

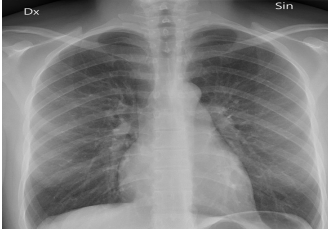
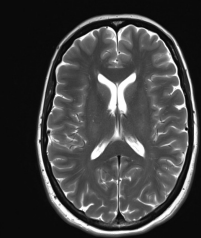




Medical Imaging for the extremities 




**KEY  
CLINICAL  
SKILLS**








MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
KEY CLINICAL SKILLS ALL RIGHTS RESERVED

1

Medical Imaging for the extremities 

<ol style="list-style-type: none"> <li>1. Hip region</li> <li>2. Thigh &amp; knee regions</li> <li>3. Ankle &amp; foot regions</li> <li>4. Shoulder region 1</li> <li>5. Shoulder region 2</li> </ol>	<ol style="list-style-type: none"> <li>6. Elbow &amp; forearm regions</li> <li>7. Wrist region</li> <li>8. Hand region</li> <li>9. Practice integration 1</li> <li>10. Practice integration 2</li> </ol>
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MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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2

## Program goals



- **What you will get:**
  - Understand the basic science of X-ray, CT, MRI, Diagnostic Ultrasound
  - Identify the commonly used imaging views of the musculoskeletal system
  - Understand the fundamental process of image interpretation and practice these skills
  - Know and apply published **utilization** guidelines for medical imaging
  - Appreciate the **utility** of various medical imaging studies
  - Integrate imaging results into your existing practice

MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Program goals



- **What you won't get:**
  - The skills needed to interpret medical diagnostic images independently
  - The right to order medical imaging (unless allowed by Provincial legislation & Regulatory College)

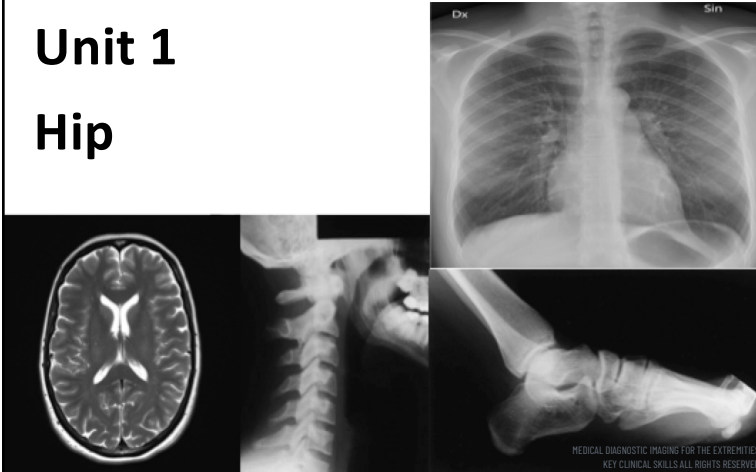
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Medical Imaging for the extremities 


# Unit 1

## Hip




5

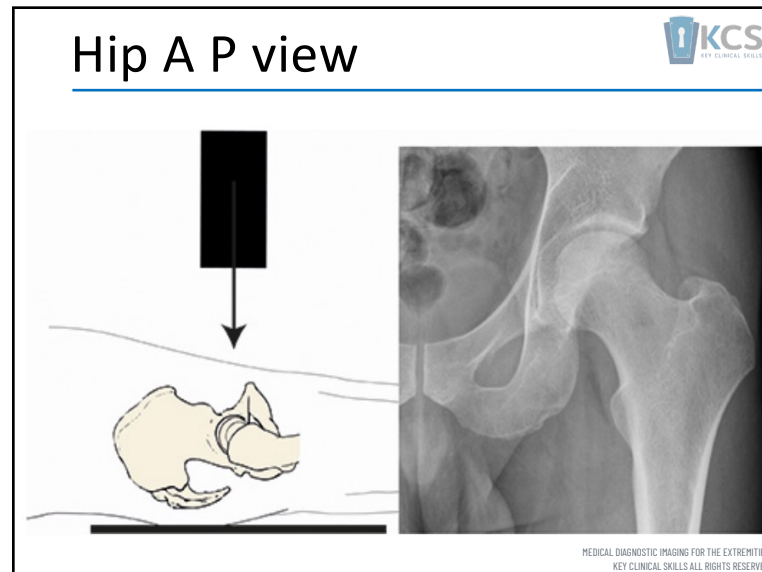
# Hip views



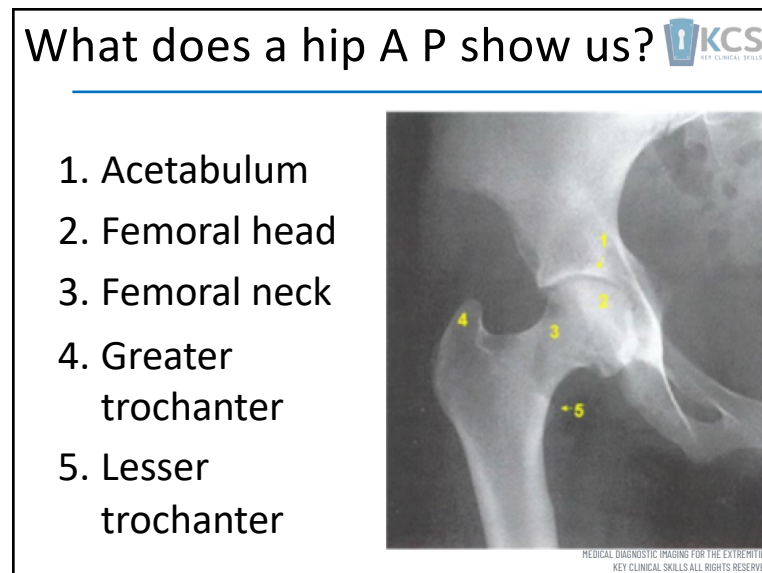
- AP
- Frog leg
- Axial lateral



6

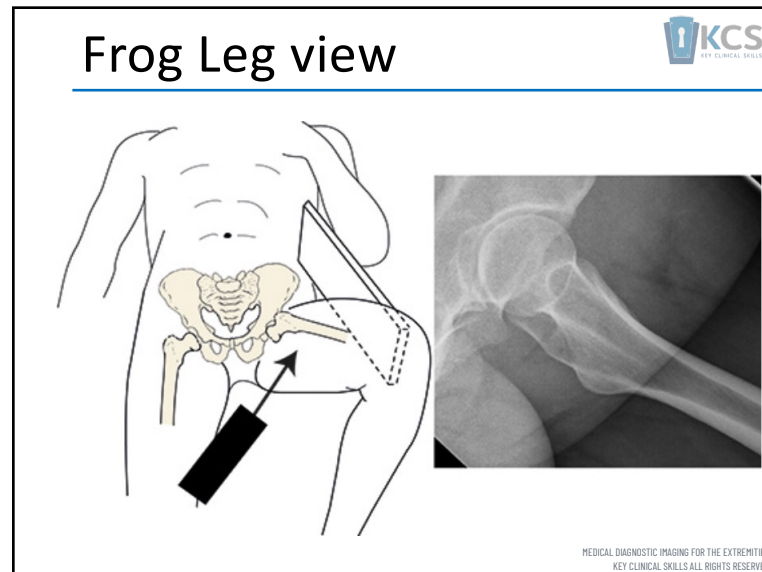


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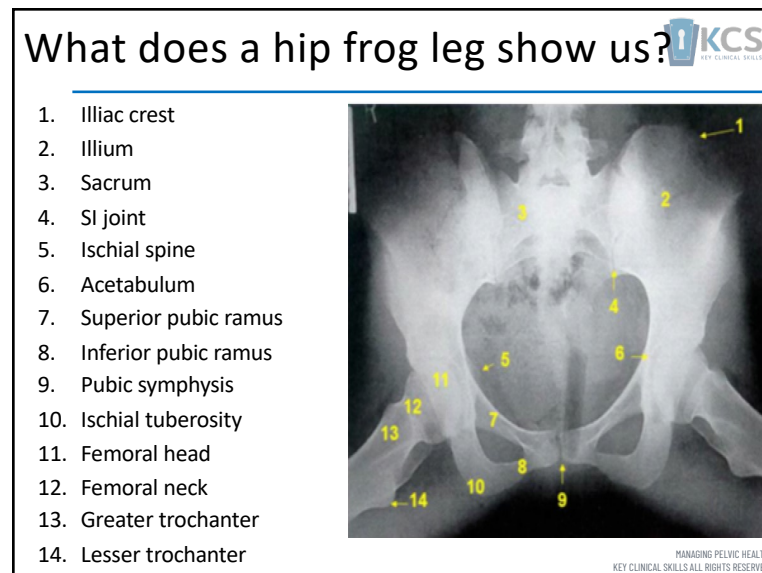


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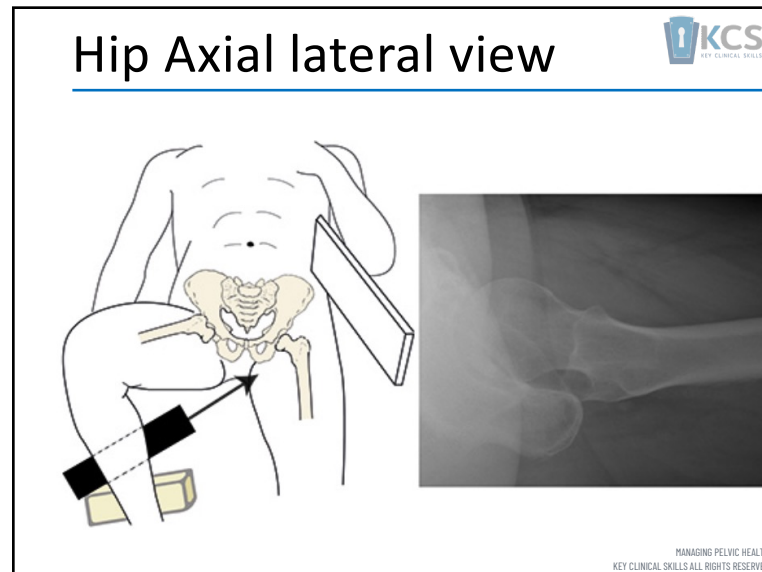




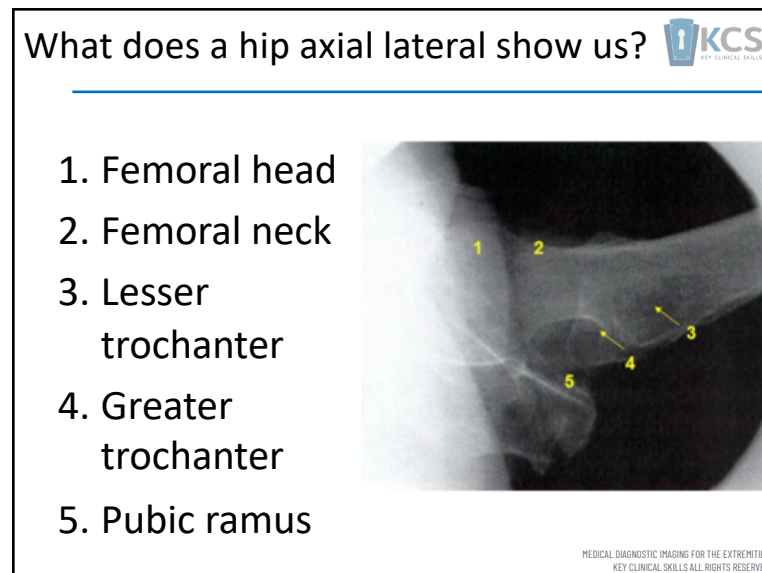
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## Hip fractures

- Most common are fractures of femoral neck
- Often related to osteoporosis
- Stress fractures may appear sclerotic
- Fractures of intertrochanteric line
- Often related to trauma



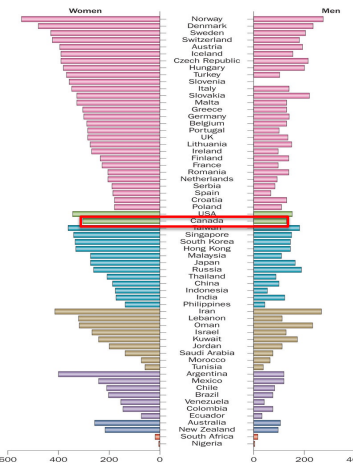
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MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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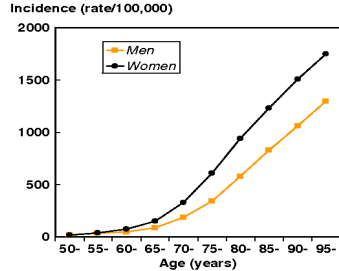
## Hip fractures



Age-standardized hip fracture incidence (per 100,000 person-years)

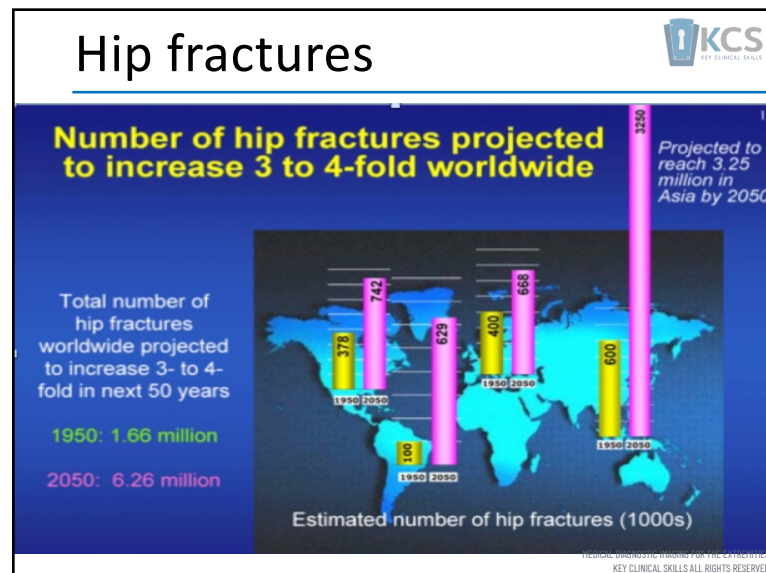


- 10% mortality within 1 month
- 1 in 3 mortality in one year



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## Hip fractures

### Garden Classification

1. Valgus impacted or incomplete (stable)
2. Complete, non-displaced (stable)
3. Complete partial displacement (unstable)
4. Complete full displacement (unstable & risk of AVN)

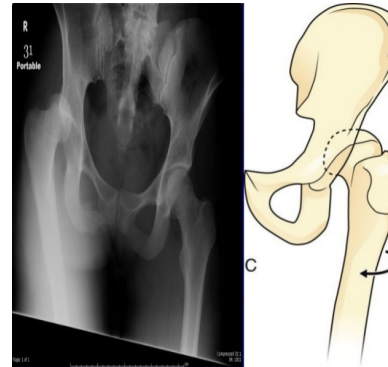
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## Posterior Dislocation



- 90% of hip dislocations posterior
- Dash board injury in head-on MVC
- High incidence of AVN
- May fracture acetabular wall



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## Posterior Dislocation



- Type 1** - Pure dislocation with or without insignificant posterior wall fragment
- Type 2** - Dislocation with large posterior wall fragment
- Type 3** - Dislocation with comminuted posterior wall
- Type 4** - Dislocation with "acetabular roof" fracture
- Type 5** - Dislocation with femoral head fracture



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## Anterior dislocation



Hyperextension force against abducted leg that levers head out of acetabulum

**Type 1** - Superior dislocations including pubic and subspinous +/- associated fractures of femoral head, acetabulum

**Type 2** - Inferior dislocations including obturator and perineal +/- associated fractures of femoral head, acetabulum



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## Non-traumatic hip pain

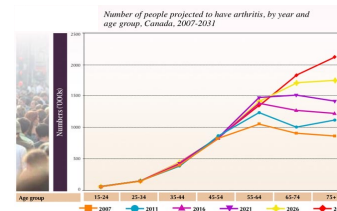


- Osteoarthritis most common cause of chronic hip pain
- 90% adults over 40 have some evidence of joint space narrowing

### BUT:

- Only 9.1% of hips with frequent pain showed OA on X ray
- Only 23.8% hips with OA on X ray were frequently painful

*Framingham 2015*




MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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### ACR criteria for diagnosis of hip OA

Combined clinical & radiological criteria	Clinical criteria	Combined clinical & radiographic (Tree format)
Hip pain plus at least 2 of: <ul style="list-style-type: none"> <li>ERS &lt; 20 mm/h</li> <li>Radiographic femoral or acetabular osteophytes</li> <li>Radiographic joint space narrowing</li> </ul>	<ul style="list-style-type: none"> <li>Hip pain</li> </ul> AND: <ul style="list-style-type: none"> <li>Internal rotation &lt; 15°</li> <li>ESR &lt; 45 mm/h</li> </ul> Or <ul style="list-style-type: none"> <li>Internal rotation &lt; 15°</li> </ul> AND <ul style="list-style-type: none"> <li>Pain on hip internal rotation</li> </ul> AND <ul style="list-style-type: none"> <li>Morning stiffness &lt; 60 min</li> </ul> AND <ul style="list-style-type: none"> <li>Age &gt; 50 yrs</li> </ul>	<ul style="list-style-type: none"> <li>Hip pain</li> </ul> AND <ul style="list-style-type: none"> <li>Femoral and/or acetabular osteophytes</li> </ul> OR <ul style="list-style-type: none"> <li>ESR &lt; 20 mm/h</li> </ul> AND <ul style="list-style-type: none"> <li>Joint space narrowing or osteophytes</li> </ul>
Sen 89%	Sen 86%	Sen 91%
Spec 91%	Spec 75%	Spec 89%

  
 MEDICAL DIAGNOSTIC IMAGING FOR THE PELVIC GARTHERS  
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### Kellgren-Lawrence grading system for hip osteoarthritis




**A**

Doubtful narrowing of joint space and possible osteophytic lipping




**B**

Definite osteophyte and possible narrowing of joint space



**C**

Moderate multiple osteophytes, definite narrowing of joint space, some sclerosis and possible deformity of bone contour




**D**

Large osteophytes, marked narrowing of joint space, severe sclerosis, and definite deformity of bone contour

MANAGING PELVIC HEALTH  
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## Aseptic Necrosis



- **A** nemia (sickle cell)
- **S** teroids
- **E** thanol
- **P** ancreatitis
- **T** rauma
- **I** diopathic
- **C** asisson's disease "The bends"


### CAUSES


Traumatic	Nontraumatic
Fracture neck of Femur	Steroid use
Fracture dislocations of hip	Excess Alcohol intake
Injuries /surgeries around hip	Sickle cell disease
	Other blood cell disorders
	Deep sea divers and miners

MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## X rays for AVN





**Femoral Head**



**AVN femoral head**

**Early stages**  
X rays not very useful even though there is pain


**Later stages**  
Bone cysts and collapse of dead bone  
Arthritic-like changes evident

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## Progression of AVN X-rays



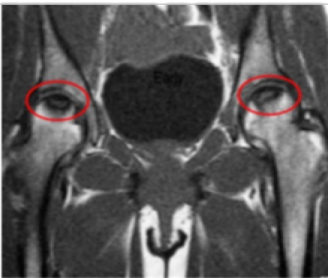
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## AVN on Bone Scan & MRI



Bone scan cannot distinguish between AVN and OA  
A cold spot in femoral head is highly specific but not sensitive



MRI can detect AVN within days  
Useful in staging disease

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## Hip pain in children







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## Slipped femoral capital epiphysis




### Etiology

- Idiopathic

### Predisposing factors

- Boys 12-16 yrs
- Girls 10-14 yrs
- Boy > girls 5:2
- Blacks > whites
- Left > right
- Seasonal (June – July)



MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Slipped femoral capital epiphysis

### Pre-slip stage:

- Slight discomfort in groin usually after activity
- Discomfort radiates anterior and medial thigh to inner aspect of knee
- Stiffness and episodic limp

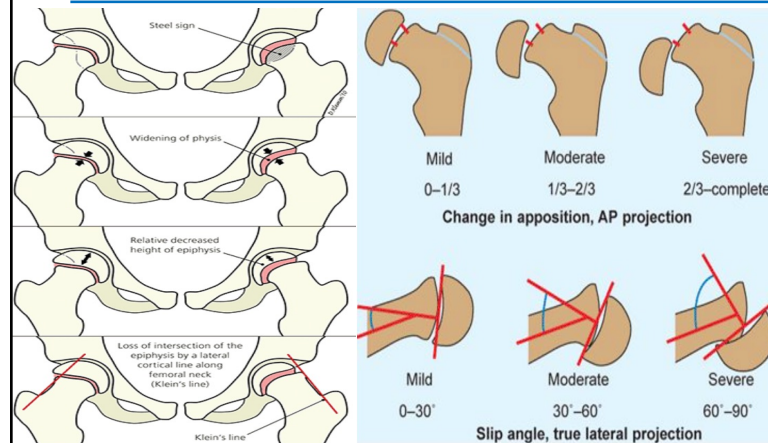
### Chronic stage:

- Pain in groin increases
- Antalgic limp persistent
- Limitation of hip internal rotation (especially in flexion)
- True shortening of leg
- Inhibition of gluteus medius (Trendellenburg gait)

MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Slipped femoral capital epiphysis



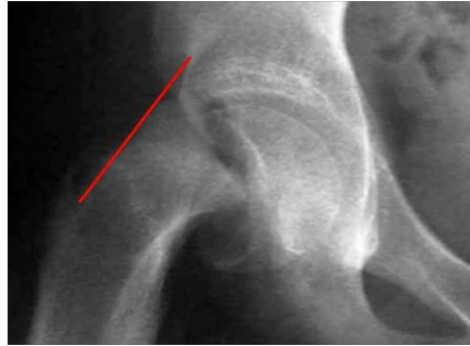
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## Klein line



- A line drawn along the superior border of the femoral neck should intersect the femoral head



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## Advanced imaging



### CT scan

- Accurately measures extent of epiphyseal displacement and angulation

### Bone scan

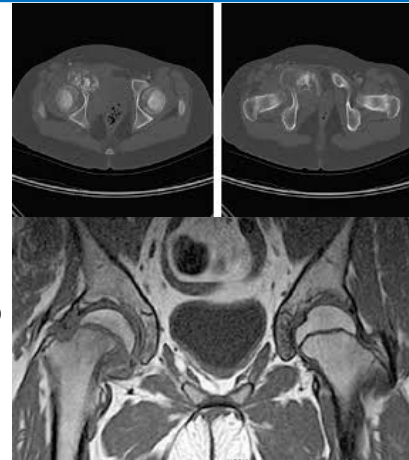
- Increased uptake in capital epiphysis

### US

- Joint effusion with step between femoral neck and epiphysis > 6mm

### MRI

- Early detection



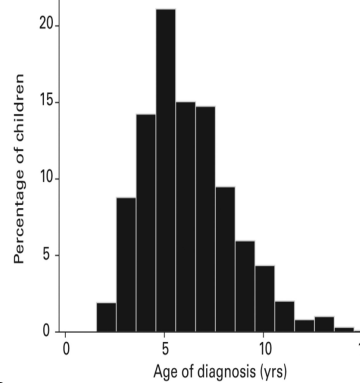
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## Perthe's Disease



- Idiopathic AVN of epiphysis of femur
- Common:
  - India SW coast (10X)
  - Central Europe
- Less common
  - Africa
  - Asia
- Boys 4-5X > girls
- Begins 5-10 yrs
- Idiopathic but may be:
  - Inherited protein deficiency
  - Venous thrombosis
  - Arterial occlusion
  - Raised intra-osseous pressure
  - Synovistis of hip joint



MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Perthe's Disease



### Necrosis Stage

- Femoral head is radiodense and smaller
- Cartilage space is wider

### Fragmentation stage

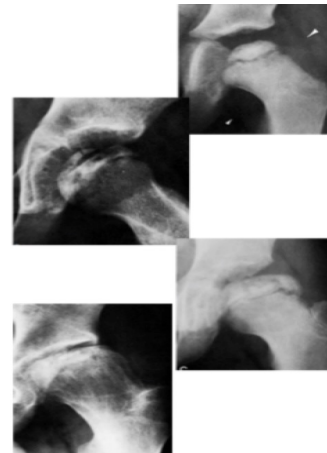
- Subchondral fracture
- Resorbption of necrotic bone
- Cyst formation

### Healing

- Re-ossification occurs peripheral to central
- Radiodensity becomes normal

### Remodelling Stage –

- Shape may be maintained or further flatten
- Residual deformity may be coxa; magna, plana or breva



MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Perthe's Disease



### “Cage sign”

- Wedge shaped defect in superior portion of epiphysis
- Early indicators of Legg Calves Perthes disease



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## Hip dysplasia



### Developmental Dysplasia of the Hip

- Partial or complete displacement of femoral head from acetabulum since birth
- Females: Males 7:1
- Left > right
- Bilat. 1 in 15 cases

#### Etiology

- Genetic
- Hereditary disposition
- Hormonal
- Intrauterine malposition
- Post natal (swaddling)



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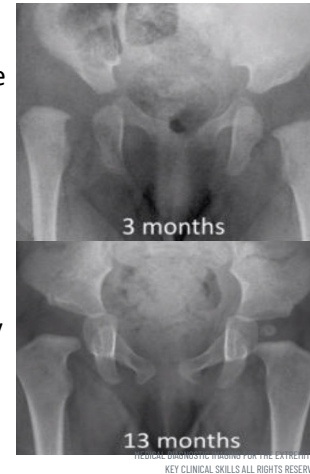
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## Hip dysplasia



### Pathology

- Dislocated at birth or dislocatable post partum
- Femoral head is dislocated upwards & laterally
- Epiphysis is small & ossicles late
- Femoral neck anteverted
- Acetabulum shallow
- Labrum may be folded into cavity
- Capsule is stretched
- Hip muscles undergo adaptive shortening



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## Hip dysplasia



### Ultrasound

- Has replaced radiography for imaging newborns
- Sequential assessment allows monitoring during period of splinting


### Plan X ray

- More useful after first 6 months



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## Labral tears



- Extrinsic vs intrinsic factors (+/- FAI)
- Pain in anterior thigh, inguinal and/or buttocks
- AROM/ PROM painful at end range
- Audible clicking/catching/locking
- +ve impingement

