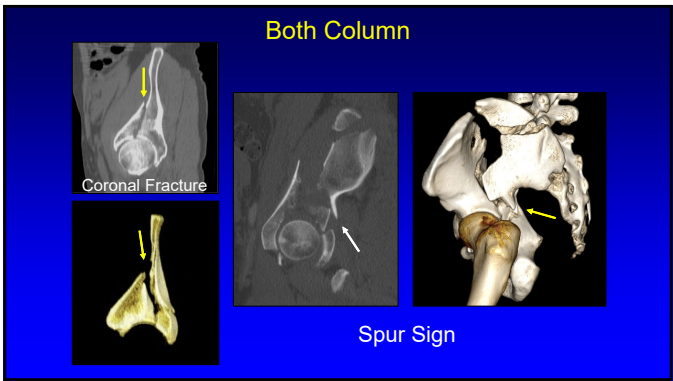
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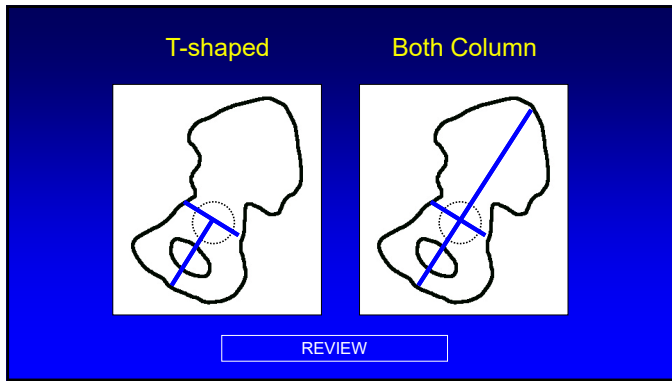
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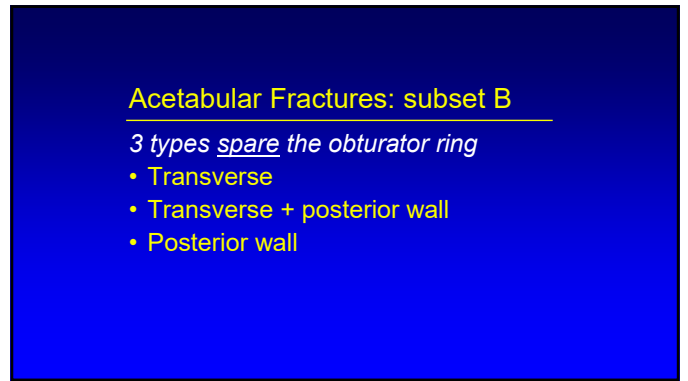
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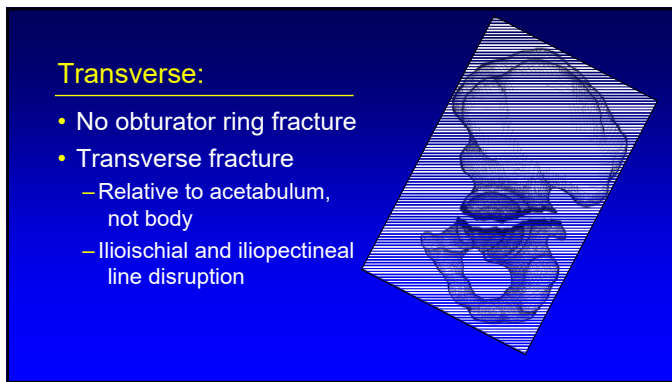
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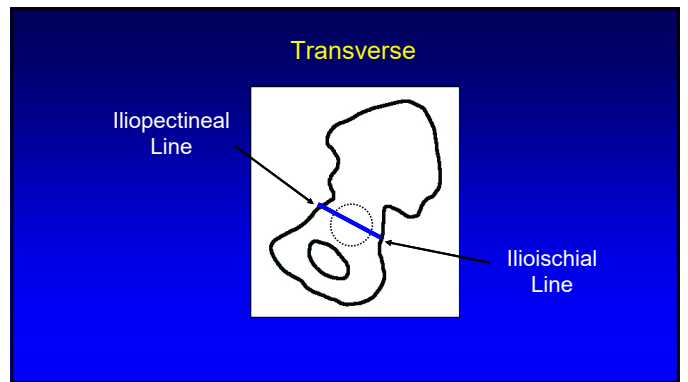