**“Anterior Impingement Test”**

Passive flexion to 90°  
followed by forced adduction  
and IR




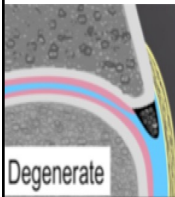
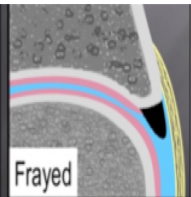
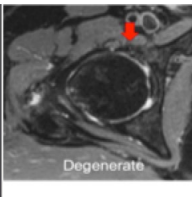
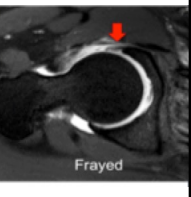

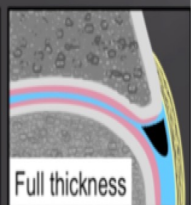
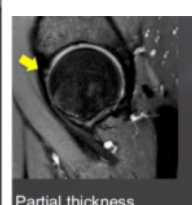

**Sn = 75%**  
**Sp = 43-100%**

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## Labral pathology



 <p>Degenerate</p>	 <p>Frayed</p>	 <p>Degenerate</p>	 <p>Frayed</p>
 <p>Partial thickness</p>	 <p>Full thickness</p>	 <p>Partial thickness</p>	 <p>Full thickness</p>

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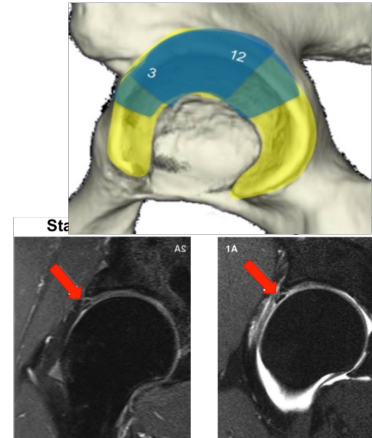
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## Labral pathology



- 55% occur between 3 and 12 o'clock
- 95% between 4 & 1 o'clock
- MRI with contrast optimal imaging tool to view tears



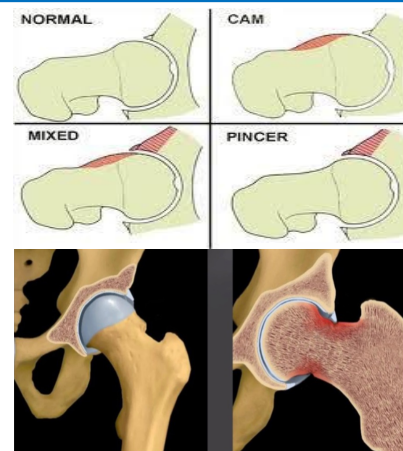
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## Femoral Acetabular impingement



- Cam or pincer or mixed
- Considered to lead to premature labral injury & OA
- Not as common in Asia



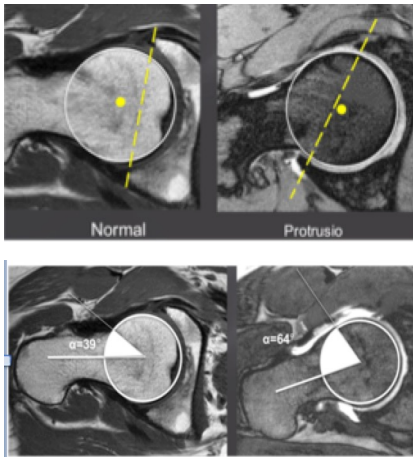
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## Femoral Acetabular impingement

**Cam**  
Normal alpha angle is  $< 55^\circ$


**Pincer**  
Head of femur is outside cup



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## FAI - controversy



- Very high number of asymptomatic radiographic deformity
- Only small number go on to OA
- Level of activity clearly important
- Considerable inherent variability in imaging assessment
- FAI is a clinical diagnosis
- Acetabular +/- femoral morphology **“tendency” towards FAI**

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## Femoral neck stress fracture

1. Young, highly active (overuse)
- 2 Older sedentary (falls or bone density)
  - Relief with non-wt bearing
  - Local groin pain
  - Bone scan is diagnostic early
  - **MRI is 100% sensitive**



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## Insufficiency fracture

### Incidence

- 250,000 hip fractures annually in USA
- Expected to double by 2040
- 90% occur in those age > 50 yrs

### Significant complications if missed

- Fracture completion
- AVN
- OA

### Presentation

- Anterior hip, groin, thigh pain
- Worse with weight bearing activity

Venkataraman 2016

MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Insufficiency fracture

### Risk factors

- Risk doubles every decade after 50
- Bone tumor
- Metabolic bone disease
- Coxa vara
- Leg length discrepancies
- Renal disease
- Smoking
- Infection

*Patel 2011*

Location	Stress Fracture Incidence Rate
Pelvis	1.6%
Femur	6.6%
Tibia	23.6%
Fibula	23.0%
Navicular	17.6%
Metatarsal	16.2%

MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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## Tuberculosis

for years 2005, 2006 and 2007

Group	Percentage
Foreign-born	67%
Canadian-born Aboriginal	19%
Canadian-born non-Aboriginal	12%
Birthplace unknown	2%

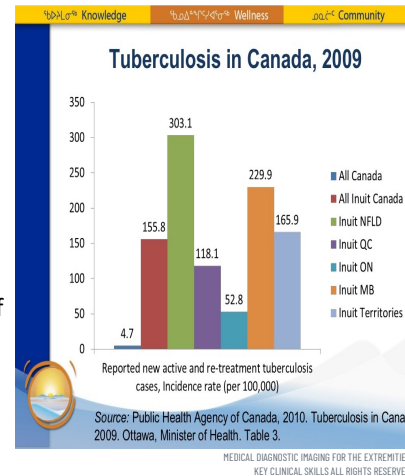
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## Tuberculosis of hip



- Second most common site after spine
- Constitutes 15% of osteo-articular TB
- Secondary to pulmonary or mediastinum TB
- Spread to hip by blood stream
- May begin in acetabular roof and slowly become symptomatic
- Often significant destruction by time of recognition



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## Tuberculosis of hip



**Stage 1** - General rarefaction of bones. Joint space appears widened (effusion)

**Stage 2** - Erosion of the articular surface and narrowing of the joint space

**Stage 3** - Destruction of the head of femur, dislocation of hip



MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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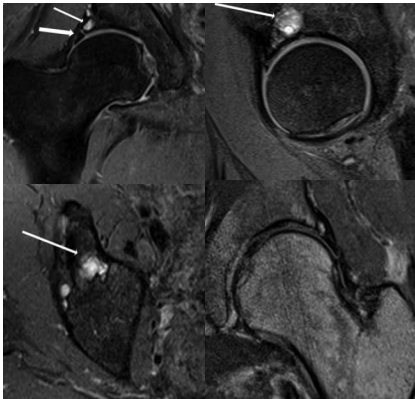
## Prevalence of abnormal findings in asymptomatics

45 subjects mean age 37.8 yrs.  
No symptoms of hip pain or  
dysfunction

MRI findings:

- Labral tears 69%
- Chondral cysts 24%
- Fibrocytic changes 22%
- Osseous bumps 20%
- Subchondral cysts 16%
- Labral cysts 13%
- Acetabular bone edema 11%
- Rim fractures 11%
- Ligamentum teres tears 2.2%

*Register 2012*



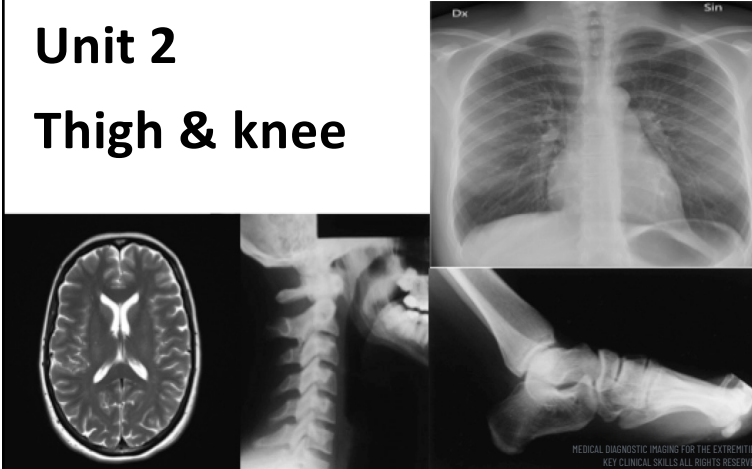
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## Medical Imaging for the extremities

### Unit 2


### Thigh & knee

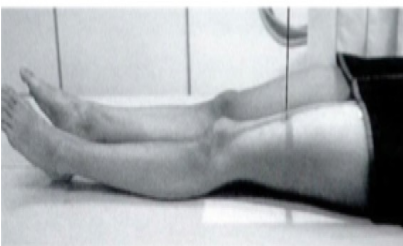



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## AP Mid and Distal Femur






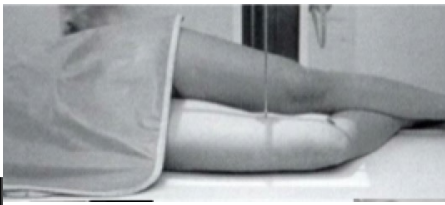



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## Femur Lateral Proximal and Distal







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## Fractures of the femur

**High energy**

- Fall from height
- Sports injuries
- Crush
- MVC

**Low energy**

- Stress fractures
- Osteoporosis
- Neoplasia
- Erosion at tip of THR stem



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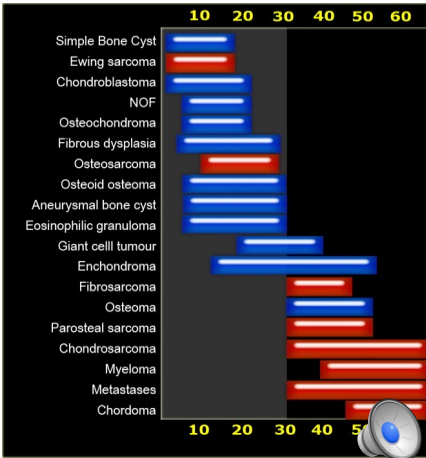
## Tumors of the femur

**Benign**

- Fibrous cortical defects
- Fibrous dysplasia
- Non-ossifying fibroma

**Malignant**

- Chondrosarcoma
- Metastases



Tumor Type	Age Range (Years)	Color
Simple Bone Cyst	10-20	Blue
Ewing sarcoma	10-20	Red
Chondroblastoma	10-20	Blue
NOF	10-20	Blue
Osteochondroma	10-20	Blue
Fibrous dysplasia	10-20	Blue
Osteosarcoma	10-20	Red
Osteoid osteoma	10-20	Blue
Aneurysmal bone cyst	10-20	Blue
Eosinophilic granuloma	10-20	Blue
Giant cell tumour	20-30	Blue
Enchondroma	20-30	Blue
Fibrosarcoma	20-30	Red
Osteoma	30-40	Blue
Parosteal sarcoma	30-40	Red
Chondrosarcoma	30-40	Red
Myeloma	30-40	Red
Metastases	30-40	Red
Chordoma	30-40	Red

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## Tumors of the femur



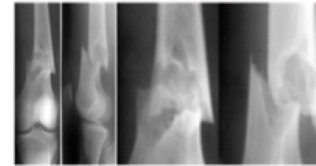
### Femur prone to tumors

#### Benign

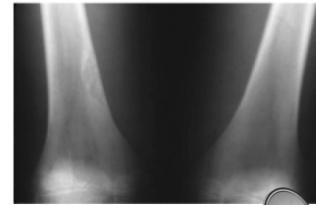
- Fibrous cortical defects
- Fibrous dysplasia
- Non-ossifying fibroma

#### Characteristics

- Generally small
- No associated periosteal reaction
- Narrow transition zone between lesion and bone
- Thin well-defined sclerotic margins



Non-ossifying fibroma



Fibrous cortical defect

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## Tumors of the femur



### Malignant

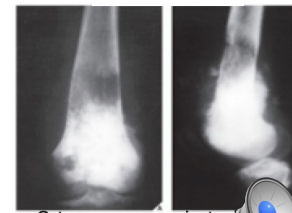
- Chondrosarcoma
- Metastases

#### Characteristics

- Lytic lesion without sclerotic margins is considered malignant till otherwise proven
- Periosteal reaction
- Breast and lung produce lytic lesion metastases



Chondrosarcoma



Osteosarcoma periosteal reaction

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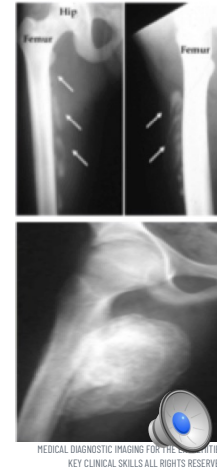
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## Myositis Ossificans



Often related to blunt trauma

- May also be:
  - Genetic (autosomal)
  - Post surgery



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## Knee

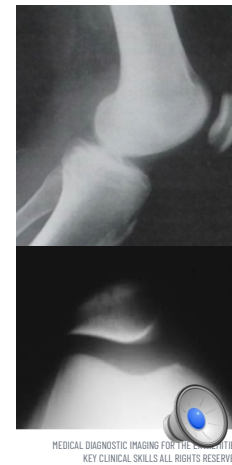


### Standard views

- AP view
- Lateral view

### Special views


- Tunnel view
- Sunrise view



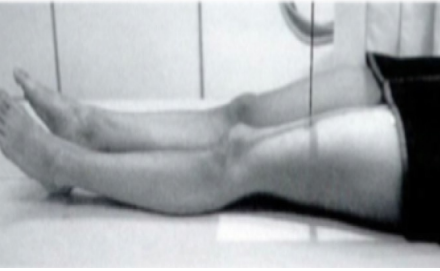

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## Knee AP view



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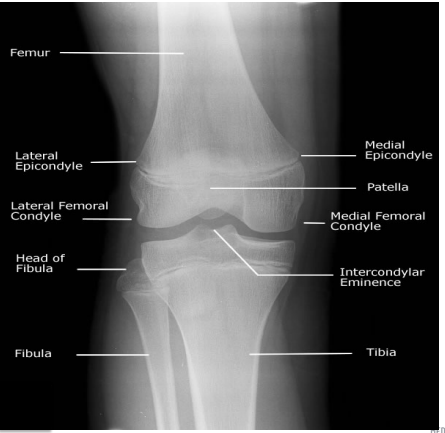
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## What does the knee AP show us?




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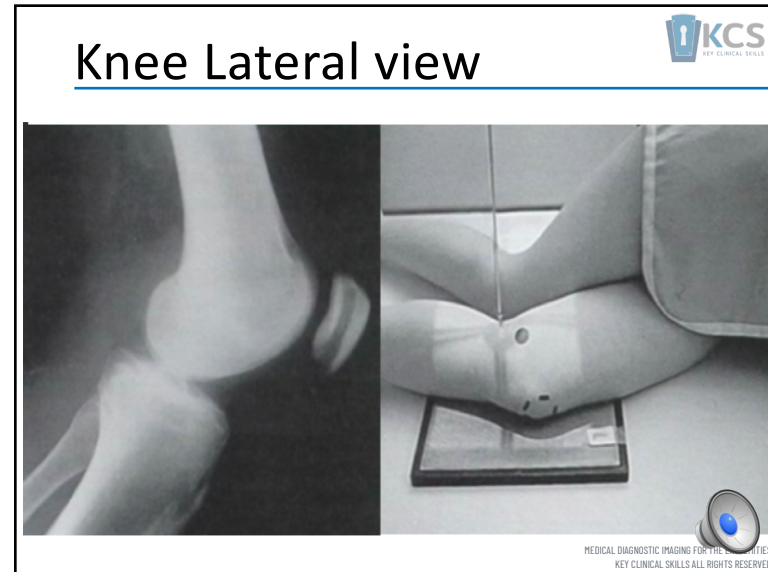
Femur ———  
Lateral Epicondyle ———  
Lateral Femoral Condyle ———  
Head of Fibula ———  
Fibula ———

Medial Epicondyle ———  
Patella ———  
Medial Femoral Condyle ———  
Intercondylar Eminence ———  
Tibia ———

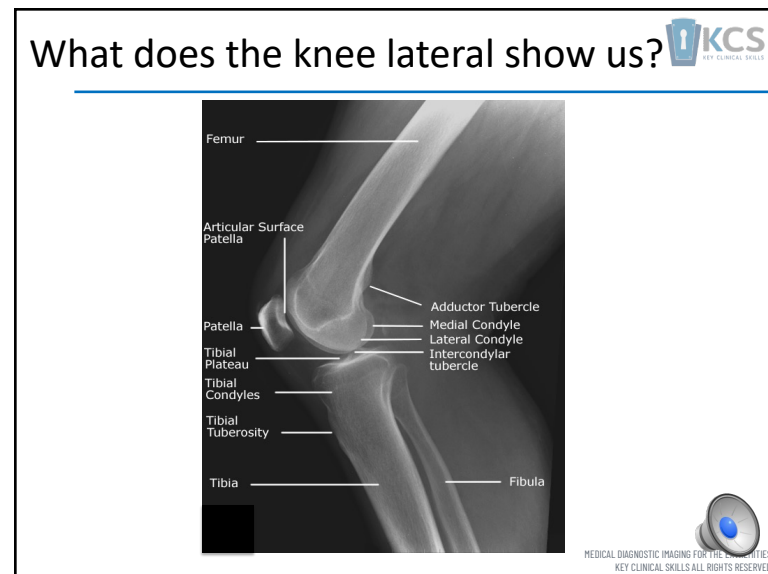


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# Knee Sunrise view



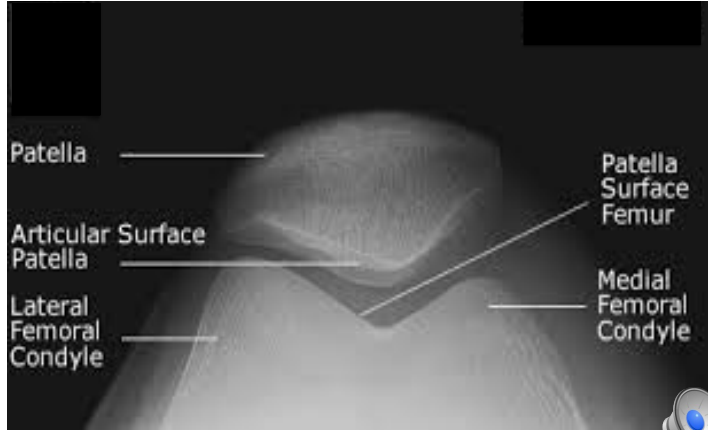
The image shows two parts: on the left, a grayscale X-ray of a knee in the sunrise view, highlighting the patella and femur; on the right, a photograph of a patient lying on their side with their knee flexed and the patella resting on a surface, with a white line indicating the X-ray beam's path.

**KCS**  
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# What does the knee sunrise view show us?



The image is an annotated X-ray of a knee in the sunrise view. Labels with leader lines point to the following structures:


- Patella
- Articular Surface Patella
- Lateral Femoral Condyle
- Patella Surface Femur
- Medial Femoral Condyle

**KCS**  
KEY CLINICAL SKILLS

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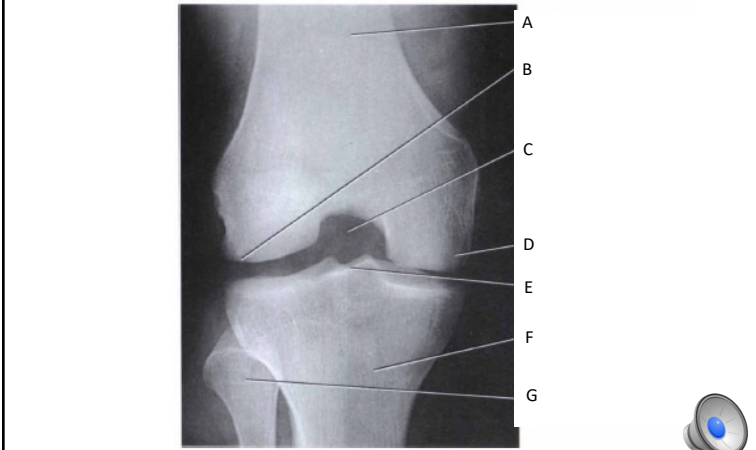
# Knee Tunnel view



The image displays two sets of knee tunnel views. On the left, two grayscale radiographic images of a knee joint are shown, labeled 'R' (Right) and 'L' (Left). On the right, a photograph shows a person's knee in a flexed position, with a blue marker on the patella and a black marker on the femur, illustrating the setup for the tunnel view. The KCS logo is in the top right corner, and a speaker icon with the text 'MEDICAL DIAGNOSTIC IMAGING FOR THE CLINICIAN KEY CLINICAL SKILLS ALL RIGHTS RESERVED' is in the bottom right corner.

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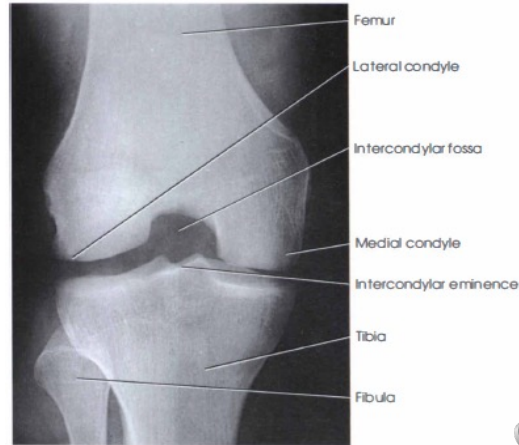
# What does the knee tunnel view show us?



The image shows a single grayscale radiographic knee tunnel view with seven anatomical structures labeled A through G. A is the femoral condyle, B is the patella, C is the femoral tunnel, D is the tibial tunnel, E is the anterior cruciate ligament (ACL), F is the posterior cruciate ligament (PCL), and G is the tibial condyle. The KCS logo is in the top right corner, and a speaker icon with the text 'MEDICAL DIAGNOSTIC IMAGING FOR THE CLINICIAN KEY CLINICAL SKILLS ALL RIGHTS RESERVED' is in the bottom right corner.

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### What does the knee tunnel view show us?



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### Knee trauma



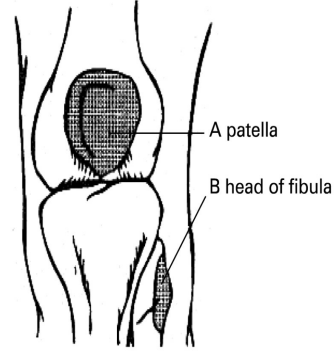
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## Ottawa Knee rules

An x-ray is indicated if the patient has any of the following features:

- Age > 55 years
- Inability to bear weight both immediately and in the emergency department (4 steps) \*\*
- Isolated tenderness of the patella\*
- Tenderness at head of fibula
- Inability to flex to 90°


\*No bone tenderness of knee other than patella  
 \*\*Unable to bear weight twice onto each limb regardless of limping<sup>6</sup>



A patella

B head of fibula

- **Sen 98.5%**
- **Spe 48.6%**



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## Pittsburg Knee rules

Fall or blunt-trauma mechanism

Yes

Age <12 or age >50 years

No

No knee radiography

Yes

Knee radiography

No

Able to walk four weight-bearing steps in ED


No

Knee radiography

Yes

No knee radiography

- **Sen 99%**
- **Spe 60%**



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## Systematic approach



- Check for an effusion on lateral view
- Trace cortex of main bones
- Check for tibio-femoral alignment
- Tibial plateau review
- Evaluate patella
- Check for patellar tendon disruption



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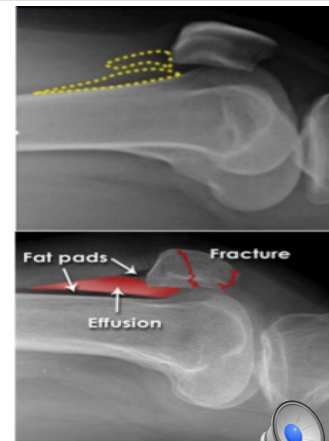
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## Knee Effusion



### 2 fat pads in knee


1. Supra-patellar
  2. Pre-femoral
- Ensure they are next to each other
  - Soft tissue density between 2 fat pads indicates effusion
  - Hemarthrosis suggests intra-articular bony or ligamentous injury



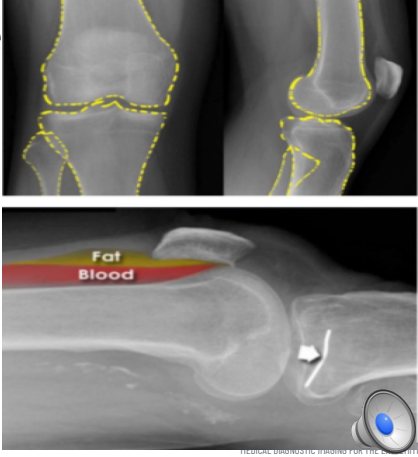
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## Cortical disruption




- Trace the cortex of each bone
- Look for:
  - irregularity
  - sclerosis



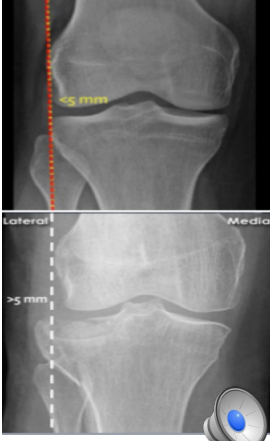
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## Tibial alignment



- Draw a line down the lateral margin of lateral femoral condyle
- If tibia > 5 mm outside line consider tibial plateau fracture

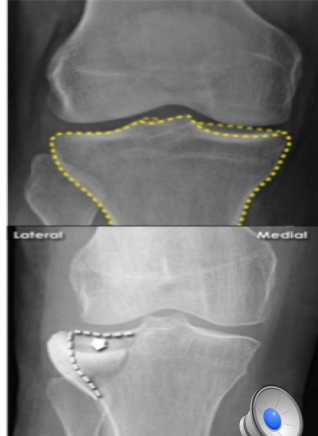


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## Tibial plateau review

- Trace proximal and distal margins of tibial plateau cortex
- Look for:
  - Breaks
  - Sclerosis
  - Displacement

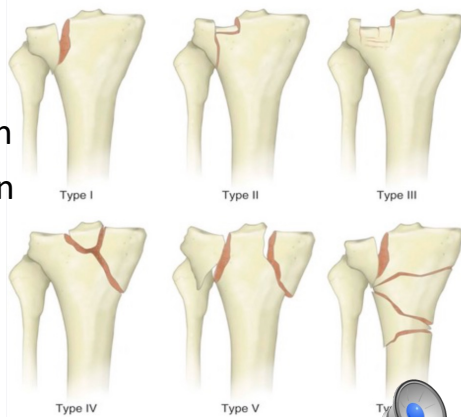


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## Tibial Plateau fractures

1. Lateral split without depression
2. Split-depression
3. Pure depression
4. Medial plateau
5. Bicondylar
6. Meta-diaphyseal dislocation




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## Intra-articular fractures


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• Partial articular



• Complete articular


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## Avulsion fractures

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- Tibial spine
- Tibial tuberosity
- Proximal fibula



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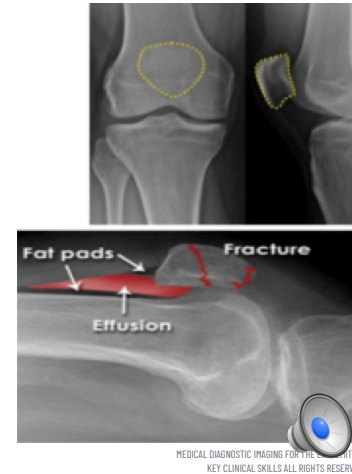
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## Evaluate the Patella



Check for:

- Vertical/horizontal cortical break down
- Irregularity
- Sclerotic line
- Fat pad sign
- Vertical fractures may require a sunrise view



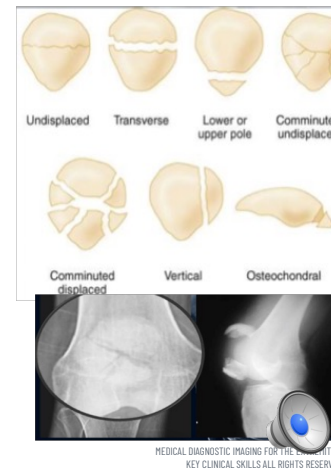
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## Patellar fractures



- Transverse 50%
- Comminuted 30%
- Vertical 20%
- AP, Lateral & Sunrise usually adequate to view



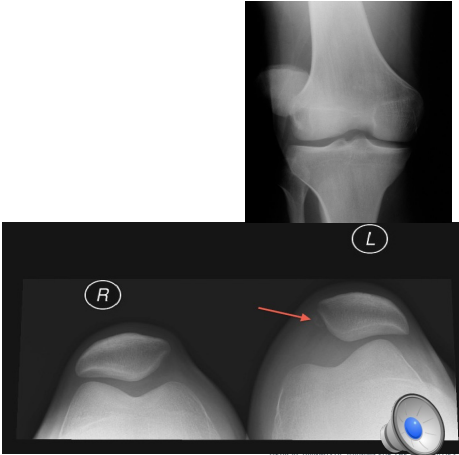
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## Dislocations

**Patella dislocation**

- Visible on AP
- Risk of dislocation may be seen on sunrise view




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## Knee dislocation

True orthopaedic emergency  
Significant risk of neurovascular compromise  
High risk of:

- Post-reduction stiffness
- Instability
- Poor function



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## Patellar tendon disruption

### Insall-Salvatti ratio

- With knee flexed to 30 degrees
  - Patellar tendon length should equal patellar length +/- 20%
  - If tendon too long “patella alta” consider tendon rupture



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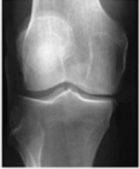
## Knee Osteoarthritis

- Knee OA common
- Xray demonstrates:
  - Joint space narrowing
  - Sclerosis
  - Osteophytes
- Cartilage may become calcified
- Chondrocalcinosis is calcification of cartilage

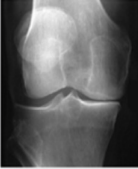


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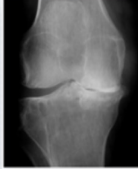
## Knee Osteoarthritis



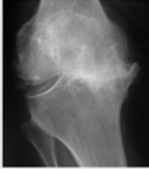
**Grade 1**  
Subchondral bone sclerosis



**Grade 2**  
Decreased joint space




**Grade 3**  
Osteophytes and geodes



**Grade 4**  
Malformation

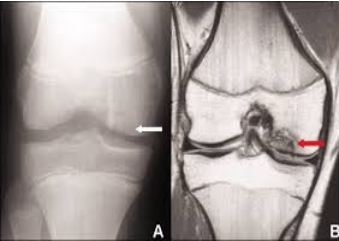
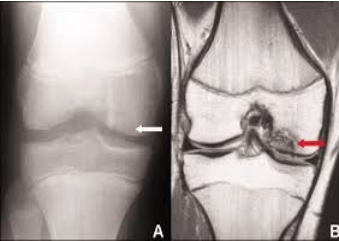
Grade	Description
1	Doubtful narrowing of joint space and possible osteophytic lipping
2	Definite osteophytes and possible narrowing of joint space
3	Moderate multiple osteophytes, definite narrowing of joint space & some sclerosis
4	Large osteophytes, marked narrowing of joint space, severe sclerosis & definite deformity of bone ends



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## Osteochondritis Dissecans

- Lesion of both bone and cartilage
- 50% of loose bodies in knee
  - Traumatic
  - Ischemic
  - Abnormal ossification centre
  - Genetic
- 3:1 Male : Female
- 85% in medial femoral condyle
- MRI Sn 75-93% Sp 93-99%

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## Osgood-Schlatter's Disease

### AKA tibial tubercle apophysitis

- Active boys 7:1 to girls 11-15 yrs.

### Sinding-Larsen-Johansson syndrome

- Involves patellar tendon and inferior margins of patella



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## Criteria for meniscal tear

1. Linear or complex intra-meniscal signal extending to the inferior or superior surface of the meniscus

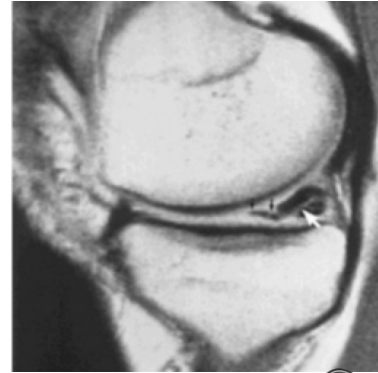


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## Criteria for meniscal tear



2. Gross disruption of the normal meniscal contour with obvious foreshortening



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## Criteria for meniscal tear



3. Complete absence of any meniscal structure

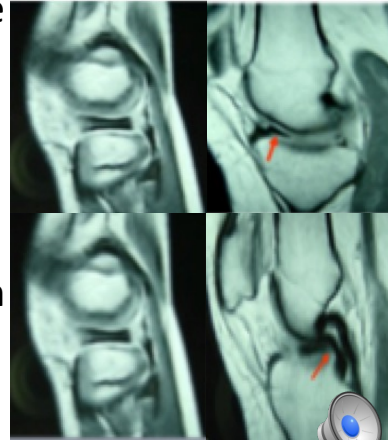


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## Bucket handle tears



1. Fragment in the inter-condylar notch
2. Flipped meniscus sign
3. Double PCL sign
4. Absent bowtie sign



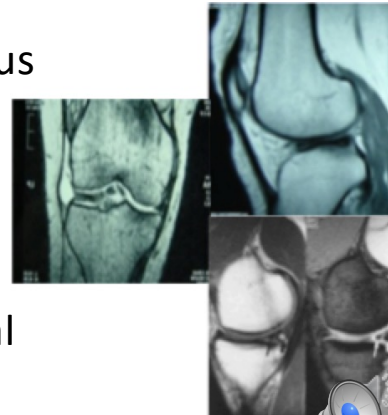
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## Other meniscal pathologies



- Discoid meniscus
- Meniscal cysts
- Meniscal ossicle



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## Ligamentous injuries

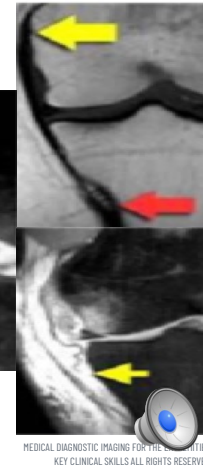
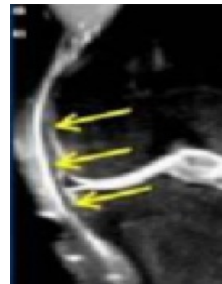


### Collateral ligaments

- X-ray only useful in young patients to differentiate from epiphyseal fractures

### MRI coronal scan

- Grade 1: Indistinct ligament (edema)
- Grade 2: Thicker, looser
- Grade 3: Severe edema



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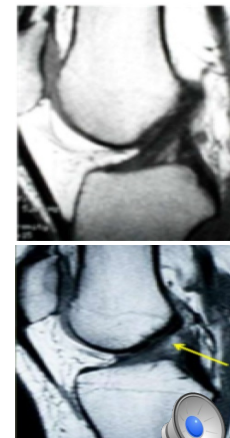
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## Ligamentous injuries



### ACL

- Second fracture of lateral tibial condyle (ACL tear with 75-100%)
- Tibial spine avulsion in young patients
- MRI 95% accuracy (all 3 planes in full extension)



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## Ligamentous injuries



### PCL

- MRI shows lower signal intensity for intact PCL compared to ACL
- Best view is sagittal oblique



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## Lower leg fractures



### Orthopaedic Trauma Association Classification

#### Type A Simple fractures

- Spiral
- Oblique
- Transverse

#### Type B Wedge fractures


- Spiral wedge
- Intact bending wedge
- Comminuted wedge

#### Type C Complex

- Spiral complex
- Segmental complex




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Medical Imaging for the extremities 


## Unit 3

### Ankle & foot



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Ankle/Foot 

### Ankle Views

- AP
- Lateral
- Mortice

### Foot Views

- AP
- Lateral
- Oblique



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## Ankle AP



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## What does the ankle AP view show us?



1. Fibula
2. Tibia
3. Lateral maleolus
4. Medial maleolus
5. Talar dome
6. Navicular



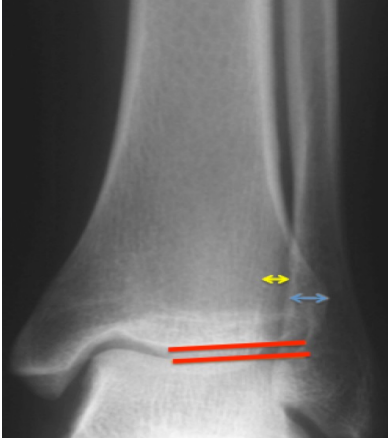
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## Evaluating an AP View

- Tibio-fibular overlap  $\leftrightarrow$  ~ 10 mm
- Tibio-fibular clearance  $\leftrightarrow$  < 5mm
- Talar tilt – none  $\equiv$

Relationship measurements are changed in fracture or instability



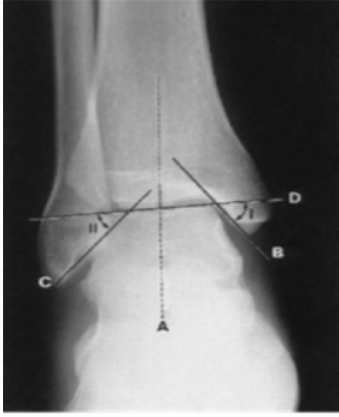
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## Measurements in AP

- Line A is through midline of tibial shaft
- Line B is tangential to medial maleolus articular surface
- Line C is tangential to lateral maleolus articular surface
- Line D is tangential to talar dome articular surface

Angles	Mean	Min	Max
Tibial (I)	53	45	65
	52	43	63

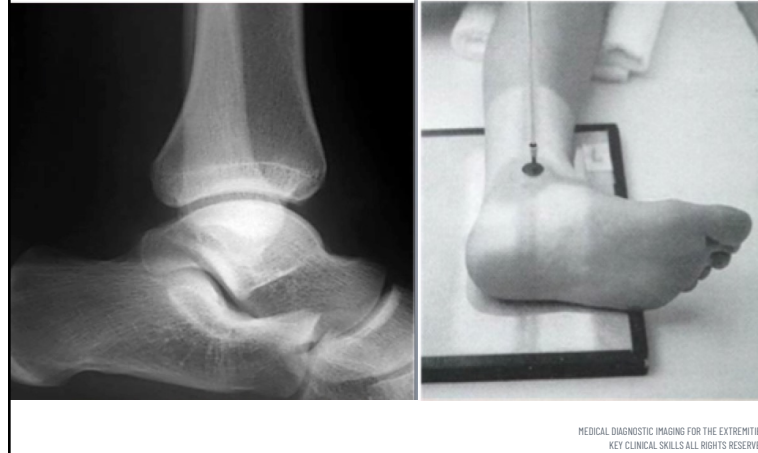


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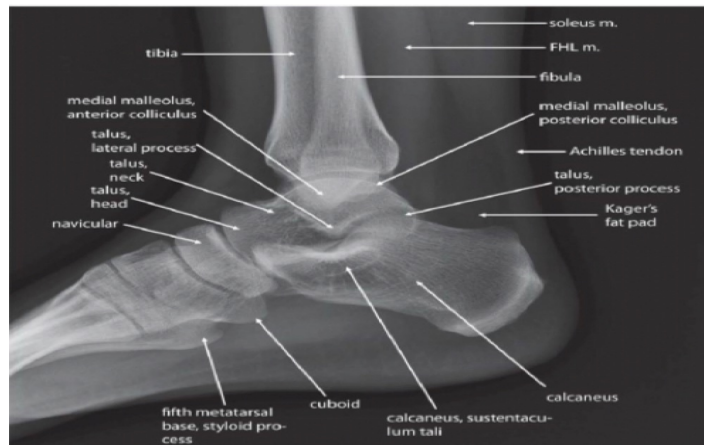
# Ankle Lateral view



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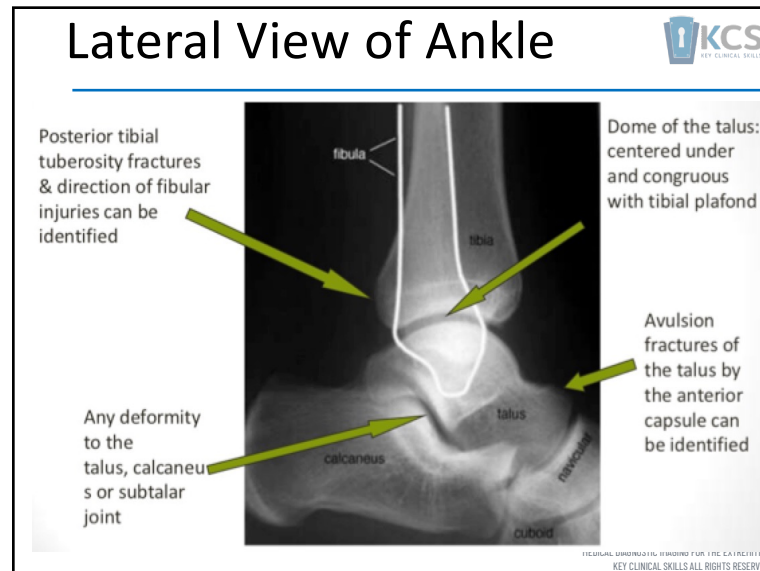
105

# What does a lateral ankle view show us?

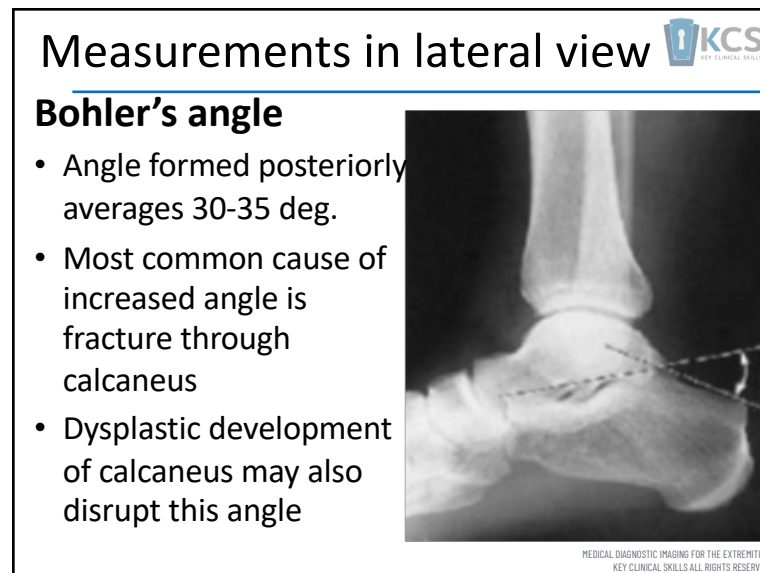


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## Measurements in lateral view

### Heel-Pad thickness

- Shortest distance between plantar surface of calcaneus and skin
- Increased thickness may indicate acromegaly or inflammatory arthritis



### Achilles tendon thickness

- Can be assessed at 1-2 cm above calcaneus
- Normally 4-8 mm

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## Ankle Mortise View



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## Ankle Mortice View



- This is an important view in the assessment of the post-traumatic ankle
- Can detect subtle fractures of the distal fibula, talar dome and base of the 5<sup>th</sup> metatarsal



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## Measurements in Mortice view



### Medial clear space

- Between lateral border of medial maleolus and medial talus
- < 4mm normal
- > 4mm suggests lateral shift of talus



### Tibio-filular overlap

- Normally > 1 mm



### Talar tilt

- Angle formed between distal tibia and talus
- Both line should be parallel (+/- 1.5 deg.)

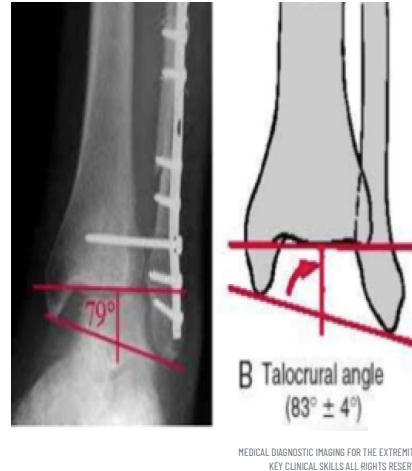
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## Measurements in Mortise view

### Talo-crural angle

- Normally 75- 87 deg.
- Should be = or 2- 5 deg. of contralateral
- Greater differences imply fibular shortening post- fracture



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## AP vs Mortise views measurements

### AP view

Syndesmotic disruption indicated by:

- Tibial clear space > 5mm
- Tibio-Fibular overlap < 10 mm

### Mortise view

Syndesmotic disruption indicated by:

- Tibio-Fibular overlap < 1 mm



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## Special lateral views

**Flexion-extension (dancer's) view**


- With or without weight bearing with foot in max. plantar and dorsi-flexion
- Bony impaction anteriorly and posteriorly sign of impingement syndrome

**Lunge view (A)**

- Weight bearing in dorsi-flexion
- Demonstrates degree of impaction of anterior tibial margin with neck of talus

**Lazy lateral (B)**

- Posterior tibial margin ("third malleolus" frequent site of fracture)
- Best demonstrated in plantar-flexion and external rotation
- Posterior impingement syndrome can be shown to advantage at the posterior talus and os trigonum




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## Stress test views


- **Talar tilt view**
  - Degree of lateral opening
  - Normal < 5 deg.
  - Abnormal > 10 deg.
- **Standing talar tilt view**
  - More sensitive
  - Foot placed in 40 deg. plantar-flexion and 50 deg. inversion
- **External rotation stress view**
  - Evaluates inferior tib-fib integrity
- **Anterior drawer view**
  - > 10 mm indicates instability



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## Advanced imaging




### CT

- Helps to delineate joint involvement
- Aids in pre-operative planning
- Evaluates hindfoot and midfoot if needed

### MRI


- Ligament injuries
- Tendon injuries
- Talar dome lesions
- Syndesmotic injuries



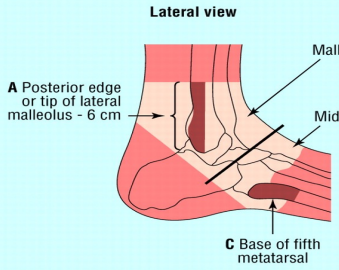
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## Ottawa ankle rules



**Lateral view**



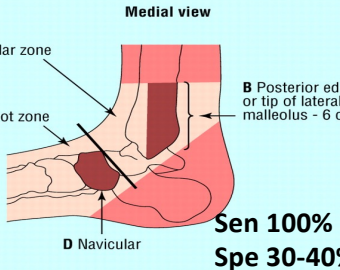
**A** Posterior edge or tip of lateral malleolus - 6 cm

**B** Posterior edge or tip of lateral malleolus - 6 cm

**C** Base of fifth metatarsal

**D** Navicular

**Medial view**



**A** Posterior edge or tip of lateral malleolus - 6 cm

**B** Posterior edge or tip of lateral malleolus - 6 cm

**C** Base of fifth metatarsal

**D** Navicular

Sen 100%  
Spe 30-40%

A series of ankle x ray films is required only if there is any pain in malleolar zone and any of these findings:

- Bone tenderness at **A**
- Bone tenderness at **B**
- Inability to bear weight both immediately and in emergency department

A series of ankle x ray films is required only if there is any pain in mid-foot zone and any of these findings:

- Bone tenderness at **C**
- Bone tenderness at **D**
- Inability to bear weight both immediately and in emergency department

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## Ankle fractures



- Most common weight-bearing skeletal injury
- Incidence has doubled since 1960's
- Highest incidence in elderly women
  - Uni-maleolar 68%
  - Bi-maleolar 25%
  - Tri-maleolar 7%
  - Open 2%
- Medial malleolar fracture
- Lateral malleolar fracture
- Bimalleolar fracture
- Pilon fracture
- Pott's fracture
- Maisonneuve's fracture
- Dupuyten's fracture
- Tillaux fracture
- Toddlers fracture

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## Ankle fracture classification



### Danis-Webber Classification

- **A-** below tibio-fibular joint
- **B-** at level of tibio-fibular joint
- **C-** above tibio-talar joint
  - Syndesmotic compromise

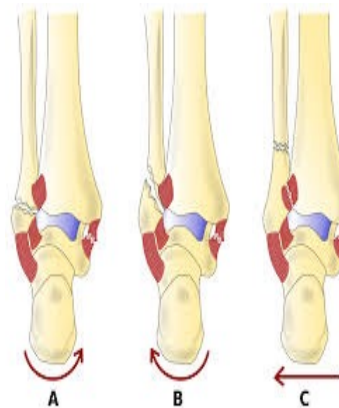
Alternative Classification systems

### Potts

- Unimaleolar
- Bimalleolar
- Trimaleolar

### OTA

- Academic purposes




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## Ankle fractures



### Danis- Webber

**Type A**



- Treat conservatively

**Type B**

- May require ORIF

**Type C**


- Surgical stabilization

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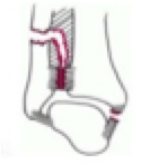

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## Ankle fractures





### Pott's Fracture

- Partial dislocation of ankle
- Fracture of fibula within 6-7 cm above lateral malleolus
- Rupture of distal tibio-fibular ligament

### Pilon (Tibial plafond)


- Fracture of distal tibial metaphysis
- Often comminuted
- Position of foot determines type of injury

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## Ankle fractures






### Maisonneuve fracture

- Forced inversion & external rotation
- Distal tibia
- Prox fibula
- Syndesmosis
- Lateral ligament complex

### Dupuytren's fracture


- Distal fibula (lat maleolus)
- Rupture of distal tibio-fibular ligaments
- Diastasis of syndesmosis
- Lateral dislocation of talus

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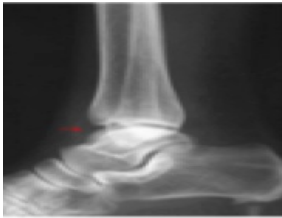
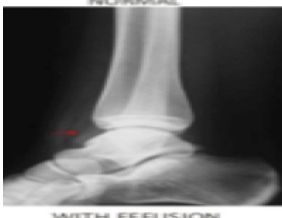
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## Ankle region soft tissues



### Teardrop sign

- An ankle effusion suggests significant injury to the ankle joint
- The anterior extra-capsular region should appear as fat-like density
- Intra-articular effusion distends the capsule
- Further investigation recommended

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## Soft tissue swelling over lateral malleolus



NORMAL

MILD

MODERATE

SEVERE

- Soft tissue swelling over lateral malleolus can be simple post ligament sprain edema
- Lack of swelling significantly reduces possibility of fracture but not as sensitive as Ottawa Rule

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## Ankle sprain imaging

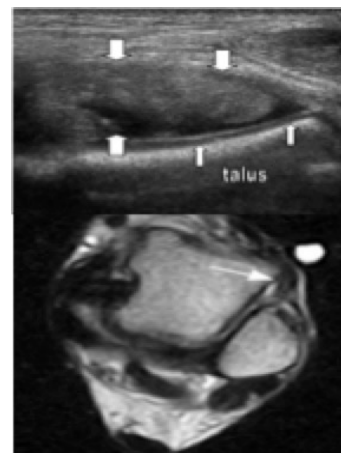


### Ultrasound

- Performed in slight plantar-flexion (stretch ATFL)
- Discontinuity of ligament
- Hypoechogenicity of ligament

### MRI

- Axial T2 weighted image used to show ATFL



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## Ankle osteoarthritis



- Trauma is most common predisposing factor
- Classic signs:
  - Joint space narrowing
  - Marginal osteophytes
  - Intra-articular body formation
  - Subchondral bone cysts
  - Sub-chondral sclerosis
- OA also common in mid-foot



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## Septic arthritis / Osteomyelitis



### Septic arthritis

- May occur secondary to local or distant source of infection
- Imaging shows joint effusion with loss of sharp cortical margins of sub-articular bone
- Joint space loss is rapid & marginal erosions may develop mimicking inflammatory joint disease

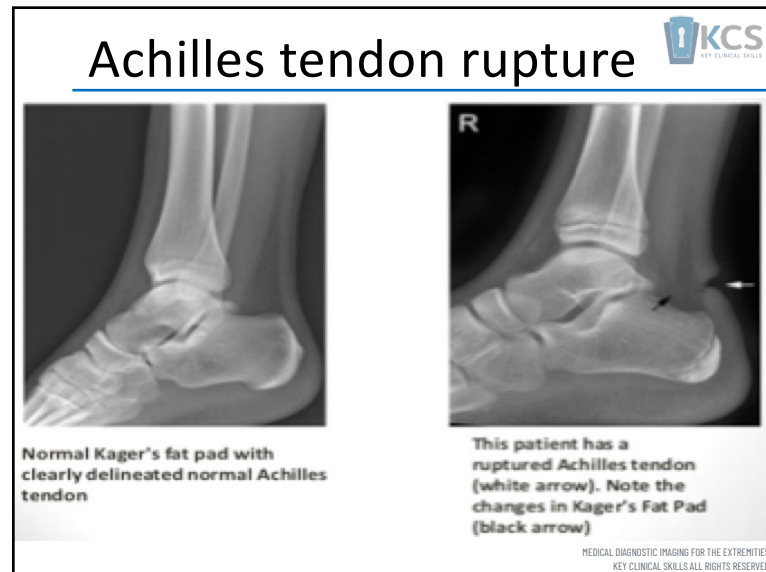


### Osteomyelitis

- Seen in susceptible populations (diabetics, bed-ridden)

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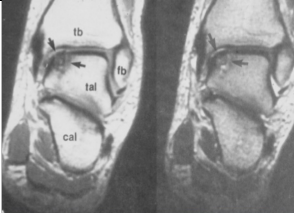
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## Advanced imaging

- Achilles injuries
  - MRI
  - Ultrasound
- Peroneal tendon injuries
  - MRI
  - Ultrasound
- Osteochondritis dissecans of talus
  - MRI
  - CT

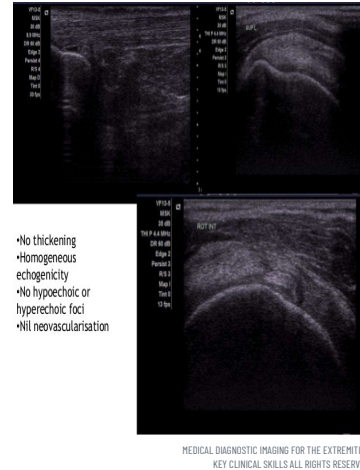
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## Ultrasonography



- Readily demonstrates tendons and peritendinous pathologies
- Dynamic examination during movement
- Synovial pathologies can be evaluated
- Small amounts of fluid normal



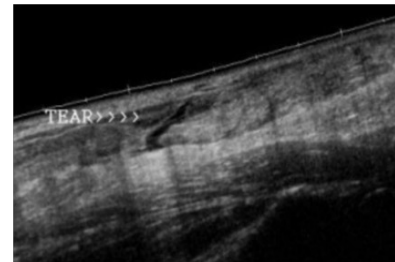
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## Ultrasonography



### Tendon tears

- Discontinuity of fibers (partial or complete)
- Focal thinning of tendon
- Hematoma of variable size
- Bone fragment (in case of avulsion)
- Non-visualization of the retracted tendon in cases of complete tears



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## MRI



### Partial tendon tears

- **T1 weighted image**
  - Partial rupture seen
- **T2 weighted image**
  - Seen as area within substance of tendon having a signal intensity similar to advanced tendinosis



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## MRI



### Complete tendon tears

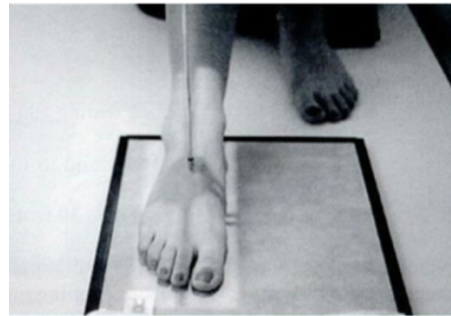
- Manifests as discontinuity with fraying and retraction
- In acute rupture tendon gap shows as intermediate signal on T1 and high signal on T2
- In chronic ruptures scar or fat may replace the tendon



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## Foot AP View



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## What does a foot AP view show us?