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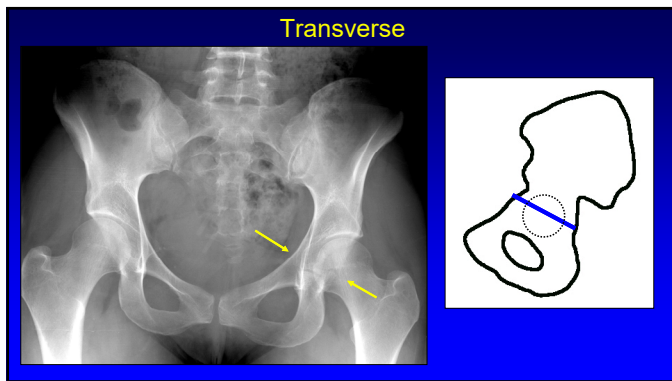
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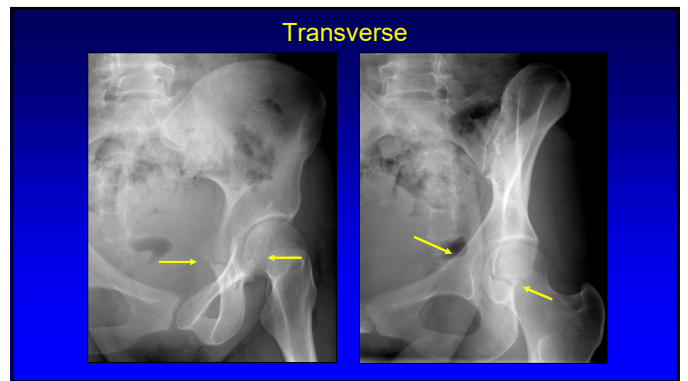
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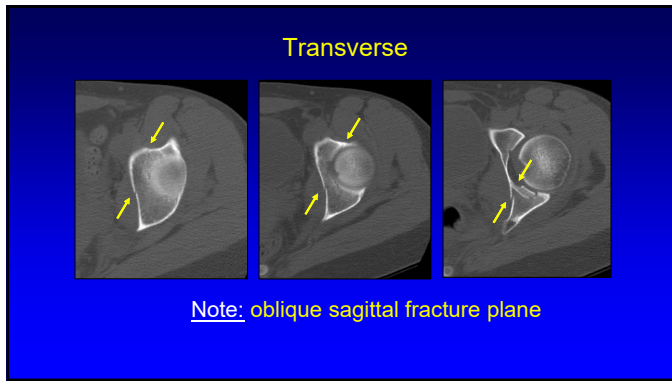
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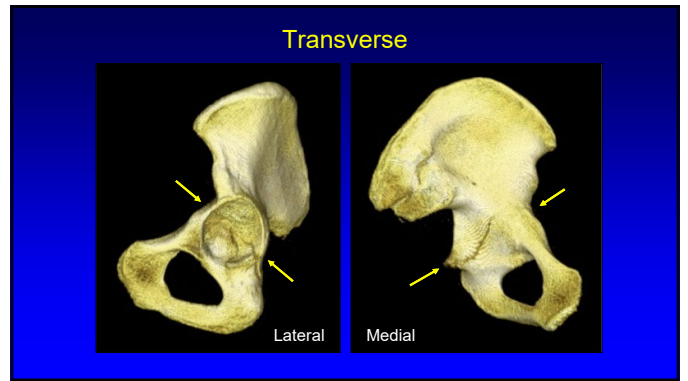
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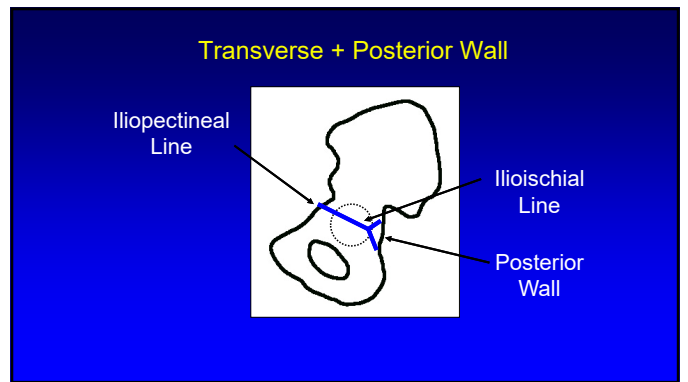