1. Medial maleolus
2. Lateral maleolus
3. Talar head
4. Calcaneus
5. Navicular
6. Cuboid
7. Medial cuneiform
8. Middle cuneiform
9. Lateral cuneiform
10. Tuberosity of 5th MT
11. MT base
12. MT shaft
13. MT head
14. Phalanges

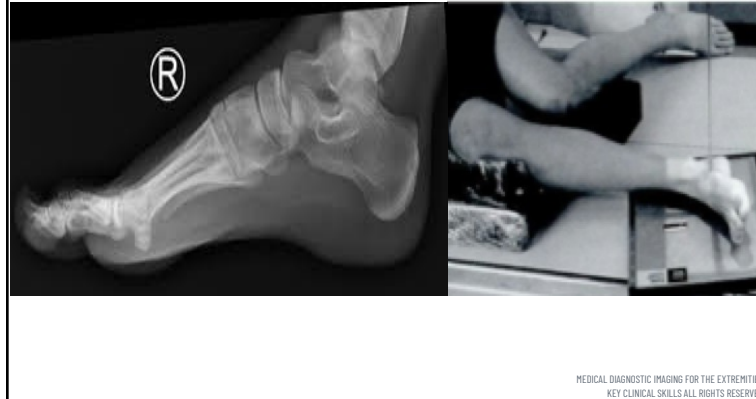


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## Lateral foot view



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## What does a foot lateral view show us?




1. Talus
2. Calcaneus
3. Navicular
4. Sustentaculum tali
5. Cuboid
6. Medial cuneiform
7. 5<sup>th</sup> MT tuberosity
8. Metatarsals
9. Sesamoids
10. Phalanges



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## Foot Oblique View




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## What does a foot oblique view show us?



PP = proximal phalanx  
MP = middle phalanx  
DP = distal phalanx  
MT = metatarsal  
cun = cuneiform

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## Fractures of the foot



### Stress fracture

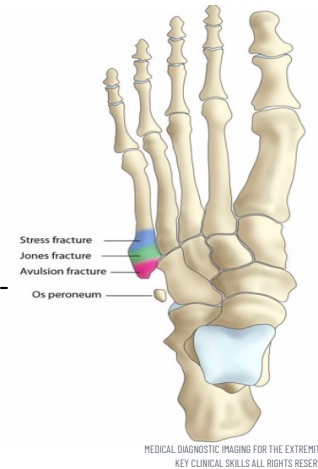
- Repetitive micro trauma
  - Runners
  - Dancers
  - New soldiers

### Jones fracture

- Laterally directed force on forefoot with ankle in plantar-flexion

### Avulsion fractures

- Forced inversion in plantar flexion



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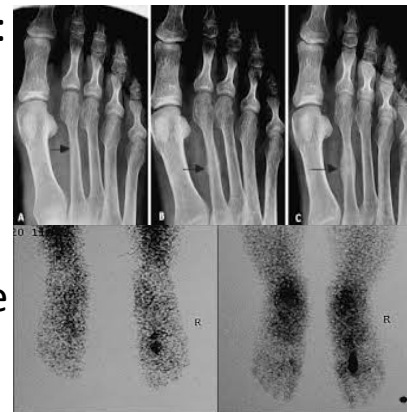
## March fracture



Stress fracture of:

- New soldiers
- Runners
- Dancers

May require bone scan to be seen



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## Lisfranc fracture



- Fracture dislocation between tarsal bones and metatarsals
- Usually a compression force through long axis of foot



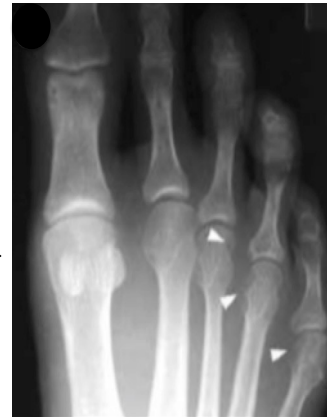
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## Rheumatoid arthritis



- Predilection for MTP joints (especially the 5<sup>th</sup>)
- Periarticular osteopenia variably present
- Inter-tarsal, subtalar and ankle joints may be involved
- Joint destruction leads to subluxation and dislocation
- Chronic inflammatory tenosynovitis can lead to tendon tears (posterior tibial tendon commonest)



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## Gout



### Seen as:

- Bony erosion (“punched out”)
- Soft tissue swelling
- Trophi
- Sclerosis and joint space narrowing



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## Halux rigidus / Halux valgus



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## Congenital variants



- Os peroneum
- Os subfibulare
- Os tibiale externum
- Ost trigonum
- Os calcaneus secundaris
- Os intermetatarsale
- Os supratalare
- Os supranaviculare
- Bipartite hallux sesamoid



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## Tarsal coalitions

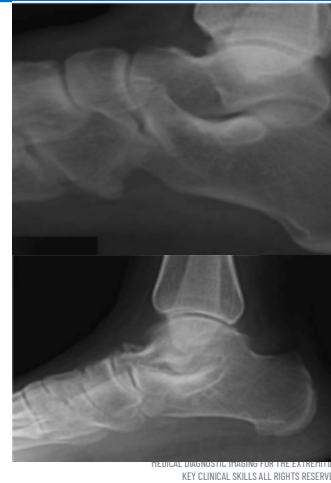


Calcaneo-navicular  
45%

Talo-calcaneal 45%

Remainder

- Calcaneo-cuboid
- Talo-navicular
- Cubo-navicular



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## Congenital abnormalities

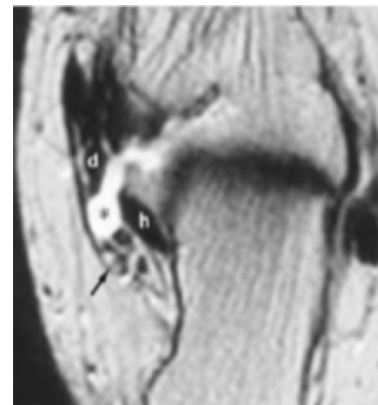
- Pes Cavus
- Talipes equinovarus (“club foot”)



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## Tarsal tunnel syndrome

- Compression of posterior tibial nerve
- Pain and paresthesia of foot and toes
- Intrinsic and/or extrinsic causes



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## Morton's Neuroma



### Ultrasound

- Visible on ultrasound as inter-digital mass

### MRI

- MRI highly accurate
- Seen as bumbell-shaped mass having intermediate signal intensity on both T1 and T2



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## Medical Imaging for the extremities



### Unit 4

### Shoulder 1



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## Shoulder and Humerus Evaluation

### X-ray studies include:

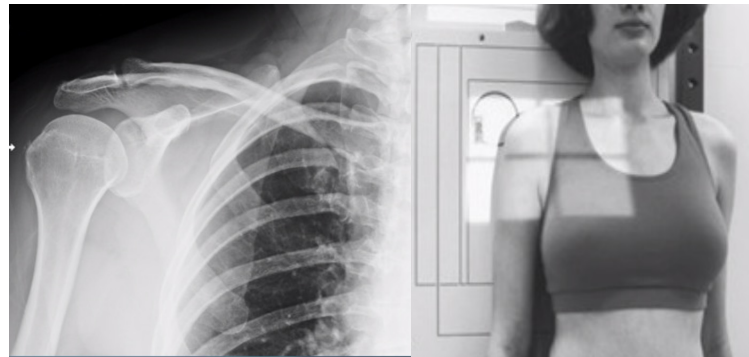
- AP with internal rotation
- AP with external rotation
- True AP vs AP
- Y-view
- Axillary view
- Specialty shoulder views
- AC joint views



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## AP Routine View



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## AP Routine View



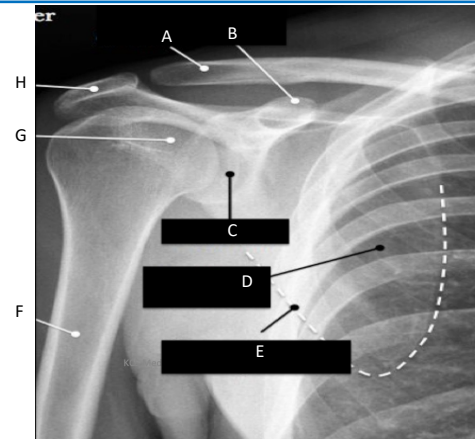
- AP relative to the thorax
- Sub-optimal view of the gleno-humeral joint
- Good view of AC joint



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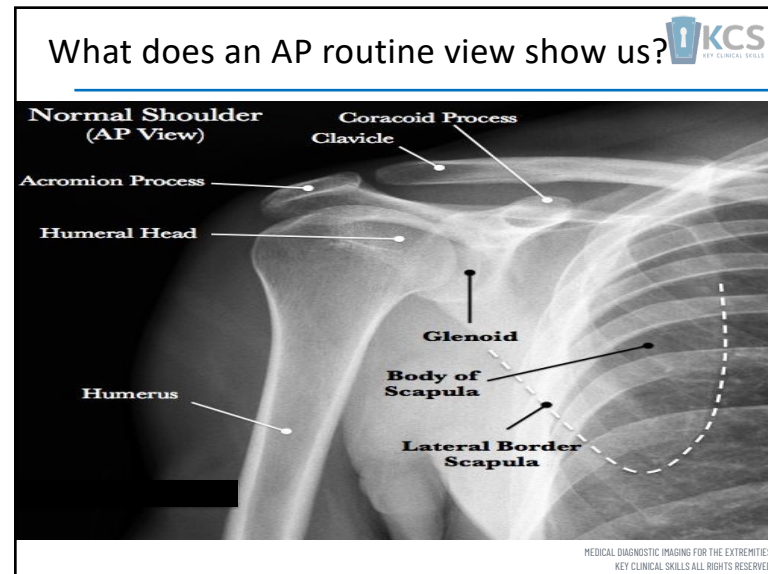
155

## What does an AP routine view show us?

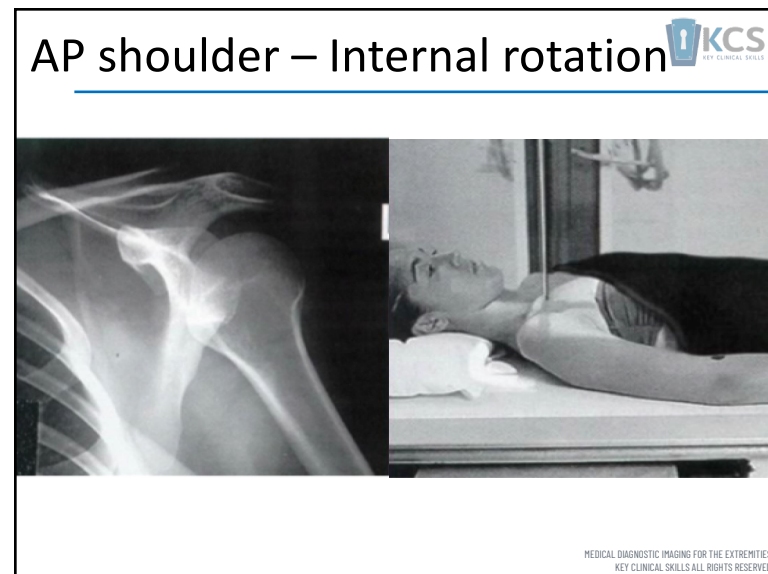


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## What does an internal rotation view show us?

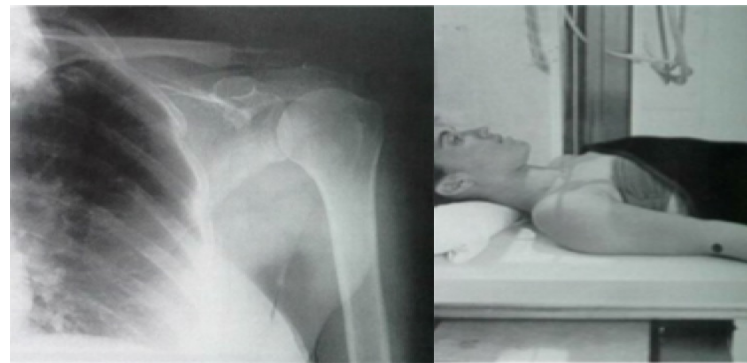
1. Clavicle
2. Acromion
3. Humeral head
4. Greater tubercle
5. Lesser tubercle
6. Glenoid fossa
7. Coracoid process
8. Scapula



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## AP shoulder External Rotation

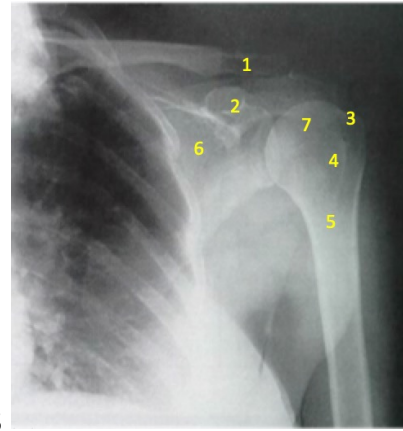


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What does an external rotation view show us? 

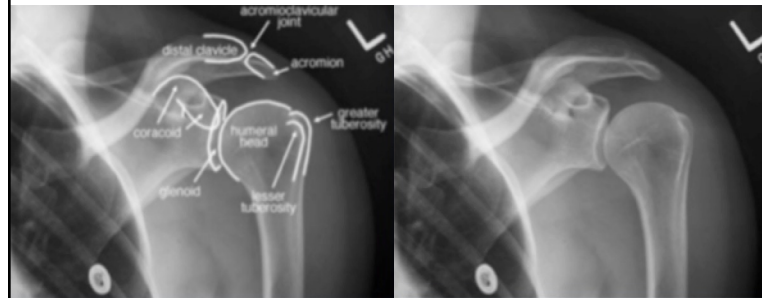
1. Acromion
2. Coracoid process
3. Greater tubercle
4. Lesser tubercle
5. Proximal humerus
6. Scapula
7. Head of humerus



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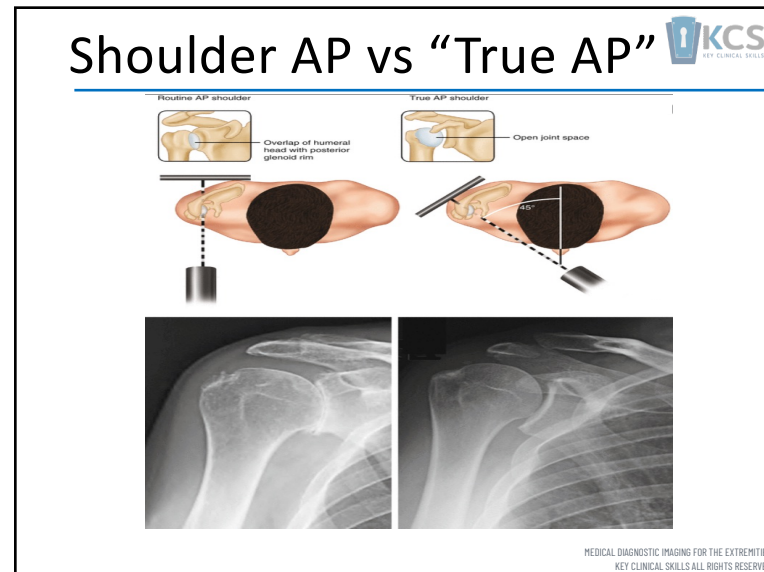
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AP shoulder External rotation 

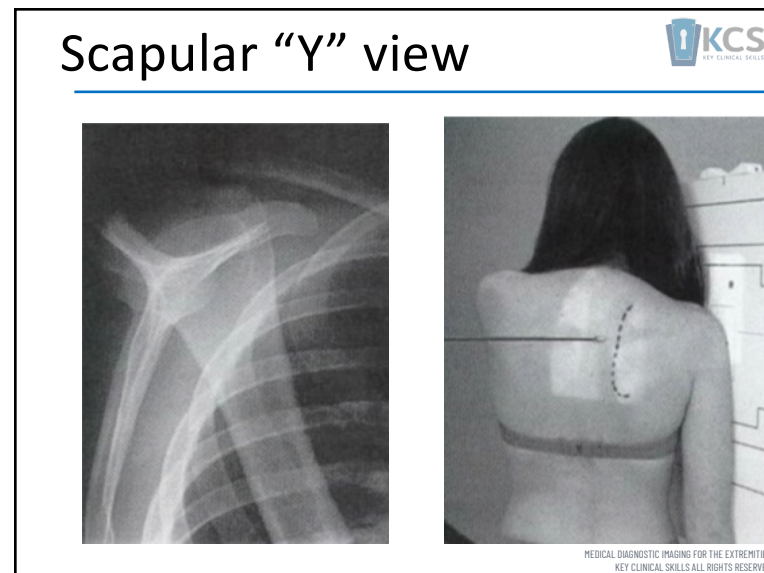


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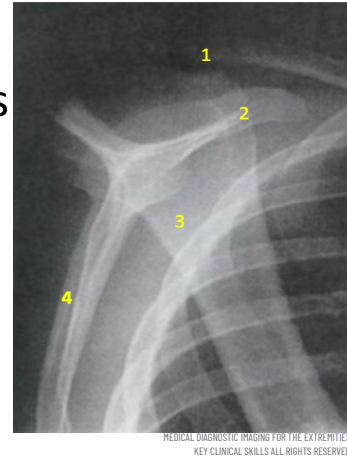
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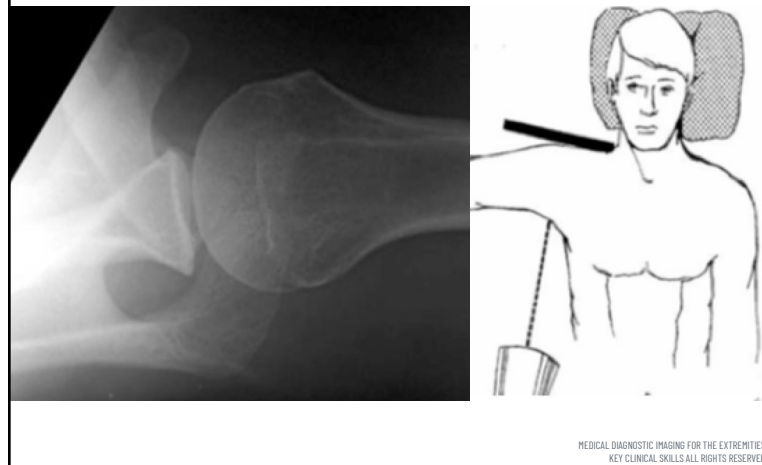
What does an scapular Y view show us? 

1. Clavicle
2. Coracoid process
3. Humerus
4. Plane of scapula



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Axillary view 

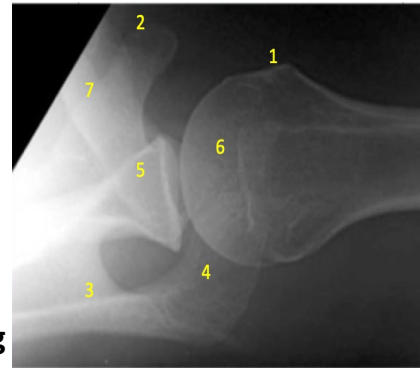


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## What does an axillary view show us?

1. Greater tubercle
2. Coracoid process
3. Spine of scapula
4. Acromion
5. Glenoid
6. Head of humerus
7. Clavicle

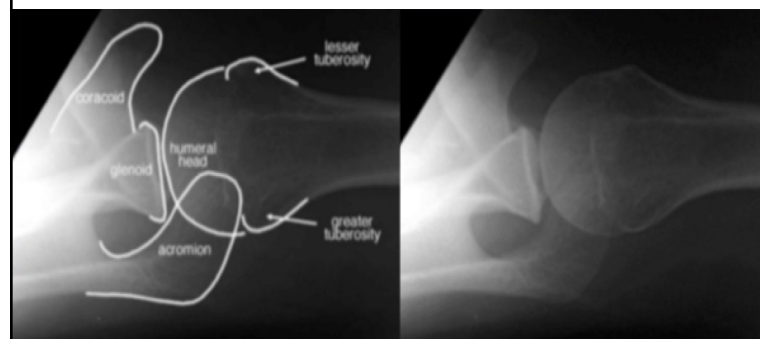
**Best view for showing direction of dislocation**



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## Axillary view

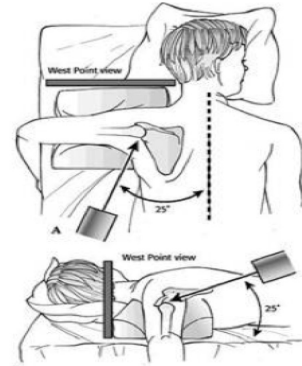


MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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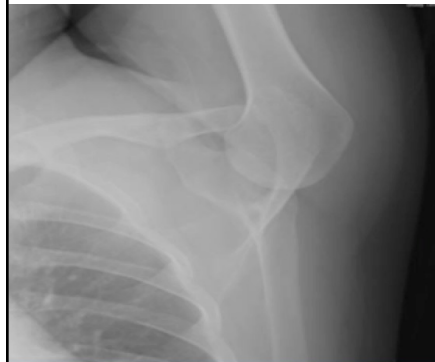
## West Point view



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## Stryker Notch View



Evaluates postero-lateral humeral head  
Demonstrates Hills Sachs lesion

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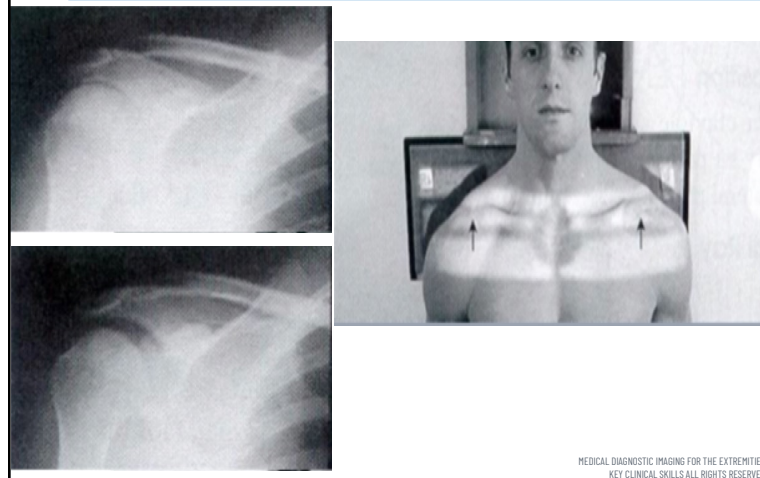
## Acromio-clavicular joint



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## AC with and without weights

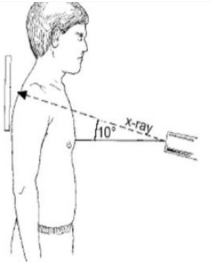
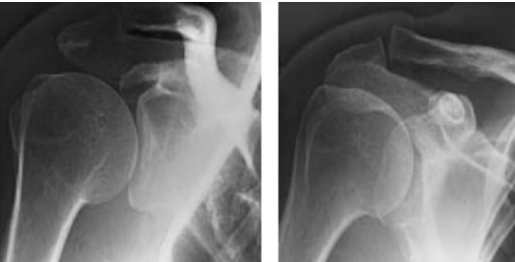