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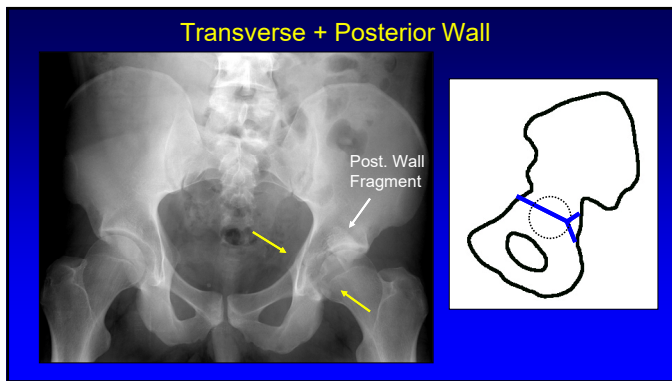
### Transverse + Posterior Wall:

- No obturator ring fracture
- Transverse fracture
  - Relative to acetabulum
  - Not to body
  - Ilioischial and iliopectineal line disruption
- Comminuted posterior wall fracture

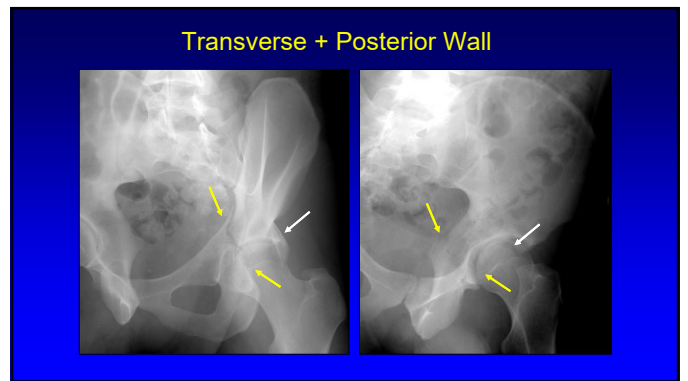
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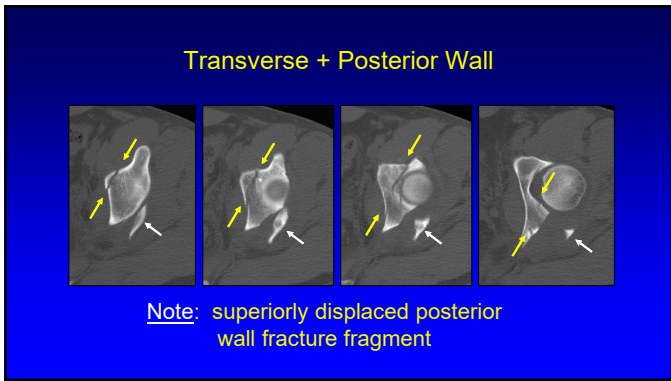


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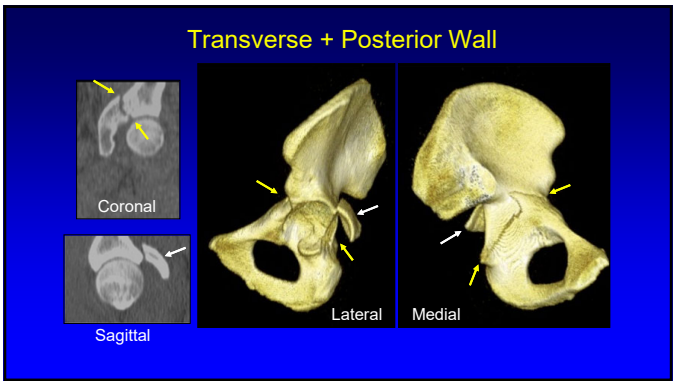


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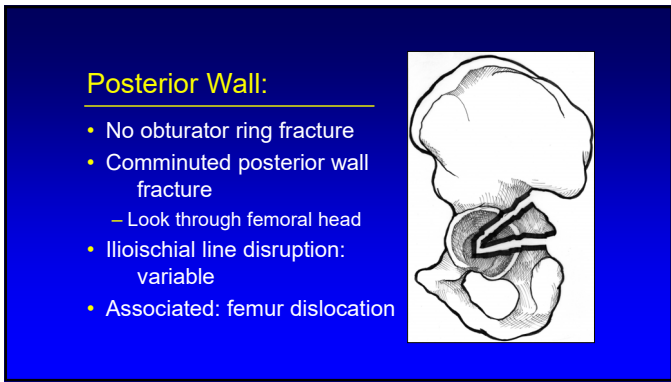