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## AC Zanca View







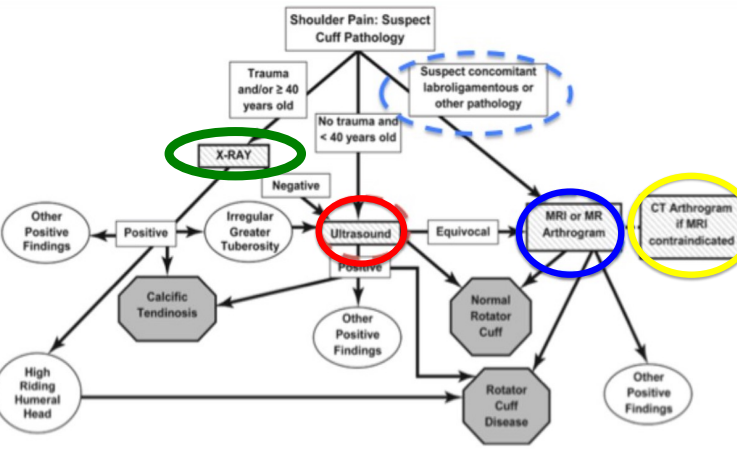
10-15 degree upwards tilt  
Best to evaluate joint displacement and intra-articular fractures

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## Rotator cuff algorithm





Nazarian 2013

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## Shoulder Ultrasound



- 90% sensitive and specific for RT tears
  - Comparable to MRI for full thickness tears
  - Operator dependent (good and bad)
- Utility**
- Biceps brachii
  - Subscapularis
  - Supraspinatus
  - Infraspinatus
  - AC joint
  - Dynamic impingement

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## Biceps brachii



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# Subscapularis



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# Supraspinatus



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## Infraspinatus



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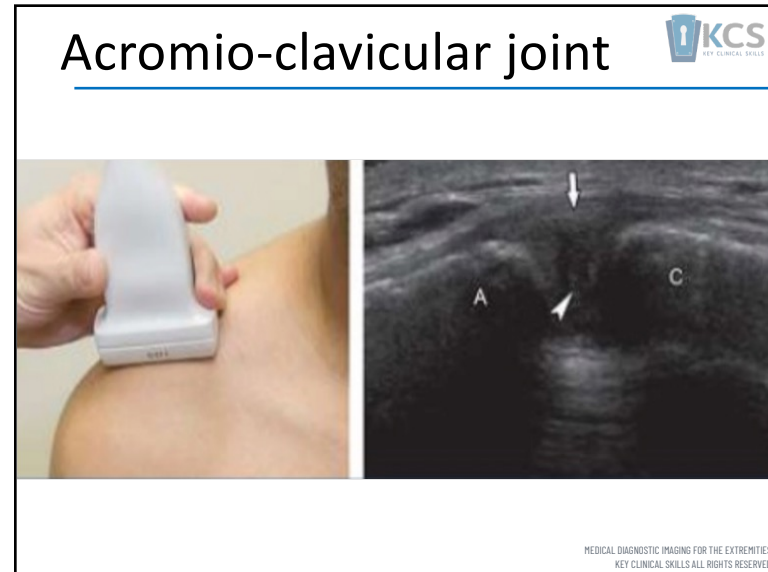
179

## Teres Minor, Posterior labrum

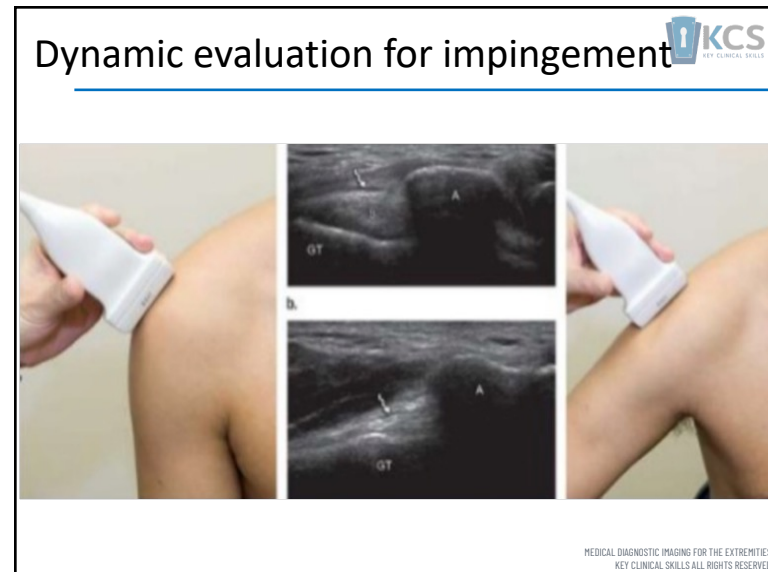


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## CT scan



- Superior to plain radiographs for:
  - Complex fractures
  - Fracture dislocations
- Facilitates treatment planning for complex fractures of proximal humerus, fracture dislocations

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## MRI



- Highly accurate for diagnosis of rotator cuff pathology
- Indicated when further investigation of rotator cuff pathology is indicated (i.e. surgical repair)

### Advantages:

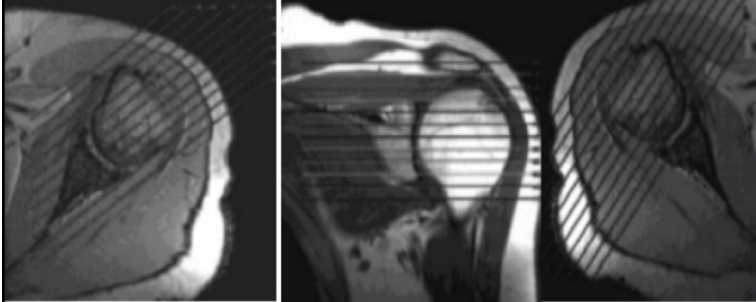
- No ionizing radiation
- Non-invasive
- Multi-planar investigation
- Demonstrates other pathologies (i.e. ACJ, AVN)
- Comprehensive display of soft tissue anatomy
- Characterization and staging tumors

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## MRI technique

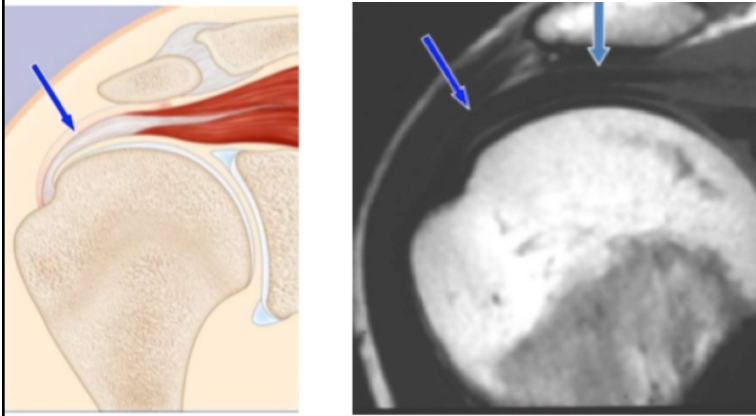


Oblique Coronal      Oblique Sagittal      Axial

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## Oblique coronal view

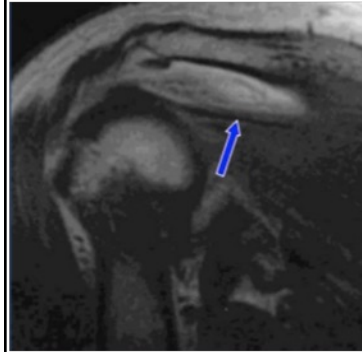


Demonstrates supraspinatus tendon and musculotendinous jnt at 12 O'clock position

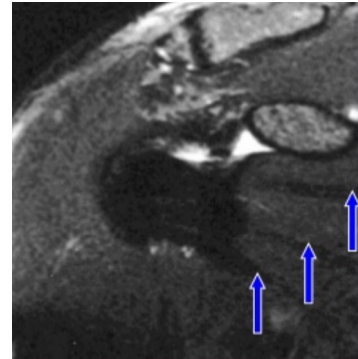
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## Oblique coronal view



Infraspinatus (located posteriorly, slopes upwards)

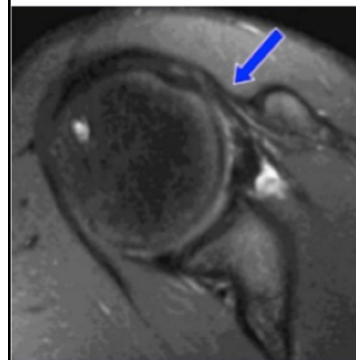


Subscapularis (located anteriorly, multi-slip tendon)

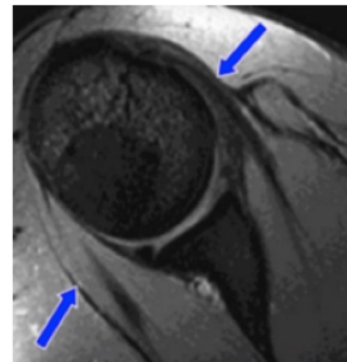
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## Axial view



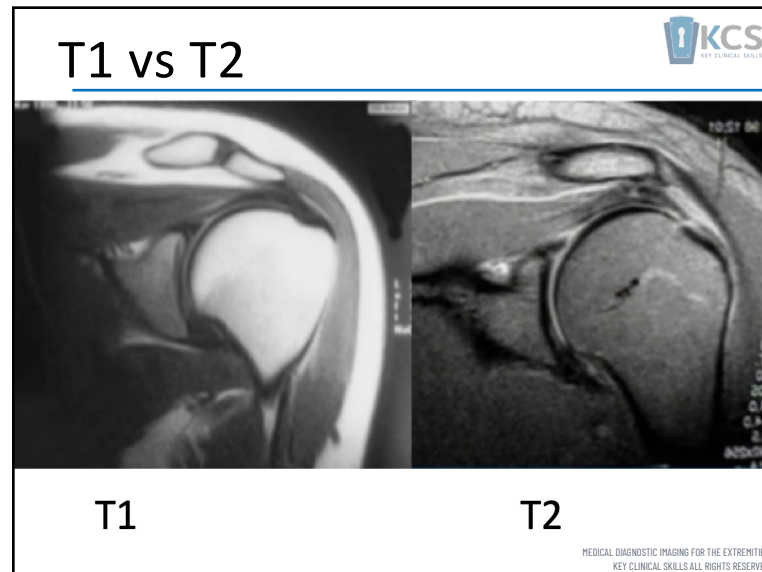
Subscapularis



Infraspinatus

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## Arthrogram

- Performed under standard X ray or fluoroscopy
- In fluoro, scout images performed prior to then repeated post injection
- Radiopaque dye
  - Omnipaque for CT and fluoro
  - Gadolinium for MRI

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## CT arthrogram



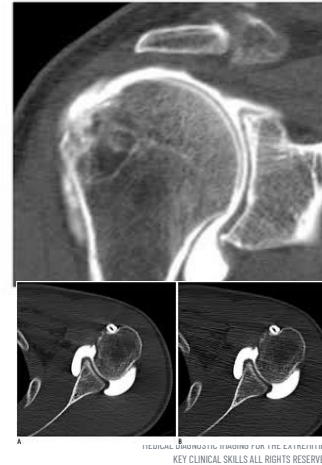
Alternative for assessing gleno-humeral instability when MRI contraindicated or unavailable

### Advantages

- Allows accurate evaluation of capsule and labrum

### Disadvantages

- Radiation
- Invasive



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## MR arthrogram



Gadolinium contrast

### Advantages


- Most accurate and first line imaging modality for defining:
  - Rotator cuff pathology
  - Labral / capsular abnormalities in gleno-humeral instability
  - Superior depiction of partial thickness tears compared to standard MRI

### Disadvantages:

- Expensive
- Invasive

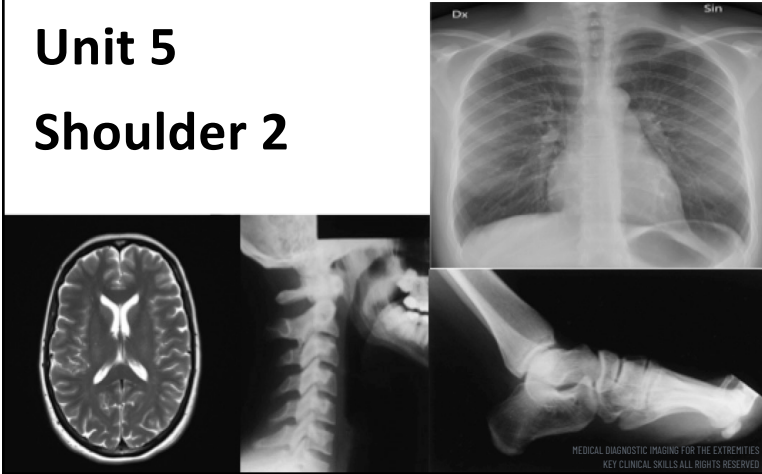


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Medical Imaging for the extremities 


## Unit 5

### Shoulder 2




MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
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Shoulder pathologies 

- Trauma
- Arthritis
- Tumors
- Adhesive capsulitis
- Labral injuries
- Impingement syndrome
- Rotator cuff tears



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## Fractures



### Shoulder region common fractures

- Clavicle
- Humeral
- Glenoid
- Scapular



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## Clavicle fractures



- Most common in children and heal well
- In adults fracture force greater, healing occurs slower and complication risk higher
  - 80% middle 1/3 “class A”
  - 15% in distal 1/3 “class B”
    - **Type 1** non-displaced
    - **Type 2** displaced (coracoid lig. ruptures allowing prox. segment to displace upward)
    - **Type 3** AC joint involved)
  - 5% in medial 1/3 “class C”



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## Scapular fractures



### Body or spine fractures (40-75%)

- Usually result from a direct blow (i.e. fall onto back or MVC)

### Acromion fractures (8-16%)

- Typically result from a downward blow to the shoulder
- Superiorly displaced fractures may be result of superior dislocation of the shoulder

### Neck fractures (5-32%)

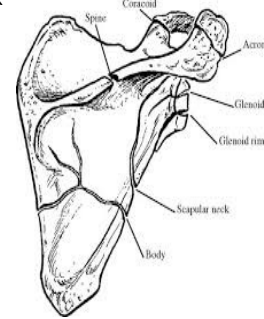
- Typically result from direct anterior or posterior blow to the shoulder

### Glenoid fractures (10-25%)

- Typically from a fall onto a flexed elbow
- Stellate fracture may be from a direct lateral blow to the shoulder

### Coracoid fractures (3-13%)

- Typically from:
  - Blow to superior shoulder
  - Avulsion fractures
  - Anterior dislocations



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## Humerus fractures



- Account for 4-5% of all fractures
- Typical mechanism of injury:
  - Direct blow to upper arm
  - Axial loading up from lower arm (FOOSH)
- Attachments of pectoralis major, deltoid and rotator cuff muscles influence the amount of displacement

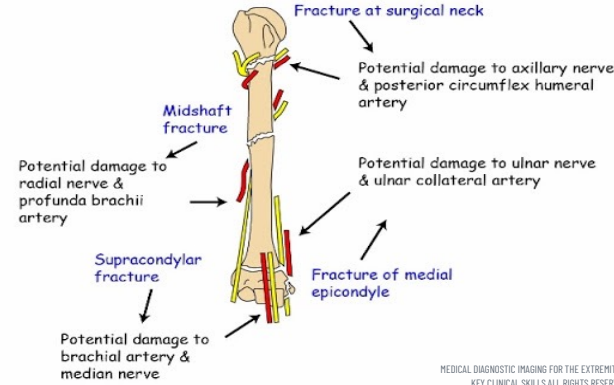


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## Vascular and neurological considerations

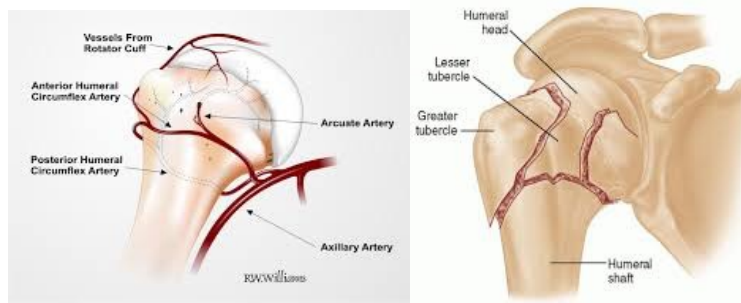
**ARTERIES AND NERVES LIABLE TO DAMAGE AT 4 SITES OF FRACTURE OF THE HUMERUS**



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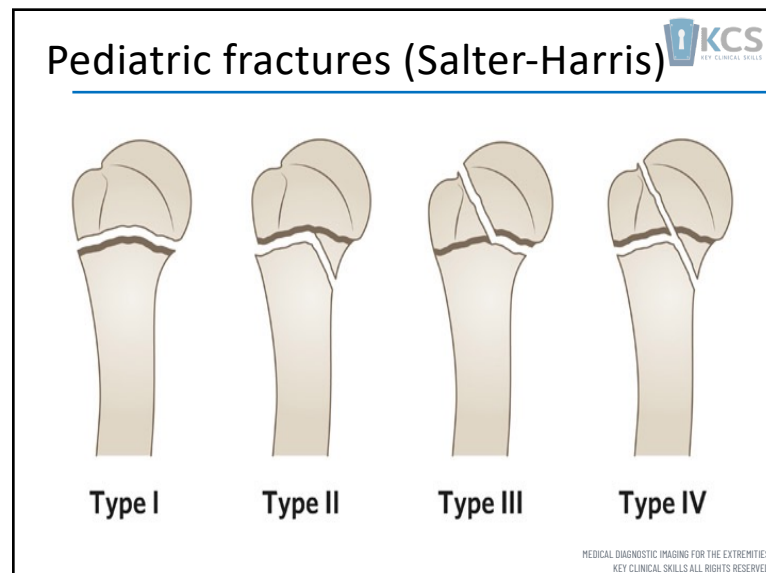
## Humeral head fractures



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## Dislocated shoulder

- 95% dislocations are with the humeral head dislocated anteriorly from the glenoid
- Medial aspect of the humeral head is inferior and medial to the glenoid
- 4% dislocations posterior
- 1% dislocations inferior



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What direction has the humerus dislocated? 

---


Standard AP

R



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203

What direction has the humerus dislocated? 

---

Standard AP                      Y view

R



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## Dislocated shoulder



### Clinical presentation

- Squared off shoulder
- Patient resists abduction and internal rotation
- Humeral head palpable anteriorly
- (Must test axillary nerve function/sensation)
- **Y view demonstrates humeral head location from central position**



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## Quebec decision rule for radiography in shoulder dislocation



### Quebec Decision rule

Radiographs needed for:

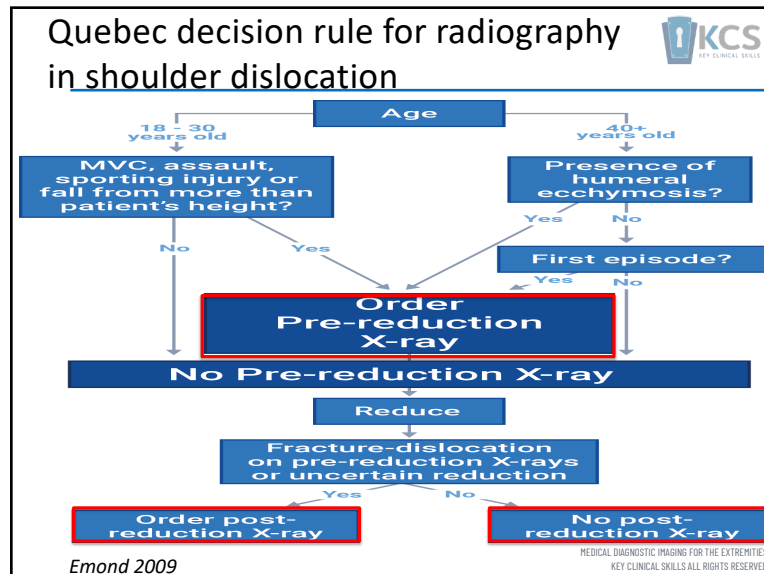
- Age > 40 and humeral ecchymosis
- Age > 40 and 1<sup>st</sup> dislocation
- Age < 40 and mechanism other than fall from standing height or lower



*Emond 2009*

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### Hills Sachs lesion

- Defect in the posterior superior humeral head
- May be chondral or osteochondral
- Indentation from where humeral head was sitting on anterior rim of glenoid
- Often associated with Bankart and labral injuries

ENGAGING HILL-SACHS IN EXTERNAL ROTATION

DISPLACED BANKART LESION

ANTERIOR GLENOID RIM

POSTERIOR GLENOID RIM

HILL-SACHS

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## Hills Sachs lesion



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## Bankart lesion



Fracture of the  
posterior glenoid rim  
+/- labral injury

**Reverse Bankart**

Anterior dislocations  
fracture anterior  
glenoid rim



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## Bankart lesion



### Radiographs

- Sub-glenoid, Subcoracoid dislocations
- Glenoid rim fractures

### CT Arthrography

- Contrast blending into labral tear

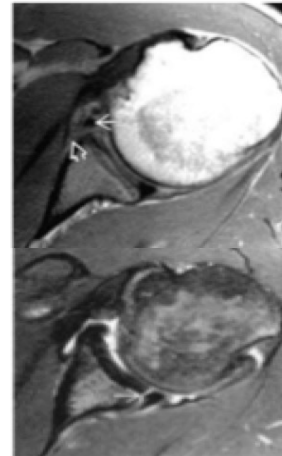
### MRI

#### T1

- Hypointense edema/sclerosis at antero/inferior glenoid
- Glenoid rim fracture

#### T2

- Hyper-intense fluid within or underlying labrum
- Fracture line at glenoid rim
- Fracture at posterior humeral head



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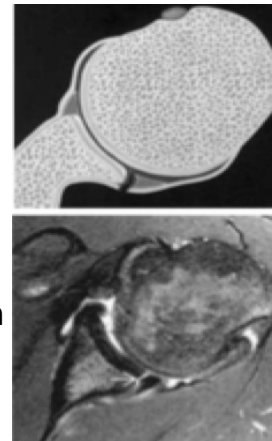
## Posterior labral tear



Secondary to posterior dislocation

### Radiography

- Reverse Bankart
- Posterior glenoid rim fracture
- “Trough sign” (Hill-Sachs on anterior humeral head)
- Lesser tuberosity avulsion fracture



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## Avacular necrosis



- Arc-like sub-chondral fracture “crescent sign”
- Articular collapse “step sign”
- Fragmentation
- Subchondral lytic sclerotic areas
- Subchondral cysts
- Deformed humeral head
- Secondary degenerative changes



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## Crues classification of AVN



Class	Description
1	Normal (can be seen on MR)
2	Sclerosis in superior central portion of the head
3	Crescent sign – caused by sub-chondral bone collapse, may have mild flattening
4	Significant collapse of humeral head articular surface



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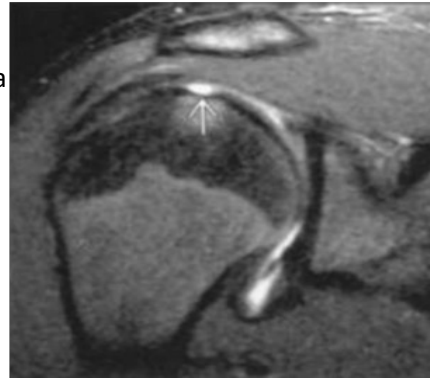
214

## Osteochondral injuries



### MRI

- T1
  - Subchondral edema and sclerosis
- T2
  - Increased signal in articular cartilage
  - Underlying bone edema



### Arthrography

- Fills the defect

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## Osteoarthritis



### Radiography

- Joint space narrowing
- Osteophytes
- Subchondral bone cysts
- Sclerosis

### MRI

- Subchondral cysts
- Osteophytes
- Thinning of articular cartilage
- Loose bodies
- Synovitis
- Increased retroversion of glenoid fossa (secondary to posterior wear)



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## Rheumatoid arthritis



- Marginal bone erosions
- Irregular shaped head
- Bilateral involvement
- Diffuse synovial thickening
- Joint effusion
- Superior migration of humeral head
- Clavicular erosions at ACJ
- Tapered and re-absorbed distal clavicle



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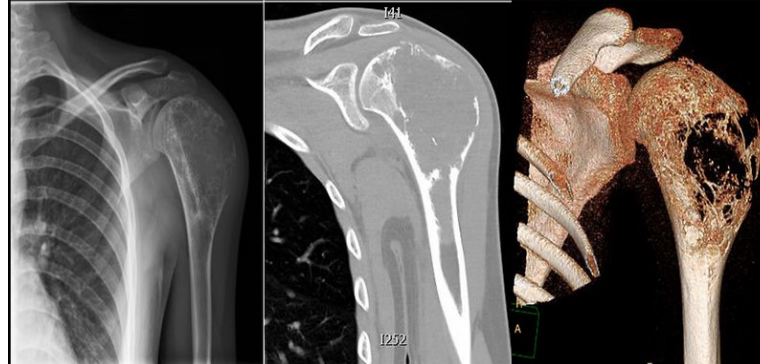
## Bone tumors



X-ray

CT scan

3D CT scan



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## Bone tumors

**Benign**

- Small sized
- No periosteal reaction
- Sharp zone of transition between bone and lesion
- Thin well-defined sclerotic margin

**Malignant**

- Any lesion without sclerotic margin should be considered malignant



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## Bone tumors

**Proximal humerus**

- Simple bone cyst
- Aneurismal bone cyst
- Giant cell tumor of bone
- Osteosarcoma (common)
- Enchondroma (relatively common)
- Periosteal chondroma
- Osteochondroma
- Chondroblastoma
- Chondromyxoid fibroma
- Metastases

**Scapula**

- Osteochondroma
- Chondrosarcoma



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## Periosteal reaction



- Thickening of periosteum (appears white on X-ray)
- Seen with:
  - normal healing fracture
  - osteomyelitis
  - benign and malignant tumors
- A radiating “sunburst” periosteal reaction is indicative of malignancy



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## Paget's Disease



### Osteitis deformans

- Excessive osteoclastic/blastic activity
- Commonly affects proximal end of long bones
- May lead to pathological fractures

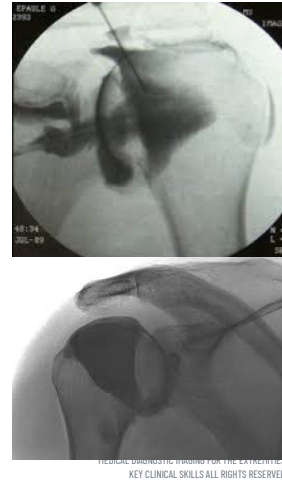


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## Adhesive Capsulitis Arthrogram

- Limited injectable fluid capacity
- Small dependent axillary fold
- Small subscapularis bursa
- Irregularity of the anterior capsule insertion at the anatomical neck
- Hydrodilatation arthrogram may be therapeutic



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## Adhesive Capsulitis MRI

### T1

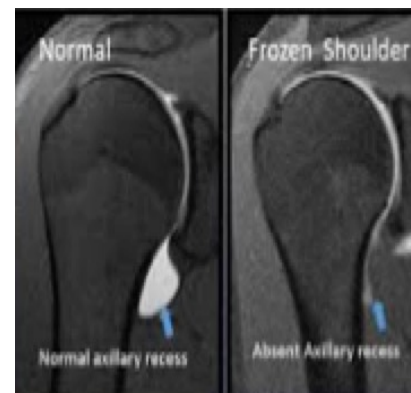
- Thickened indistinct capsular margins

### T2

- Thickened capsule (>3mm on coronal)
- Increased signal

### MR arthrography

- Capsule enhances diffusely
- Restricted capsule volume



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## Labral cysts



### MRI

#### T1

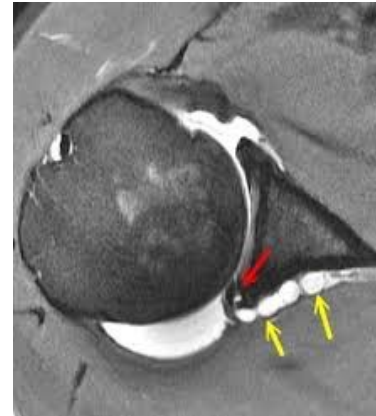
- Decreased signal intensity

#### T2

- Hyper intense signal
- Arising from or immediately adjacent to the labrum/capsule

### MRI Arthrography

- Cyst filled with contrast



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## SLAP lesions



### MRI findings

#### SLAP 1

- Moderate to hyper-intense labral degeneration

#### SLAP 2

- Lineal hyper-intense fluid signal between superior labrum and glenoid
- > 5 mm displacement of labrum

#### SLAP 3

- Fragmented (2 separate components)
- Bucket handle tear through the meniscoid superior labrum

#### SLAP 4

- Split of the biceps tendon with hyper-intense longitudinal tear



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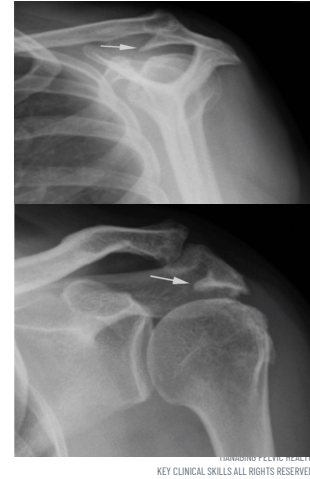
226

## Sub-acromial impingement

Physical impingement with repeated micro-trauma

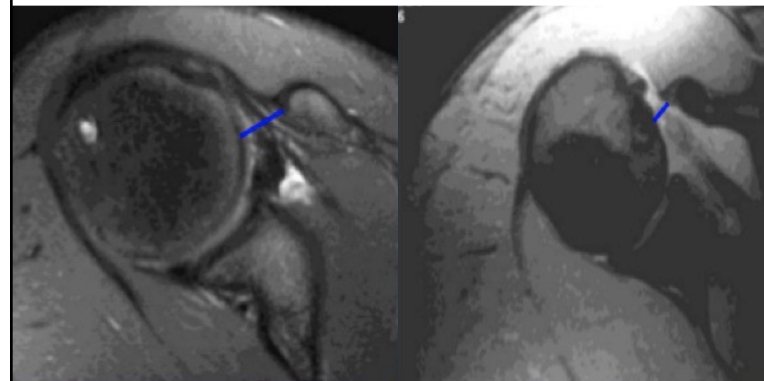
### Etiology

- Primarily extrinsic – sub-acromial spur
- Type 3 hooked acromion (disputed)
- Lateral down sloping anterior acromion
- Os acromiale
- Non-osseous abnormality of coraco-acromial arch



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## Coracoid impingement



Normal coraco-humeral Distance > 11 mm

Narrowed C-H distance can impinge subscapularis

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## Musculo-tendinous pathologies

- Biceps tendon dislocation
- Biceps tendon tendinosis
- Biceps tendon tears
- Rotator cuff pathology
- Calcific tendinitis



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## Biceps tendon dislocation

### Ultrasound

- Empty groove
- Displaced tendon hypoechoic and edematous



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## Biceps tendon dislocation MRI

### T1

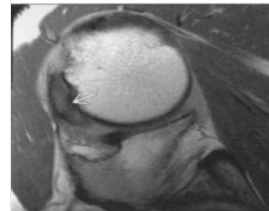
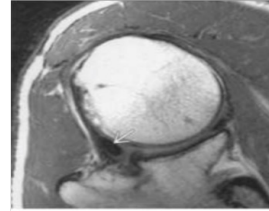
- Increased signal intensity
- Fat fills the groove

### T2

- Tendon not in groove
- Mostly displaced medially
- Flattened, thickened if previous tendinosis

### MR arthrography

- Empty groove
- Tendon sheath filled with contrast



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## Biceps tendinosis

### Radiography

- Sclerosis at superior aspect of groove

### Ultrasound

- Thickened hypoechoic tendon
- Visible tears
- Allows dynamic evaluation



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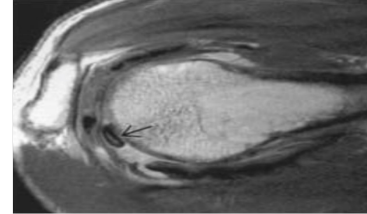


## Biceps tendinosis MRI



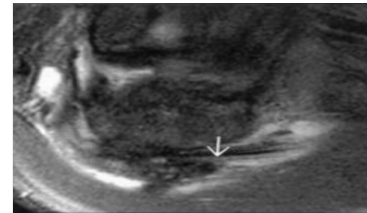
### T1

- Thickened intermediate signal intensity tendon



### T2

- Thickened (>5mm), irregular frayed tendon
- Increased signal



### MR arthrography

- Thickened filling defect (enlarged tendon)

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## Biceps tendon tear



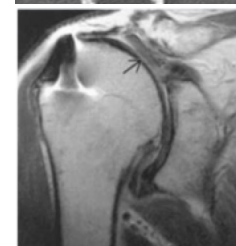
### CT Arthrography

- Bicipital groove filled with contrast



### MRI

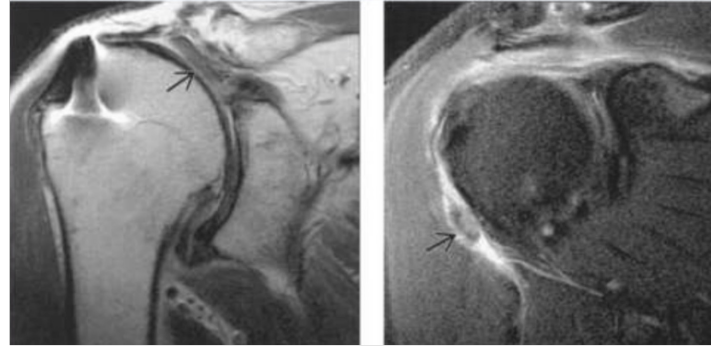
- Irregular stump at superior aspect of joint
- Partial or complete hyper-intense fluid gap in the tendon (T2)



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## Biceps tendon tear



Coronal MR shows distal stump (arrow) within the groove surrounded by edema

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## Rotator cuff tendinopathy

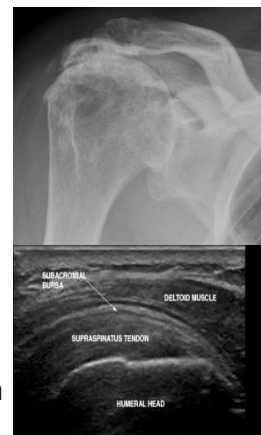


### Radiographic

- Acromion remodeling
- AC joint hypertrophy
- Humeral head subchondral sclerosis & cysts

### Ultrasound

- Thickened hypoechoic
- Visible tears
- Allows dynamic evaluation with pain correlation



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## Rotator cuff tendinopathy MRI

### T1

- Thickened heterogeneous tendons with intermediate signal intensity

### T2

- Low to intermediate signal

### MR arthrography

- No defect in tendon



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## Rotator cuff calcific tendinitis

### Radiography

- Calcific deposits
- Internal rotation view demonstrates posterior tendons well
- Axillary and Y views also helpful

### CT

- Better localization of calcium deposits
- Denser, granular well-demarcated calcium deposits



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## Partial tears RC



### Radiographic

- Acromial spurs
- Type 3 “hooked acromion”
- Humeral head arthritic changes at greater tuberosity
- AC joint degenerative changes
- Superior migration humeral head

### Ultrasound

- Decreased echogeneity and thinning of tendon
- Loss of convexity of tendon
- Calcific foci



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## Partial tears RC MRI



### T1

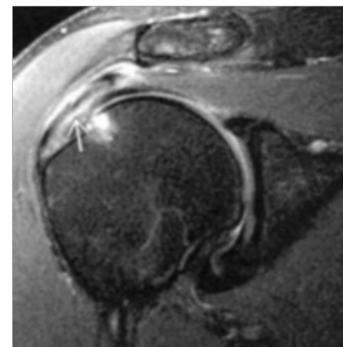
- Thickening of tendons
- Intermediate signal
- Calcifications

### T2

- Fluid signal intensity filling incomplete gap in tendon
- Fluid in sub-acromial bursa
- Retraction and degeneration of tendon edges

### MR Arthrography

- Contrast may fill the tear if in communication with joint



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## Full thickness tear RC



### Radiography

- Acromial spurs
- Type 3 “hooked acromion”
- Humeral head migration
- Humeral head arthritic changes
- AC degenerative changes

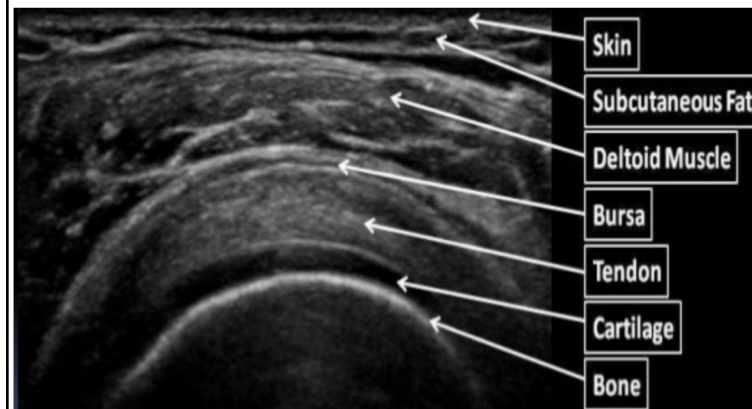
### Ultrasound

- Focal tendon disruption
- Fluid filled gap
- Loss of convexity of tendon
- Tendon retraction



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## Diagnostic Ultrasound



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## Diagnostic Ultrasound



Massive full-thickness tear of the supraspinatus tendon.

- The moderately hypoechoic layer (*ST*) is subcutaneous soft tissue
- The hypoechoic layer between the deltoid muscle (*D*) and humeral head (*H*) is intra-articular fluid (*F*).
- The deltoid muscle should not be mistaken for the rotator cuff \*.



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## Full thickness tear RC MRI

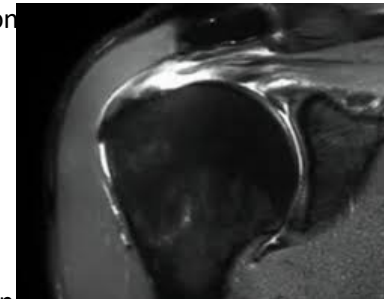


### T1

- Thickened indistinct tendon
- Tear edges not delineated on T1
- Calcifications

### T2


- Hyper-intense fluid signal filling a gap in the tendon 'bald spot sign'
- Fluid in the sub-acromial bursa
- Retraction and degeneration of tendon edges
- Fatty atrophy of muscles

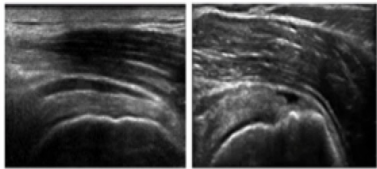


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## BUT . . .





51 men without symptoms Age range 40-70 years  
 US scans: 25 - right shoulders / 26 - left shoulders

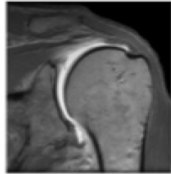
**Findings:**

- ▶ Subacromial bursal thickenings 78%
- ▶ Acromioclavicular joint degeneration 65%
- ▶ Supraspinatus tendinosis 39%
- ▶ Partial thickness tear supraspinatus 22%

**Shoulder abnormalities in 96% of asymptomatic people**

Girish et al (2011). AJR

### MRI Scans



- ▶ Subacromial impingement (n=42)
- ▶ Age matched asymptomatic control (n=31)

**Findings (pathology on MRI):**

Impingement group: 22 / 42 (55%)  
 Control group: 16 / 31 (52%)


**RC pathology related to age**  
**RC pathology does not correlate with symptoms**

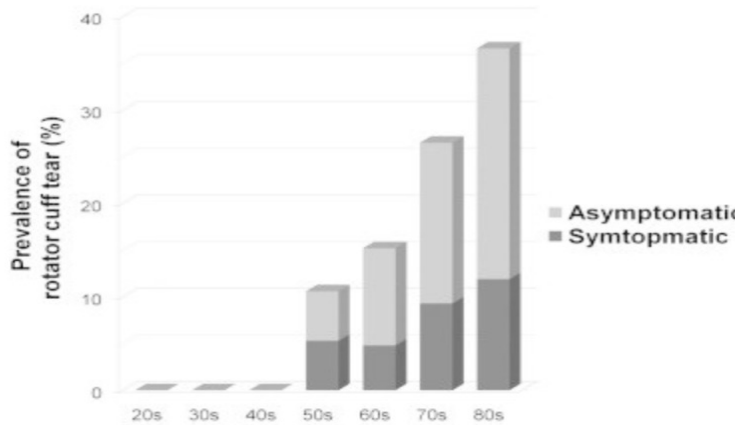
Frost et al (1999) J Sh El Surg 8 (6) 565-568

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## AND . .






Age Group	Asymptomatic (%)	Symptomatic (%)
20s	0	0
30s	0	0
40s	0	0
50s	~5	~5
60s	~10	~5
70s	~17	~10
80s	~25	~12

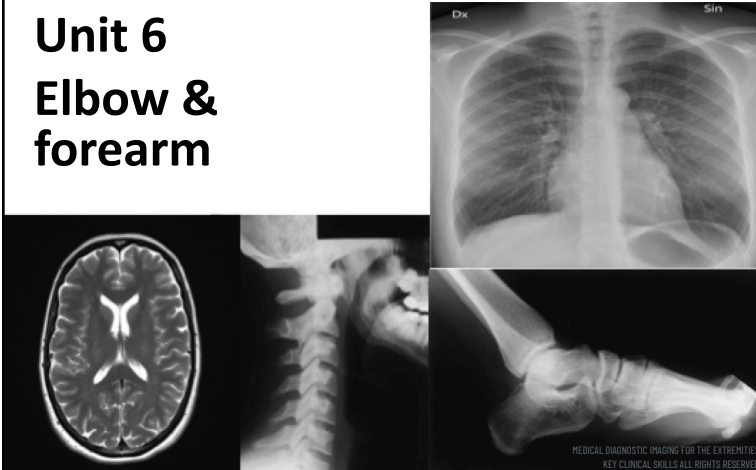
Minagawa 2013

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Medical Imaging for the extremities 


## Unit 6 Elbow & forearm



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Imaging of the elbow 

- Radiography
  - Fractures
  - Dislocations
  - Tendon
- Diagnostic ultrasound



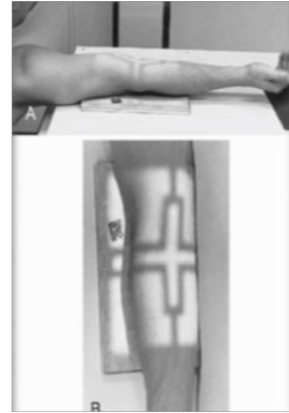
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## Anterior Posterior (AP) view

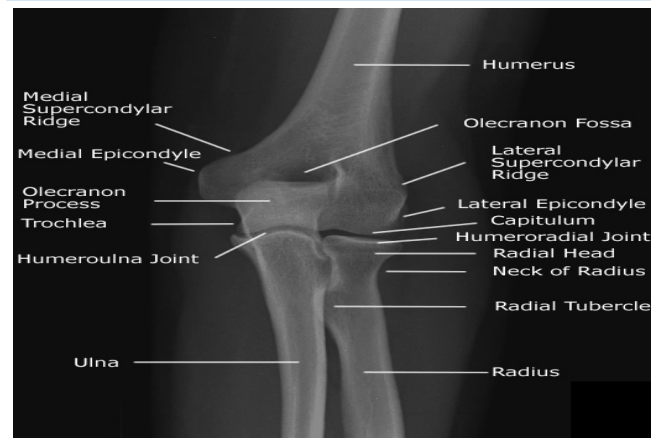
- AP through elbow at level of epicondyles
- Elbow fully extended and supinated
- Demonstrates:
  - Distal humerus
  - Proximal ulna
  - Proximal radius
  - Elbow joint



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## What does the A P elbow view show us?



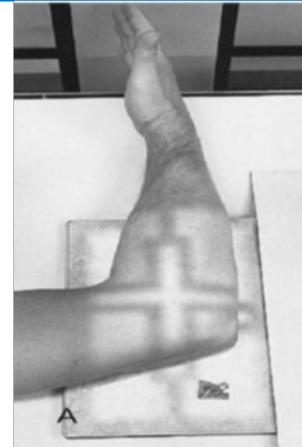
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## Lateral View



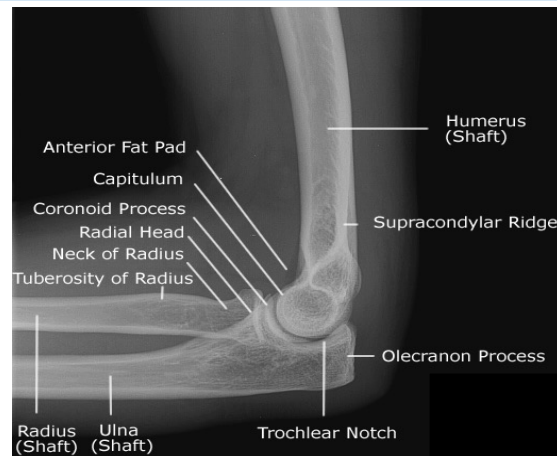
- Lateral at level of epicondyles
- Elbow flexed to 90 degrees, forearm flat on table (patient must abduct shoulder to 90 degrees), forearm in neutral pronation/supination
- Demonstrates:
  - Distal humerus
  - Proximal ulna
  - Proximal radius
  - Elbow joint



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## What does the lateral elbow view show us?



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## Additional views




**Lateral Oblique View**

- Elbow in full extension and supination
- Demonstrates
  - Fracture of lateral epicondyle
  - Fractures of radial head


**Medial Oblique view**

- Elbow fully extended forearm pronated
- Demonstrates
  - Distal humerus
  - Proximal radius
  - Proximal ulna
  - Elbow joint



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## Elbow fractures

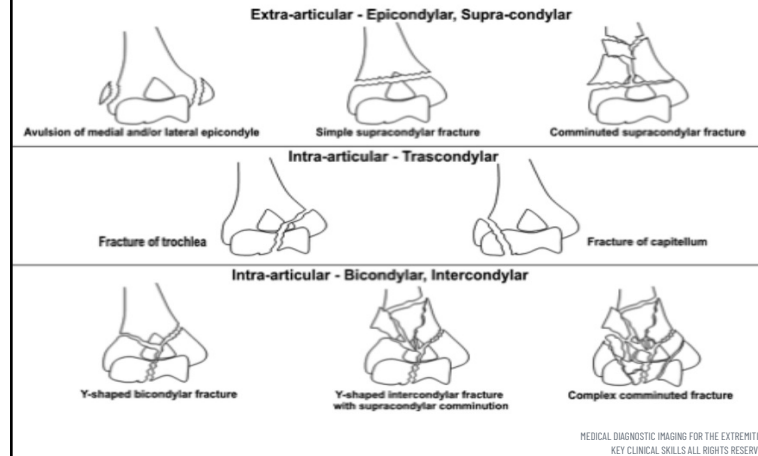


ADULTS		CHILDREN	
Location	Incidence	Location	Incidence
Radial Head/neck	50%	Supracondylar	60%
Olecranon	20%	Lateral Epicondyle	15%
Supracondylar	10%	Medial Epicondyle	10%
Fracture/Dislocations	15%		

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## Distal humerus fractures



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## Supracondylar fractures



- Most common pattern in children
- Fracture line extends transversely or obliquely through the distal humerus above the condyles
- Distal fracture fragment displaces posteriorly



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## Inter-condylar fractures



- Fracture line extends between the medial and lateral condyles & communicates with the supra-condylar region
- The fracture line may take on a Y or a T shape



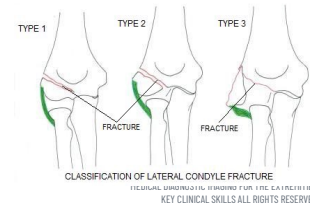
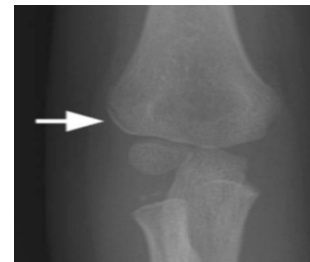
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## Condylar fractures



- A single condyle may be sheared off by an angular force
- Fractures may occur along the articular surface of the capitulum or the trochlea
- Convex surface of capitulum particularly susceptible
- Radial head and capitulum may be fractured together



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## Fractures of capitulum



Mechanism: Head of radius impacted

### Type 1:

- Large fragment of bone and articular surface (involves trochlea)

### Type 2:

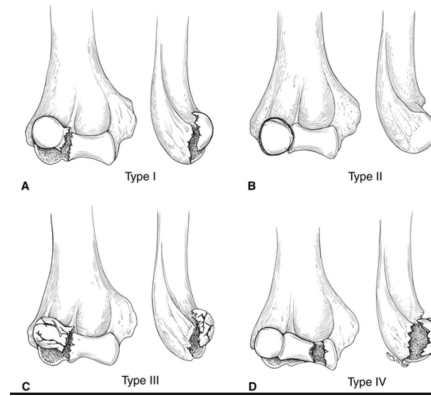
- Small shell of bone and articular surface (does not involve trochlea)

### Type 3:

- Comminuted fracture

### Type 4

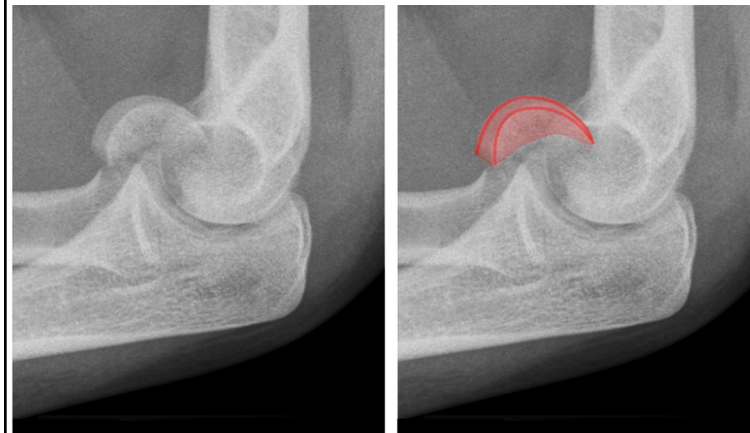
- Includes the trochlea



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## Fractures of capitulum



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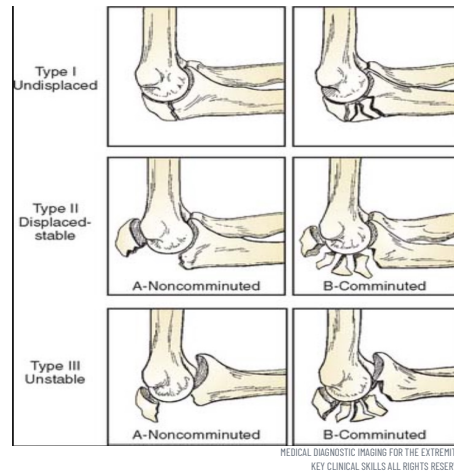
260

## Fractures of proximal ulna

Mechanism:

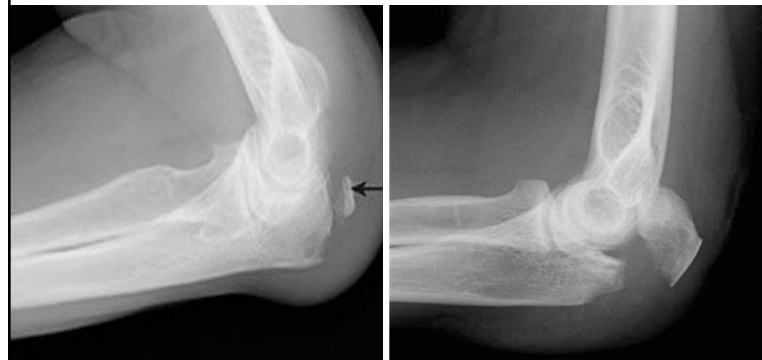
- Fall on the flexed elbow
- FOOSH
- Avulsion

May be intra-articular



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## Fractures of proximal ulna



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## Coronoid fracture

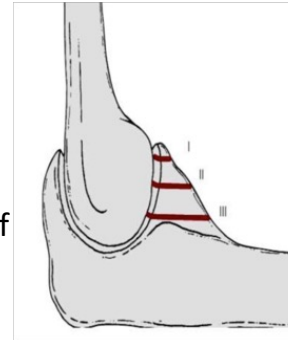


Mechanism:

- Striking of coronoid in trochlea
- Avulsion

Associated with severe trauma to elbow

- **Type 1:** simple avulsion of tip
- **Type 2:** Involve 50%
- **Type 3:** Involve > 50%