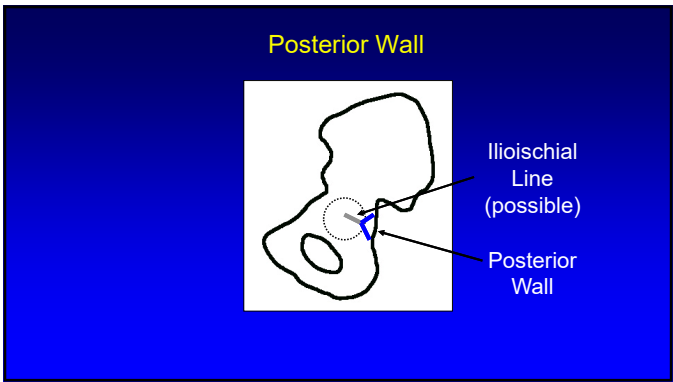
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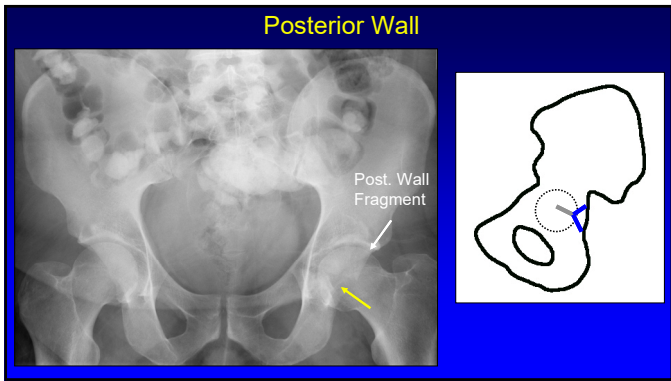
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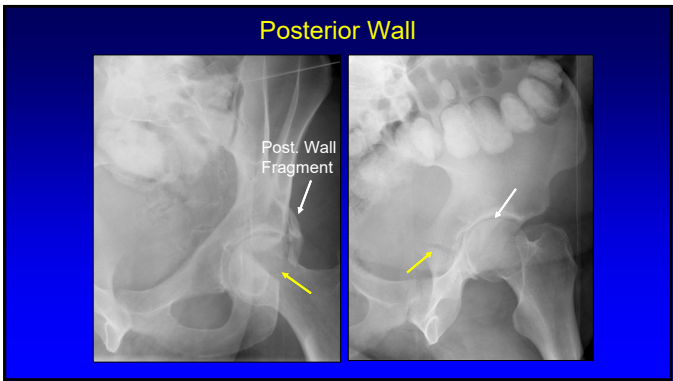
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### Posterior Wall: CT

- Comminuted
- Displaced
- Intra-articular bodies
- Bubble sign: indicates prior hip dislocation

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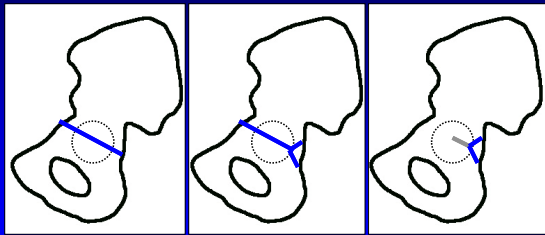
### Posterior Wall



*Note: Look for bubble sign*

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Transverse      Transverse + Posterior Wall      Isolated Posterior Wall

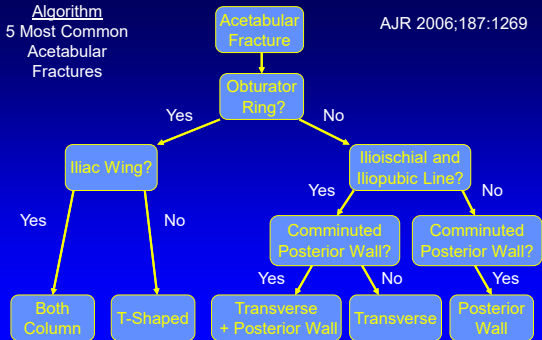


REVIEW

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Algorithm  
5 Most Common  
Acetabular  
Fractures

AJR 2006;187:1269



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### Outline:

- Anatomy
- Mechanisms of injury
- Acetabular fractures
- **Other pelvic fractures**
- Approach to radiographs

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### Pelvic Fractures: Radiographic Assessment

- Obturator ring fracture
- Sacroiliac joints
- Pubic symphysis
- Iliac wing fracture
- Arcuate lines: sacrum

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### Pelvic Fractures:

- Lateral compression: 57 – 72%
- Anteroposterior compression: 13 – 16%
- Vertical shear: 6 – 16%
- Complex: 0 – 22%

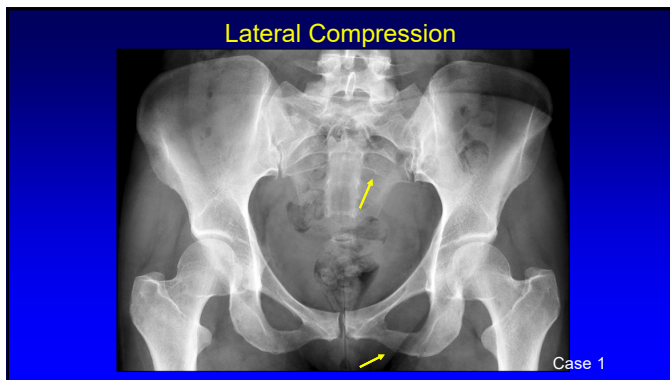
Hunter et al. Radiol Clin North Am 1997; 35:559

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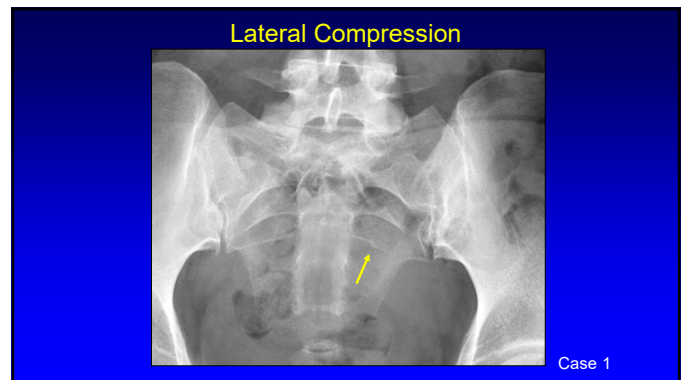
### Lateral Compression:

- Internal rotation of hemipelvis
- Unilateral obturator ring fracture: 99.9%
  - Possible puboacetabular junction
- Sacral fracture: 90%
  - Vertical, parallel to SI joint
  - Ipsilateral or contralateral
  - Arcuate line disruption

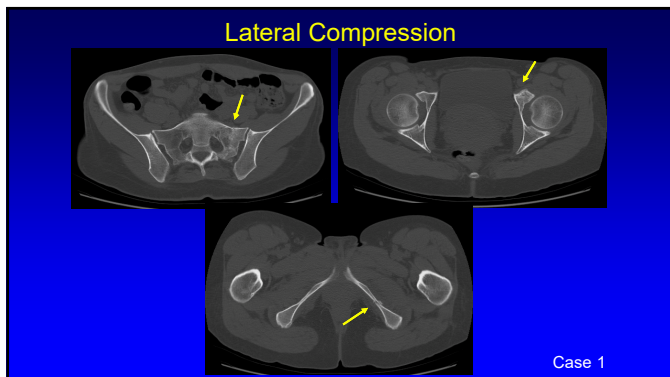
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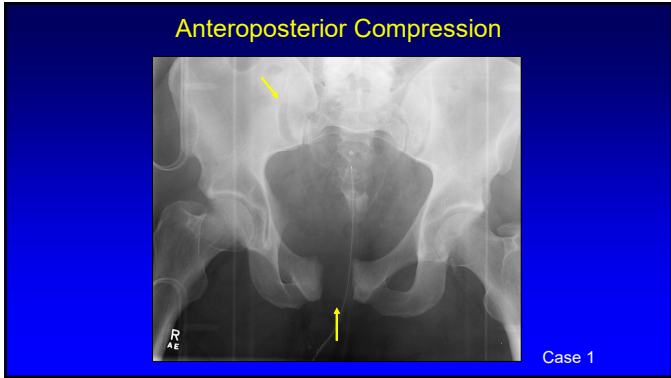


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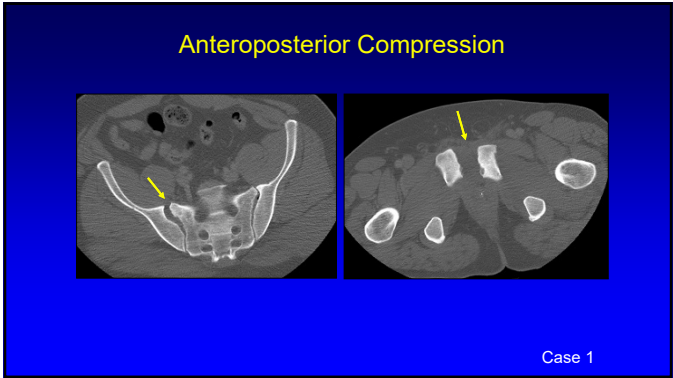
### Anteroposterior Compression:

- External rotation of hemipelvis
- Bilateral rami fractures
- Pubic symphysis **diastasis**
  - > 5 mm women, 6 mm men, 7 mm pregnant
- SI joint **diastasis**
- Sacral and obturator ring fractures

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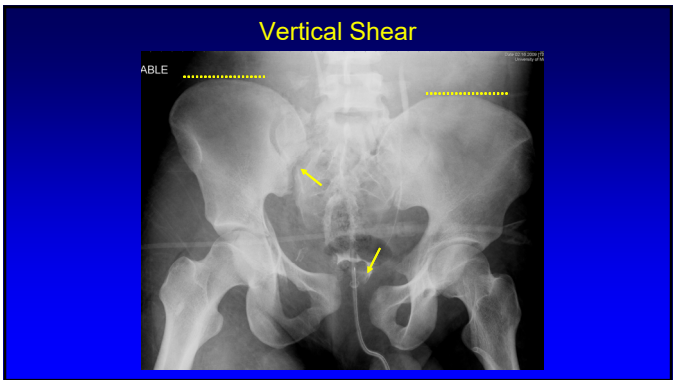
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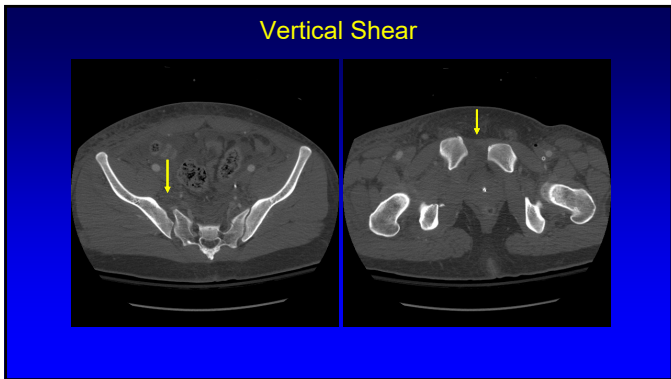
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- Vertical Shear:
- Significant injury: fall from height
  - Obvious abnormalities
  - Hemipelvis displaced superior
  - Variable sacral and rami fractures
  - Variable SI joint and pubic symphysis diastasis

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- Miscellaneous
- Isolated iliac wing
  - Avulsion fractures
  - Hip dislocation

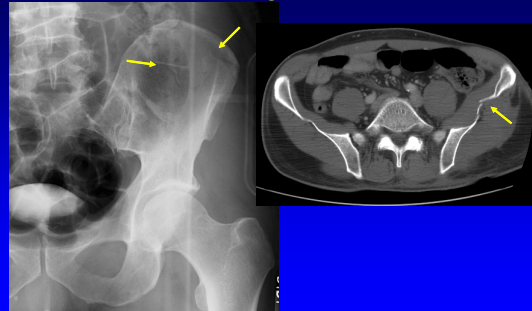
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### Iliac Wing Fracture:

- Duverney fracture
- Stable
- Direct trauma
- Usually lateral compression
- Little displacement
- Major hemorrhage unusual

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### Iliac Wing Fracture



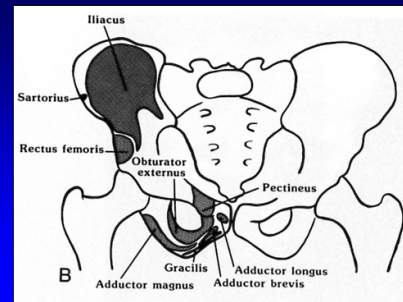
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### Avulsion Fractures:

- More common in children
- Tendon attachments
  - Sartorius: anterior superior iliac spine
  - Rectus femoris: anterior inferior iliac spine
  - Hamstrings: ischiopubic ramus
  - Adductors: pubis

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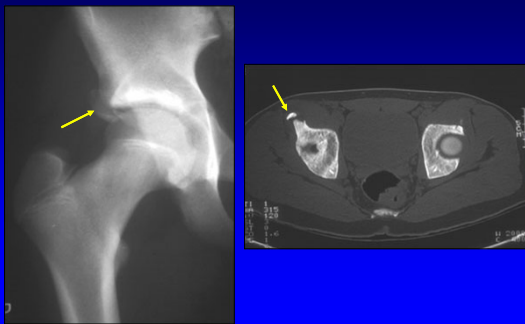
### Avulsion Sites