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## Coronoid fracture



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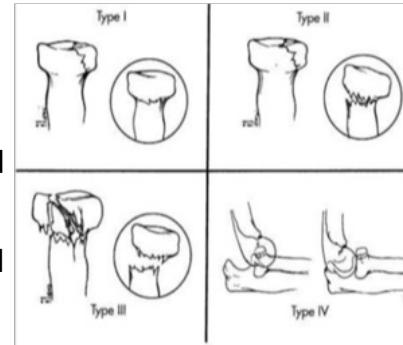


## Fractures of radial head



Mechanism:

- FOOSH on extended/pronated arm
- **Type 1:** Un-displaced
- **Type 2:** Displaced
- **Type 3:** Comminuted
- **Type 4:** Associated with posterior dislocation and coronoid fracture



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## Fractures of radial head



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## Fat pad sign



- In normal elbow the fat pad of the elbow lies between the synovial and fibrous layers of the anterior and posterior joint capsule
- Acute intra-capsular swelling causes fat pad to be pushed outwards
- Indicates an intra-articular effusion



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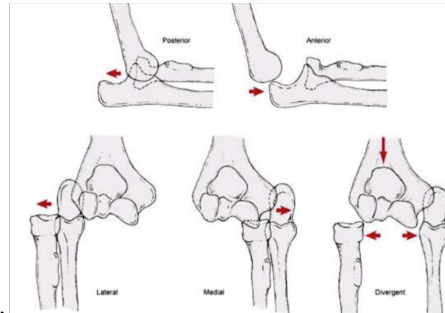
267

## Elbow dislocation



### Mechanism of injury:

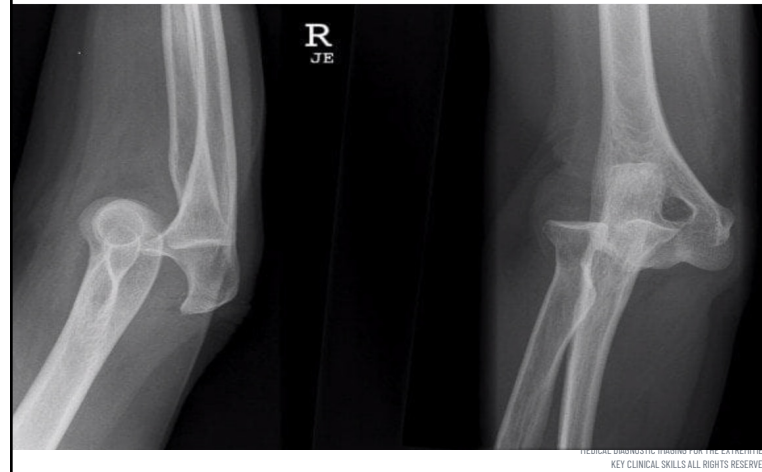
- FOOSH on extended elbow
- 20% of all joint dislocation (after shoulder and fingers)
- 80% are posterior direction
- May be associated with neuro-vascular injuries



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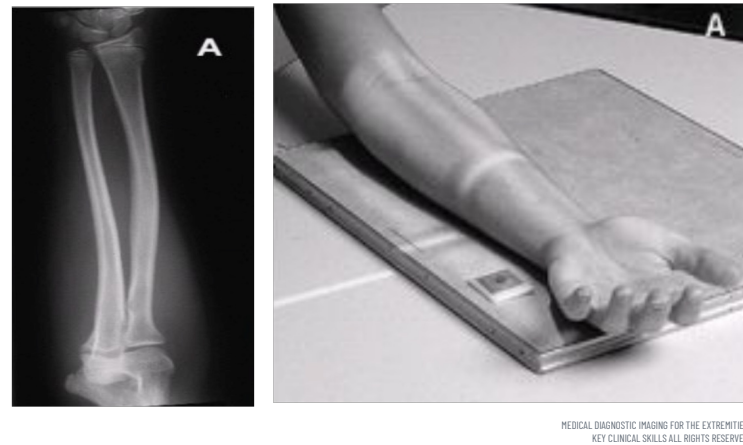
268

## Elbow dislocation



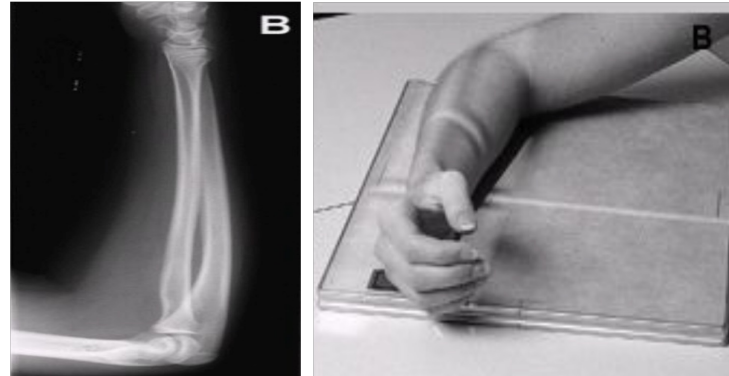
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## Forearm AP View



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## Forearm Lateral View



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## Forearm fractures



### Night stick

- Fracture mid-shaft of ulna



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## Forearm fractures



### Monteggia

- Fracture proximal ulna & dislocation of radial head



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## Forearm fractures



### Galeazzi

- Fracture distal radius & dislocation ulnar head from wrist



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## Forearm fractures



### Greenstick



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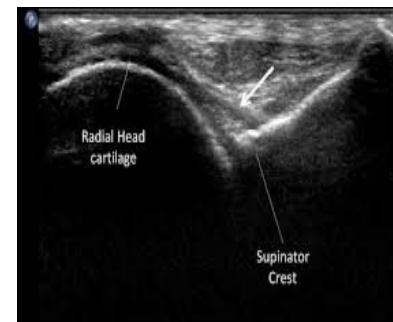
275

## Role of Ultrasound



### Valuable in viewing:

- Muscle
- Tendon
- Ligament
- Nerve
- Bursitis
- Joint effusion
- Hematomas
- Masses
- Ganglia
- Edema



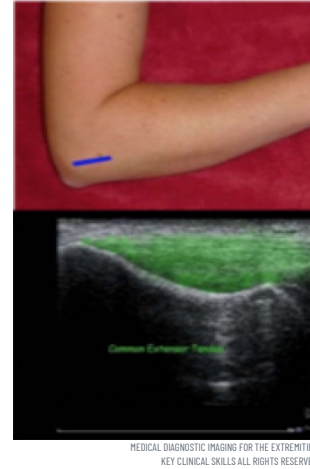
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## Ultrasound: Lateral elbow

### Views:

- Common extensor tendon
- Radial collateral ligament
- Radial nerve
- Annular ligament

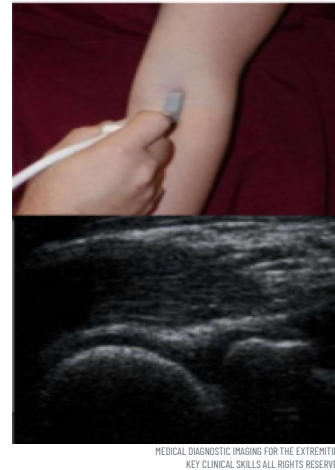


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## Ultrasound: Anterior elbow

### Views:

- Elbow joint
- Biceps tendon
- Median nerve

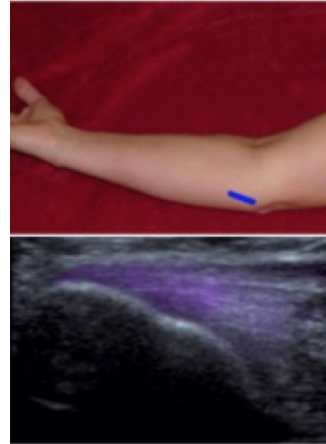


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## Ultrasound: Medial elbow

Views:

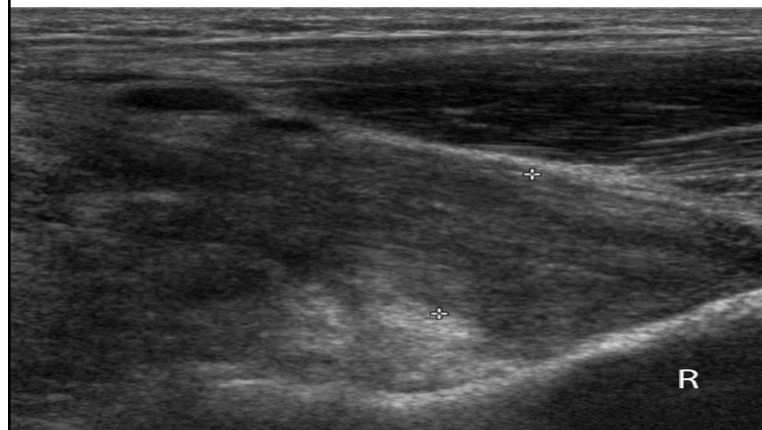
- Common flexor tendon
- Ulnar nerve
- Ulnar collateral ligament



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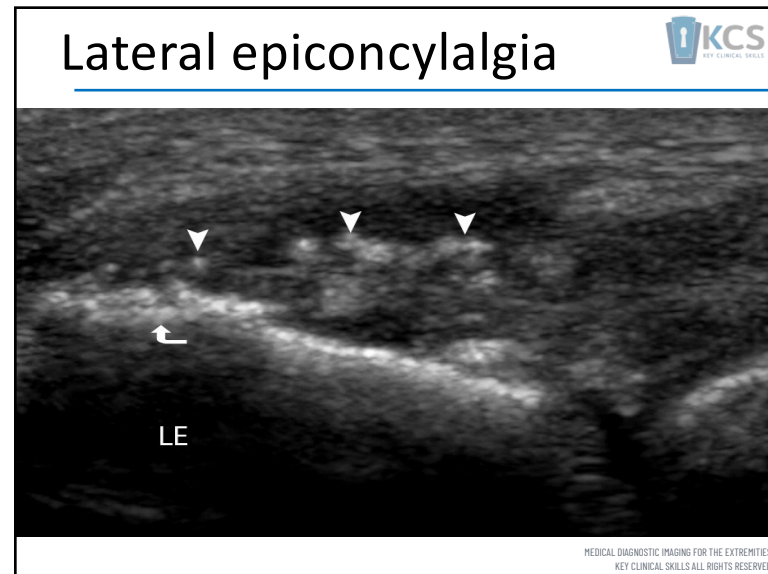
## Distal biceps tendon tear



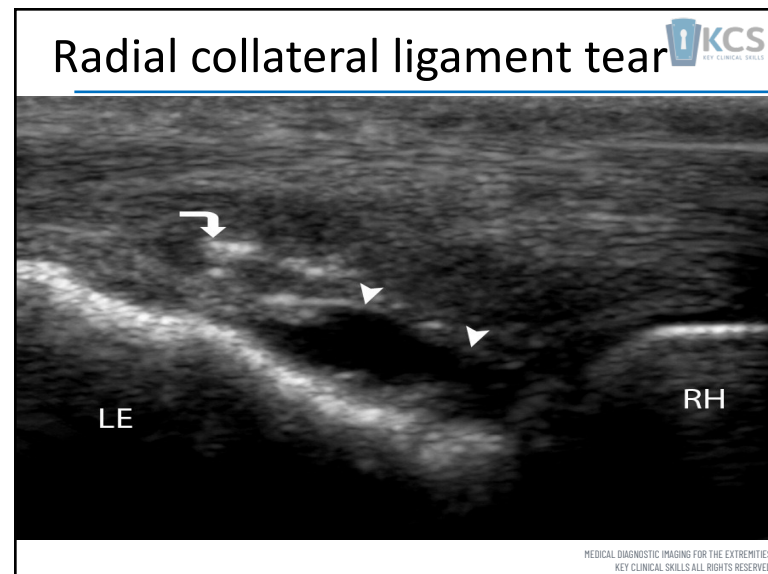
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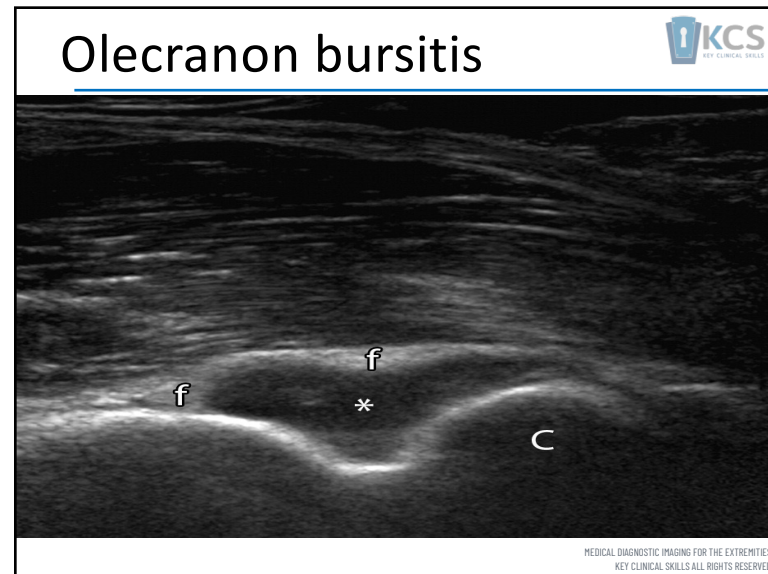




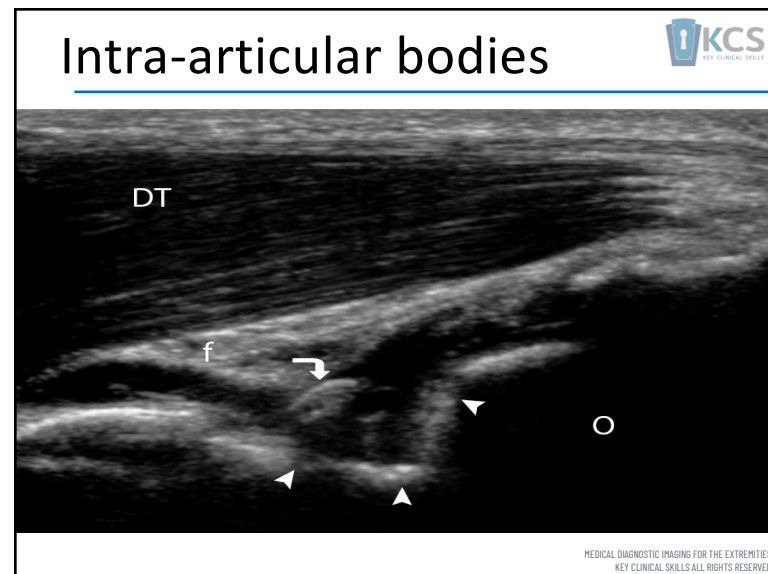
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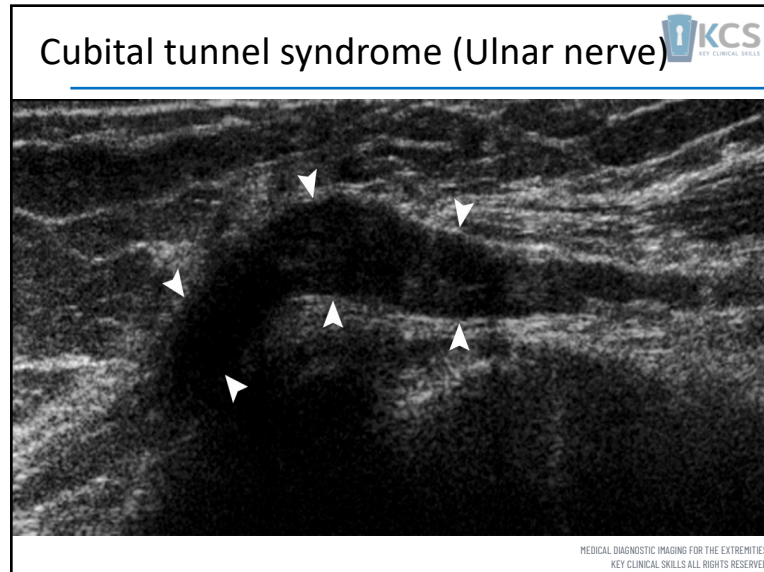
282



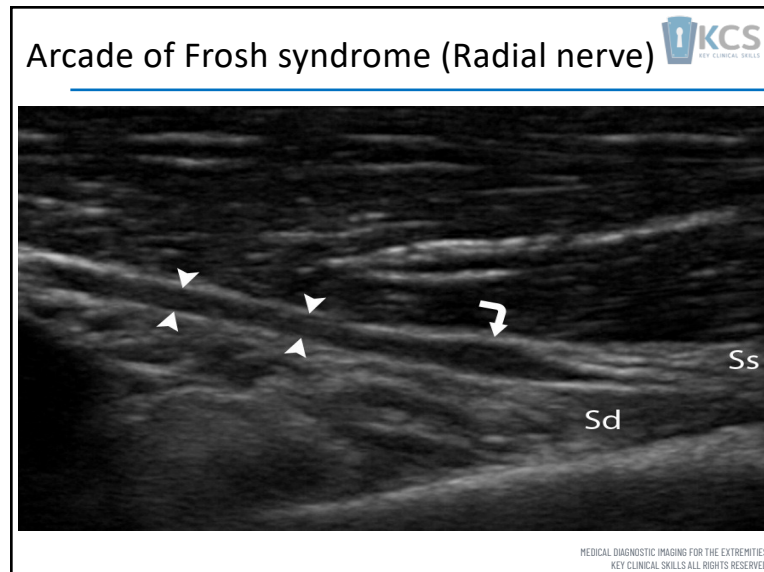
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## Ultrasound visualized structures & pathologies

Compartment	Important structures	Common pathologies
Anterior	Distal biceps muscle & tendon Brachialis muscle Median nerve Anterior joint recess	Tear of DBT Bicipital bursitis Median nerve entrapment
Lateral	Common extensor tendon L C ligament Radial head Capitulum Radial nerve	Lat. Epicondylagia L C Lig. tear Osteochondritis dissecans Radial nerve entrapment
Medial	Common flexor tendon Anterior band of M C Lig.	Medial epicondylagia M C Lig. injury
Posterior	Distal triceps tendon Posterior joint recess Olecranon bursa Ulnar nerve	Distal triceps tendon tear Joint effusion Olecranon bursitis Ulnar nerve dislocation

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## Medical Imaging for the extremities

### Unit 7 Wrist



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## Wrist / Hand Views



- Wrist PA (**not AP**)
- Wrist lateral
- Wrist oblique
- Hand PA (**not AP**)
- Hand lateral
- Hand oblique
- Scaphoid view



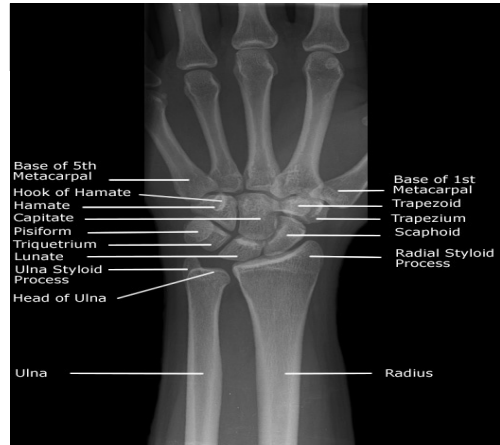
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## Wrist PA View



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## What does the wrist PA view show us?



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## Carpals

### Proximal row

- Boat-shaped scaphoid
- Crescent-shaped lunate
- 3-sided triquetrum
- Pea-shaped pisiform

### Distal row

- Irregular 4-sided trapezium
- Regular 4-side trapezoid
- Capitate has a head
- Hamate has a hook



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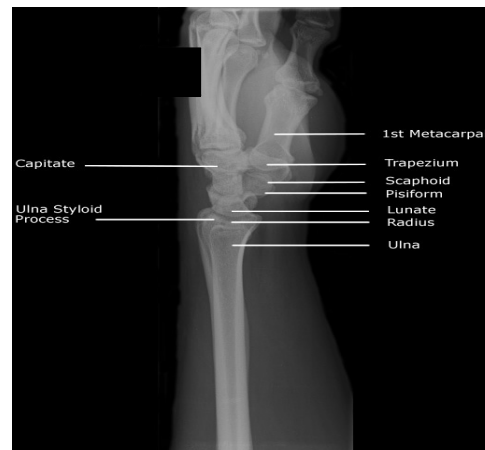
# Wrist Lateral View



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# What does the wrist lateral view show us?



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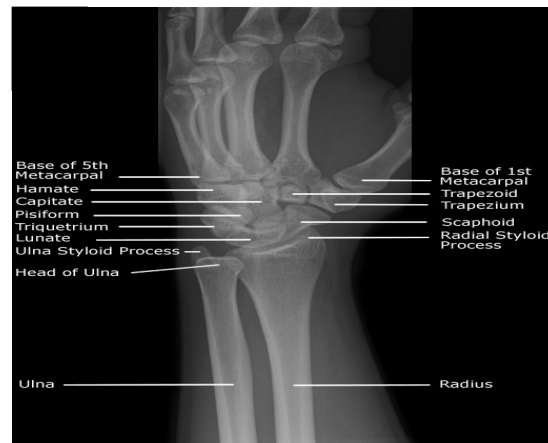
# Wrist Oblique View



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# What does the wrist oblique view show us?



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## Scaphoid view



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## Carpal tunnel View



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## Fractures of the distal forearm

### Colles Fracture

- Fracture of the distal metaphysis of the radius
- Dorsal angulation of distal fragment “dinner fork deformity”



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## Fractures of the distal forearm

### Smith Fracture

- Younger patients
- High energy FOOSH
- Volar comminution and intra-articular extension are more common



300

## Fractures of the distal forearm

### Barton Fracture

- Volar-type Barton: fracture-dislocation of volar rim of radius
- Dorsal-type Barton: fracture-dislocation of dorsal rim of radius
- Shear-type Barton: fractures of distal articular surface of the radius
- High tendency for re-dislocation & mal-union



301

## Fractures of the distal forearm

### Die-Punch Fracture

- Depression fracture of lunate fossa of the distal radius
- Result of transverse load through lunate
- May easily be missed on x-ray



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## Fractures of the distal forearm

### Chauffeur's Fracture

- Isolated fracture of the distal radial styloid process
- Displacement of the fracture fragment uncommon
- Can be associated with injury to scapho-lunate ligament



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## Fractures of the distal forearm

### Ulnar styloid process fracture

- Usually associated with radius fractures (Colle's, Smith's)
- Isolated fracture clinically insignificant
- Displaced fractures associated with TFC tears +/- instability of DRUJ



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## Fractures of the distal forearm

### Greenstick Fractures

- Occur in children
- Only one cortex of bone is broken
- Tension side with plastic deformation



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## Fractures of the distal forearm

### Torus (Buckle) Fracture

- Seen in children
- Similar to Greenstick fractures
- Longitudinal compression of bone



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## Fractures of the distal forearm

### Epiphyseal Fractures

- Usually Salter-Harris Type II
- “Epiphysiolysis” fractures
- Re-dislocation common



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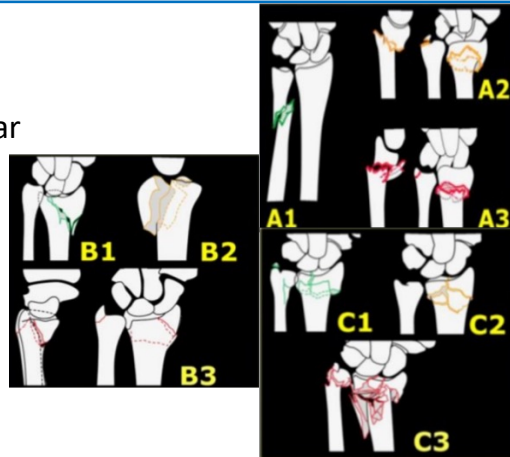
## Fractures of the distal forearm

### Mueller AO Classification:

A. Extra-articular

B. Partially-articular


C. Completely-articular

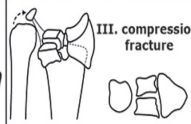
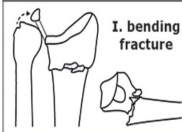
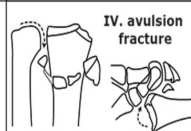

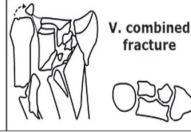


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## Distal Radio-Ulnar Joint (DRUJ) in fractures of the distal forearm




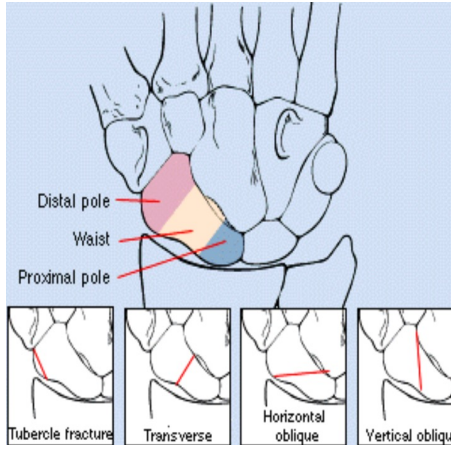
<p><b>Stable</b></p> <ul style="list-style-type: none"> <li>• Avulsion fracture of tip of ulnar styloid or ulnar neck</li> </ul>	<p><b>Fernandez classification</b></p>  <p>III. compression fracture</p>
<p><b>Unstable</b></p> <ul style="list-style-type: none"> <li>• Avulsion of the base of the ulnar styloid &amp; tear of the TFC</li> </ul>	 <p>I. bending fracture</p>  <p>IV. avulsion fracture</p>
<p><b>Unstable &amp; intra-articular</b></p> <ul style="list-style-type: none"> <li>• Fracture of the sigmoid notch or intra-articular fracture of the ulnar head</li> </ul>	 <p>II. shear fracture</p>  <p>V. combined fracture</p>

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## Carpals




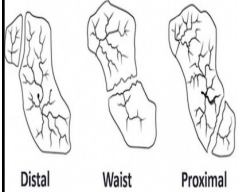
<p><b>Relative incidence</b></p> <ul style="list-style-type: none"> <li>• Scaphoid 68.2%</li> <li>• Triquetrum 18.3%</li> <li>• Trapezium 4.3%</li> <li>• Lunate 3.9%</li> <li>• Capitate 1.9%</li> <li>• Hamate 1.7%</li> <li>• Pisiform 1.3%</li> <li>• Trapezoid 0.4%</li> </ul>	 <p>Distal pole Waist Proximal pole</p> <p>Tubercle fracture    Transverse    Horizontal oblique    Vertical oblique</p>
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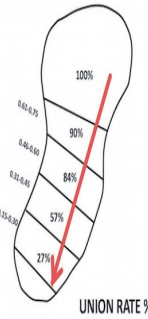
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## Scaphoid fractures