From: Weissman's Orthopedic Radiology

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### Avulsion: rectus femoris



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### Hip Dislocation:

- Posterior: 80 – 85%
- Anterior: 5- 10%
- Central: not a true dislocation
  - Femoral head displaced in acetab. fracture
- **Bubble sign:**
  - Nitrogen gas bubble: prior dislocation

Fairbairn AJR 1995;164:931

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### Hip Dislocation:

- Posterior
  - Possible internal rotation of leg
  - Head centered at or above acetabulum
  - Posterior acetabular wall fracture
    - Joint space widening: intraarticular body
  - Delayed avascular necrosis: up to 25%
  - Femoral head fracture: Pipkin

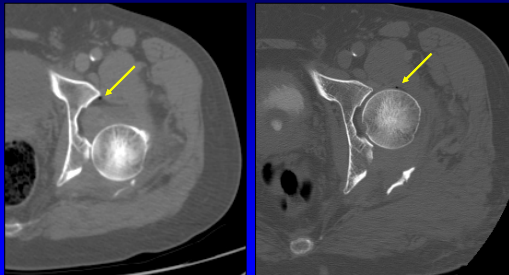
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### Posterior Hip Dislocation + Post. Wall Fracture



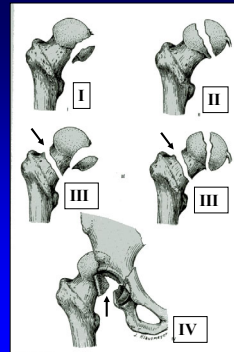
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### Posterior Hip Dislocation: bubble sign



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### Pipkin Classification



From: Resnick's Internal Derangements of Joints

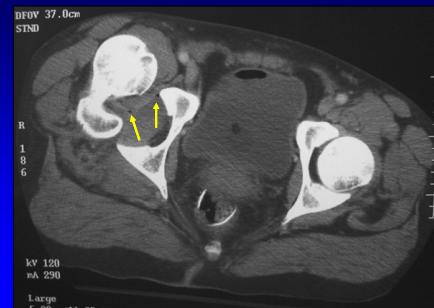
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### Hip Dislocation:

- Anterior
  - Leg may be externally rotated
  - Flexed hip: obturator dislocation
  - Extended hip: pubic dislocation
  - Fracture: compression of femoral head
    - Posterosuperior and lateral

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### Anterior Hip Dislocation: bubble sign



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### Outline:

- Anatomy
- Mechanisms of injury
- Acetabular fractures
- Other pelvic fractures
- Approach to radiographs

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### Approach to Radiographs:

#### 1. Overview assessment:

- ✓ Pelvic lines: iliopectineal, ilioischial, posterior acetabular wall, arcuate
- ✓ Obturator ring
- ✓ Iliac wing
- ✓ Pubic symphysis, SI joints
- ✓ *Acetabular versus other pelvic fracture*

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### Approach to Radiographs:

#### 2. Obturator ring fracture:

- + Acetabular fracture
  - Iliopectineal + ilioischial: T-shaped
  - Plus iliac wing: *Both column*
- + Sacral fracture
  - Double check arcuate lines
  - *Lateral compression injury*

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### Approach to Radiographs:

#### 3. Posterior acetabular wall and/or ilioischial line disruption

- ✓ Look through femoral head
- ✓ Consider Judet views
- ✓ *Transverse, PW, trv + PW fractures*

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### Approach to Radiographs:

#### 4. SI joints, pubic symphysis diastasis

- Anteroposterior compression
- Superior displacement: *Vertical shear*

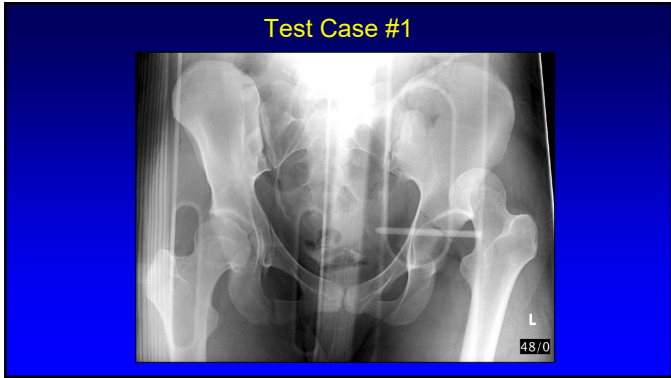
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### Approach to Radiographs:

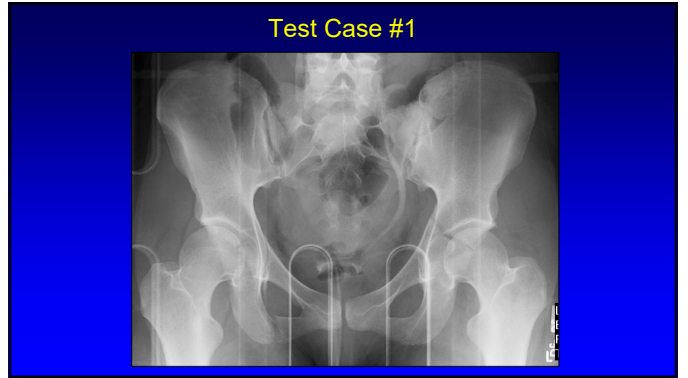
#### 5. Miscellaneous

- Isolated iliac wing fracture
- Avulsion fracture

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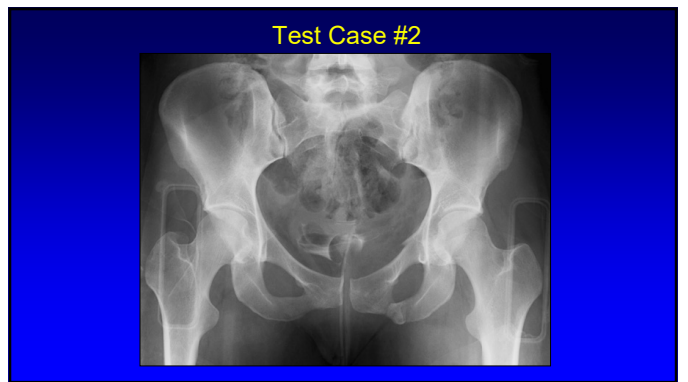
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- Test Case #1: answer
- Right:
    - ✓ T-shaped acetabular fracture
  - Left:
    - ✓ Posterior hip dislocation
    - ✓ Transverse acetabular fracture

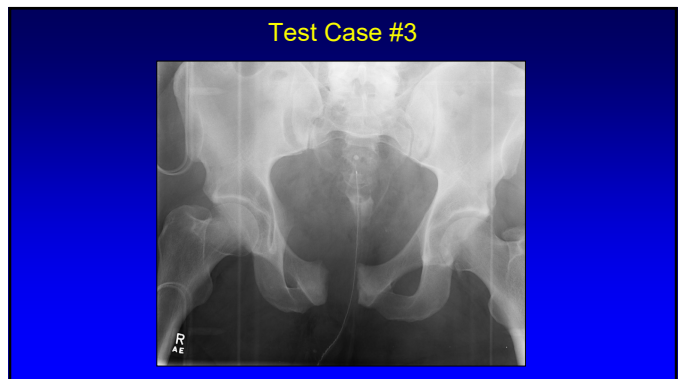
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- Test Case #2: answer
- Left obturator ring fracture
  - Vertical sacral fracture
  - ✓ Lateral compression injury

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Test Case #3: answer

- Pubic symphysis diastasis
- Right sacroiliac joint diastasis
- No vertical displacement
- ✓ Anteroposterior compression injury

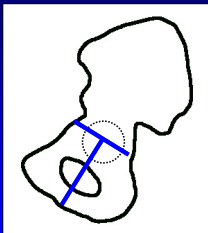
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Take Home Points:

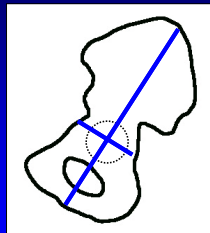
- Key pelvic lines and structures
- Fracture identification
- Fracture classification: radiographs
- Acetabular vs. other pelvic fracture
- Associated fractures

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T-shaped



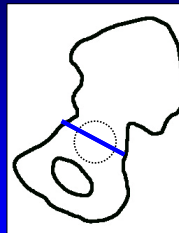
Both Column



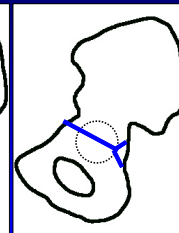
REVIEW

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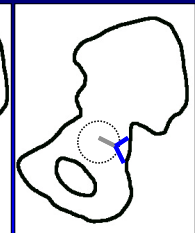
Transverse



Transverse + Posterior Wall



Isolated Posterior Wall



REVIEW

100



Syllabus on line and additional educational material:  
[www.jacobsonmuskus.com](http://www.jacobsonmuskus.com)

Twitter handle: @jjacobsn

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