Distal      Waist      Proximal




UNION RATE %



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## Scaphoid fractures



History compatible with possible fracture  
**AND**  
Examination confirms tenderness:  
Anatomical snuffbox and/or scaphoid tubercle

↓

Plain radiographs, scaphoid views

**No Fracture**

↓

Immobilise in "Colles" cast or wrist splint  
(according to local practice) until MRI scan.  
Thumb immobilisation is not required.  
(Senior medical review may be useful to exclude alternative causes of symptoms)

↓

MRI scan  
(CT scan if MRI contra-indicated)

↓

**No Fracture**

→

Discharge:  
no follow-up required

**Fracture**

↓

"Colles" cast and orthopaedic follow-up

↓

**Fracture**

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## Scaphoid fractures CPR's

<ol style="list-style-type: none"> <li>1. Male gender</li> <li>2. Sport activity</li> <li>3. Anatomical snuff box pain on ulnar deviation within 72 hrs of injury</li> <li>4. Scaphoid tubercle tenderness at 2 weeks</li> </ol> <p><b>All 4 present</b></p> <ul style="list-style-type: none"> <li>• <b>91% fracture risk</b></li> <li>• <b>No patients had fracture if no # 4</b></li> </ul> <p><i>Duckworth 2012</i></p>	<ol style="list-style-type: none"> <li>1. Snuff box tenderness Sp 0.19</li> <li>2. Scaphoid tubercle tenderness Sp 0.3</li> <li>3. Longitudinal compression Sp 0.48</li> </ol> <p><b>All 3 present</b></p> <ul style="list-style-type: none"> <li>• <b>Sn = 100%</b></li> <li>• <b>Sp 74%</b></li> </ul> <p><i>Parvizi 1998</i></p>
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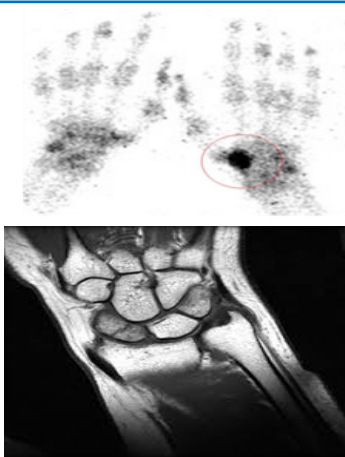
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## Best imaging modalities for scaphoid fractures

Modality	Specificity	Sensitivity
Follow-up X-ray	91.1%	99.8%
Bone scan	97.8%	93.5%
CT	85.2%	99.5%
MRI	97.7%	99.8%

*Yin 2012*



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## Carpal instability

**Scapho-Lunate Advanced Collapse "SLAC"**

- Occurs in 10-30% of intra-articular radial fractures
- Disruption of the Gula lines
- "Terry Thomas sign"

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## Carpal instability

**Dorsal intercalated segment instability "DISI"**

- Result of altered kinematics from instability
- Dorsal ligament are stronger
  - Scaphoid will hyperflex
  - Lunate hyperextend
- Leads to early mid-carpal OA & SLAC

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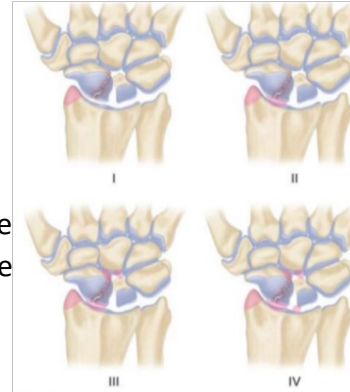
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## Carpal instability



### Scaphoid non-union advanced collapse "SNAC"

- Post-scaploid non-union
- Prox. scaphoid fragment remains attached to lunate
- Scaphoid and lunate rotate in opposite directions during extension
- Leads to early radial styloid- scaphoid OA



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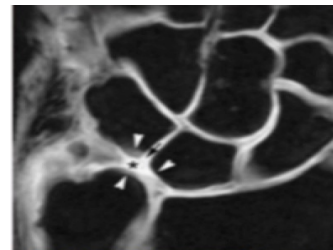
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## Ulnar impact syndrome



### Predisposing factors

- Congenital +ve ulnar variance
- Malunited distal radius fracture
- Premature physeal closure of radius



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## Ulnar impingement syndrome

### Predisposing factors

- Congenital negative ulnar variance
- Premature physal closure of ulna
- Surgical removal distal ulna



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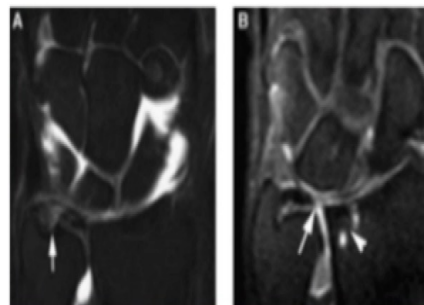
319

## Triangular fibrocartilage of the Ulna

### TFCC Tear

#### Palmer classification (traumatic)

- Central perforation
- Ulnar avulsion +/- distal ulnar fracture
- Distal Avulsion
- Radial avulsion +/- sigmoid notch fracture



**MRI Sn 74%, Sp 80%**

Joshy, 2008

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## Keinbock's disease



### Avascular necrosis of lunate

- High association with negative ulnar variance (75%)

#### Males

- Young adult
- Most common on dominant hand

#### Women

- Mid-50's
- Equal dominant / non-dominant hand

#### X-ray

- Sclerosis and flattening
- Fragmentation & secondary OA later

#### Bone scan

- Negative can exclude but positive not specific

#### MRI

- Most sensitive and specific for early detection
- Bone edema (high T2, intermediate T1 signal)



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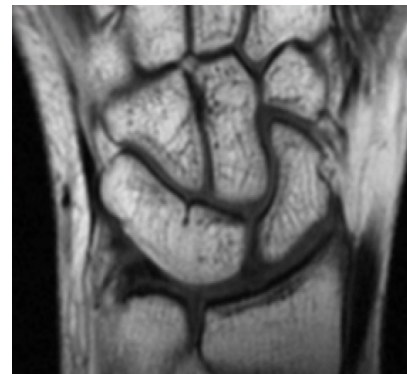
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## Carpal coalition



### Minar de Viller's classification

1. Prox. pseudo-atrothrosis
2. Prox. osseous bridge
3. Complete osseous fusion
4. Associated other carpal abnormalities



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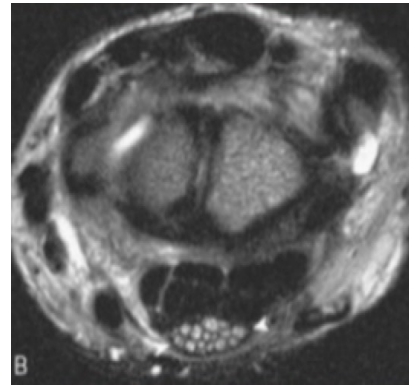
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## Carpal tunnel syndrome



### MR Image Signs

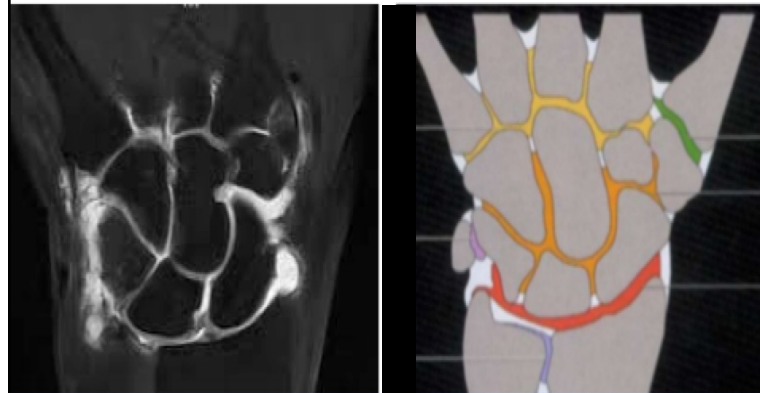
- Swelling of nerve
- Flattening/angulation of nerve
- Bowing of flexor retinaculum > 15%
- Increased T2 signal of nerve



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## MRI with contrast



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## MRI with contrast

**Scapho-lunate lig.**

**Lunate-triquetrum lig.**

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## Inflammatory joint arthritis

**Marrow edema**

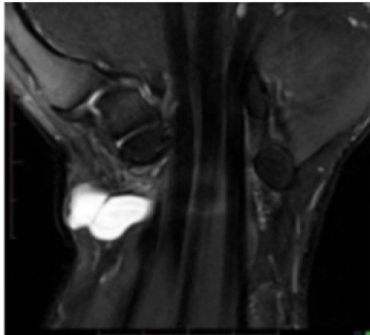
**Synovitis**

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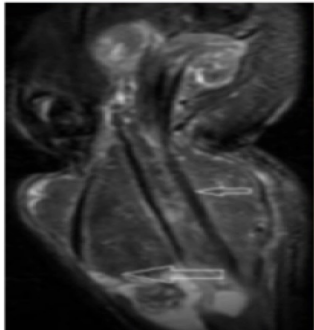
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## Soft tissue lesions

### Ganglion cyst



### Compound palmar ganglion

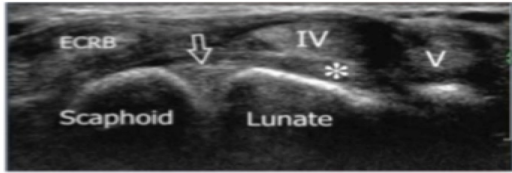



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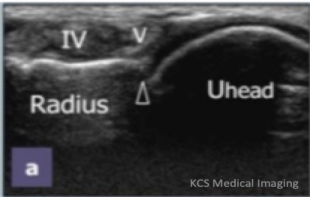
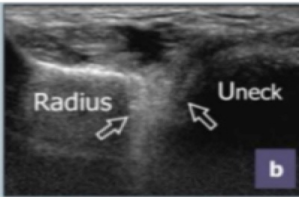
## Ultrasonography of the wrist

### Scapho-lunate ligament

### DRUJ




KCS Medical Imaging

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## Ultrasonography of the wrist




---

### de Quervain's disease

- Stenosing tenosynovitis
- Involves 1<sup>st</sup> extensor tendon

### Carpal tunnel syndrome


- Hypoechoic swollen nerve
- Loss of fascicular pattern



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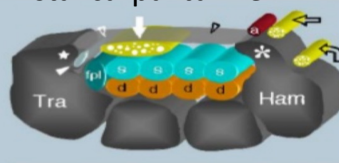
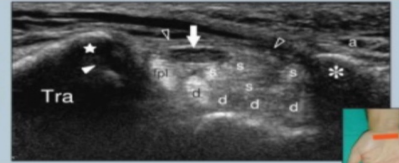
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## Ultrasonography of the wrist



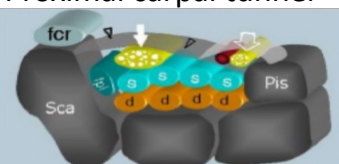
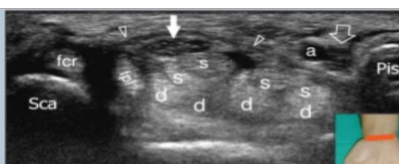
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### Distal carpal tunnel

Legend: a, ulnar artery; asterisk, hamate hook; curved arrow, deep motor branch of the ulnar nerve; d, flexor digitorum profundus tendons; fpl, flexor pollicis longus tendon; s, flexor digitorum superficialis tendons; star, tubercle of trapezium; void arrowheads, flexor retinaculum; void curved arrow, superficial sensory branch of the ulnar nerve; white arrowhead, flexor carpi radialis tendon; white arrows, median nerve


### Proximal carpal tunnel

Legend: a, ulnar artery; arrowheads, flexor retinaculum; d, flexor digitorum profundus tendons; fcr, flexor carpi radialis tendon; fpl, flexor pollicis longus tendon; s, flexor digitorum superficialis tendons; void arrowheads, flexor retinaculum; void curved arrow, superficial sensory branch of the ulnar nerve; white arrowhead, flexor carpi radialis tendon; white arrows, median nerve

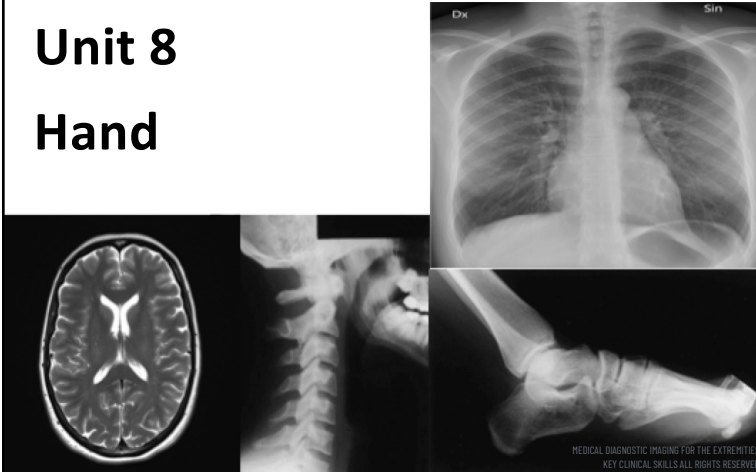
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Medical Imaging for the extremities 

## Unit 8

## Hand



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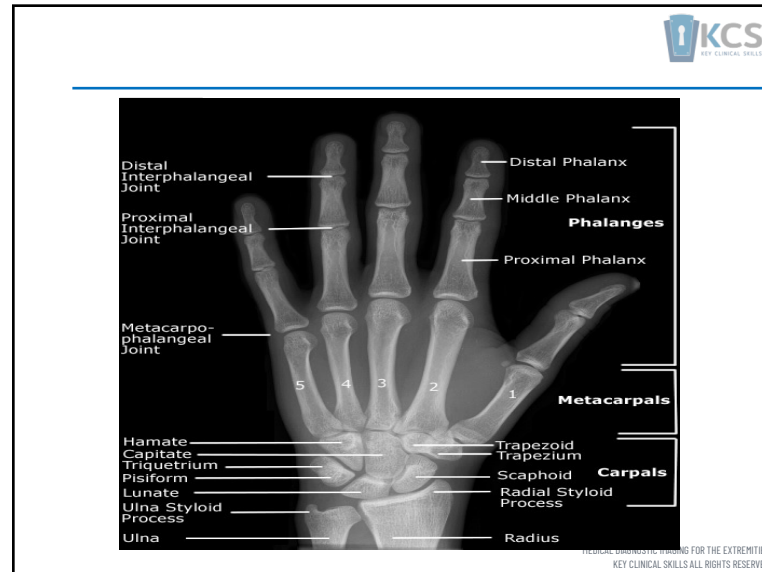
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Hand PA View 

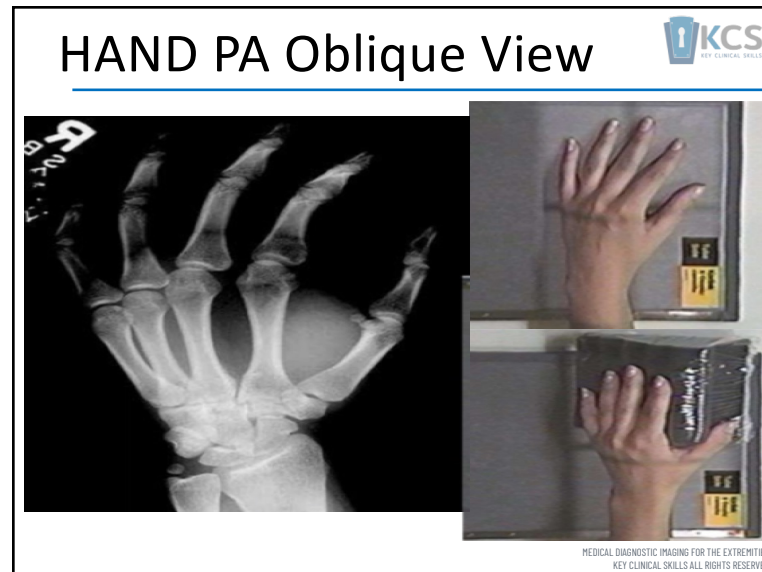


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### What does the hand PA Oblique view show us?




**Phalanges**

- Distal Phalanx
- Middle Phalanx
- Proximal Phalanx

**Metacarpals**

- 5
- 4
- 3
- 2
- 1


**Carpals**

- Hamate
- Capitate
- Triquetrum
- Pisiform
- Lunate
- Ulna Styloid Process
- Ulna
- Trapezoid
- Trapezium
- Scaphoid
- Radial Styloid Process
- Radius


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### Special hand views



#### Fan Lateral View



#### Lateral View



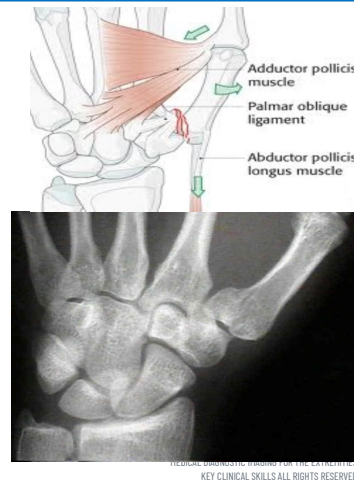
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## Bennet Fracture



- Intra-articular fracture through base of 1<sup>st</sup> MC
- Shaft dislocated laterally due to pull of abductor pol. long.
- Medial fragment remains in place due to volar oblique lig.
- Reduction difficult to maintain w/o Sx fixation

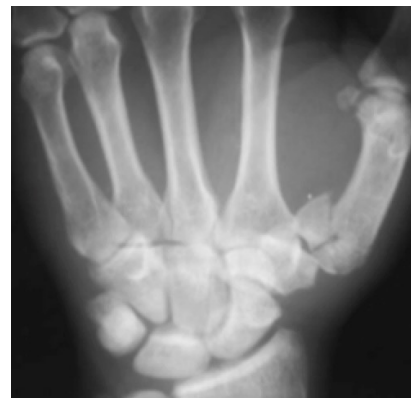


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## Rolando Fracture



- Comminuted 1<sup>st</sup> MC base fracture
- Presents as a “Y” or “T” pattern
- Differs from Bennett that usually has no diaphyseal displacement
- High likelihood of post-traumatic OA



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## Thumb CMC dislocations



- Dorsal dislocation most common
- Mechanical hypertension injury
- Originally termed “gameskeeper’s thumb”
- Now commonly termed “skier’s thumb”

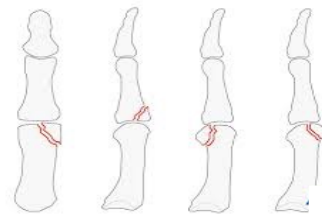


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## Thumb Metacarpophalangeal joint fractures



Usually involve ulnar margin of proximal phalanx due to UCL avulsion



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## Carpo-metacarpal fracture-dislocations



- Often obscure due to swelling and overlap metacarpal on lateral view
- Most commonly involves 5<sup>th</sup> MC displaced dorsally with 4<sup>th</sup>
- Alternatively 4<sup>th</sup> may displace volarly
- CT helpful in determining extent of injury



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## Intra-articular fracture of the 5<sup>th</sup> metacarpal base



- Similar to Bennett's # in that pull of ECU draws fragment away from MC



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## Boxer's fracture



- Commonly from angry young male punching the wall (or another angry young male)
- Metacarpal neck fracture of 5<sup>th</sup> +/- 4<sup>th</sup> digits



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## Boxer's fracture



- Deformity common
- Metacarpal head tilts volarly causing joint to hyperextend and collateral ligaments to become slack



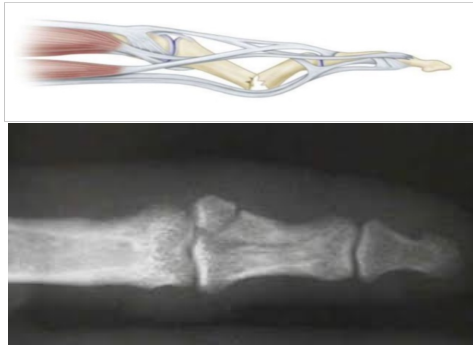
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## Middle or proximal phalanx fracture

- Direct blow over dorsum
- Palmar angulation +/- clawing common



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## Mallet finger

- Blow to tip of digit
- Hyper-flexion force avulsion fracture of extensor tendon from distal phalanx



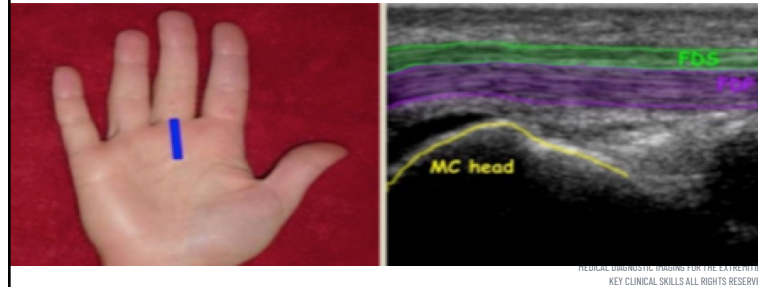
MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
KEY CLINICAL SKILLS ALL RIGHTS RESERVED

346

## Ultrasonography of the hand

### Finger flexors

- Flexor digitorum superficialis
- Flexor digitorum profundus

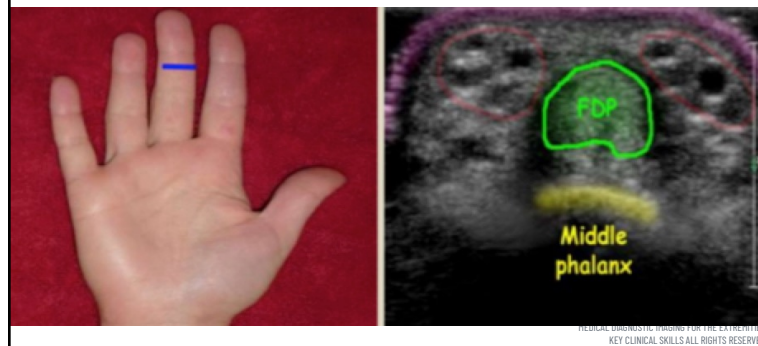


347

## Ultrasonography of the hand

### Finger flexors

- Flexor digitorum profundus

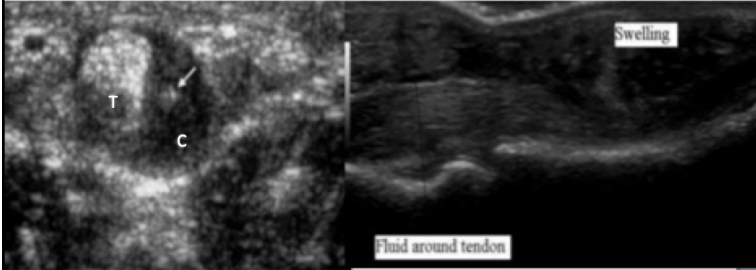


348

## Ultrasonography of the hand

### Tenosynovitis

- Hyperechoic sheath (C)
- Tendon (T)

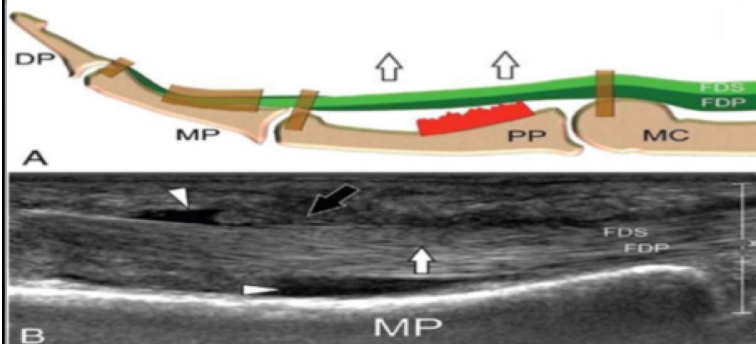


MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
KEY CLINICAL SKILLS ALL RIGHTS RESERVED

349

## Ultrasonography of the hand

### Pulley rupture



MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
KEY CLINICAL SKILLS ALL RIGHTS RESERVED

350

## Ultrasonography of the hand

### Pulleys

- A2 pulley at the proximal phalanx

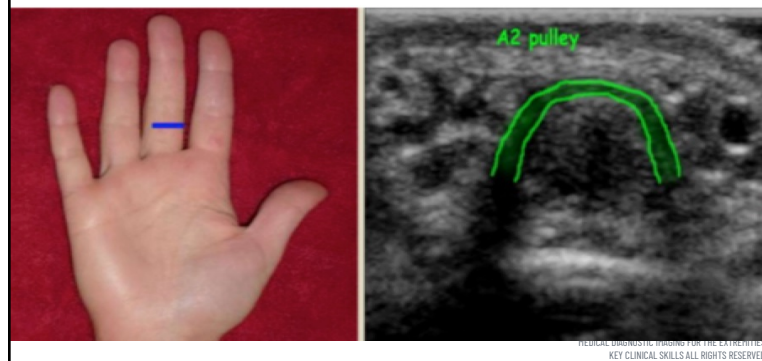


351

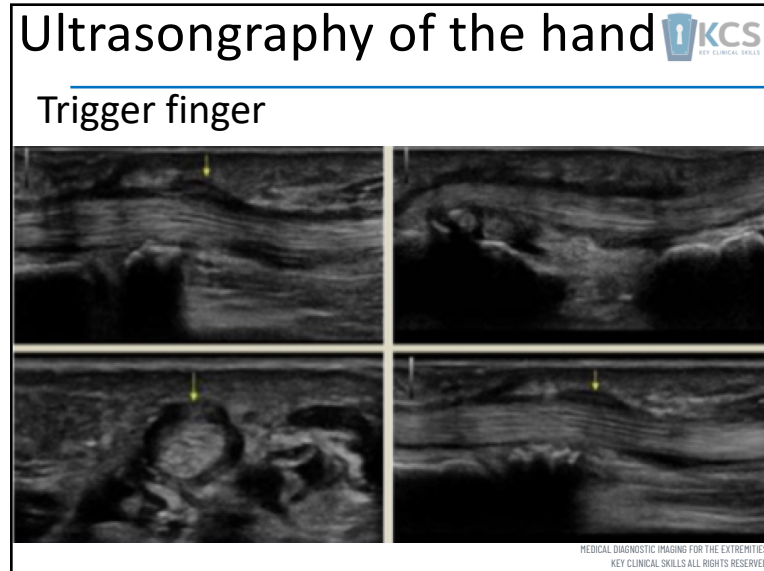
## Ultrasonography of the hand

### Pulleys

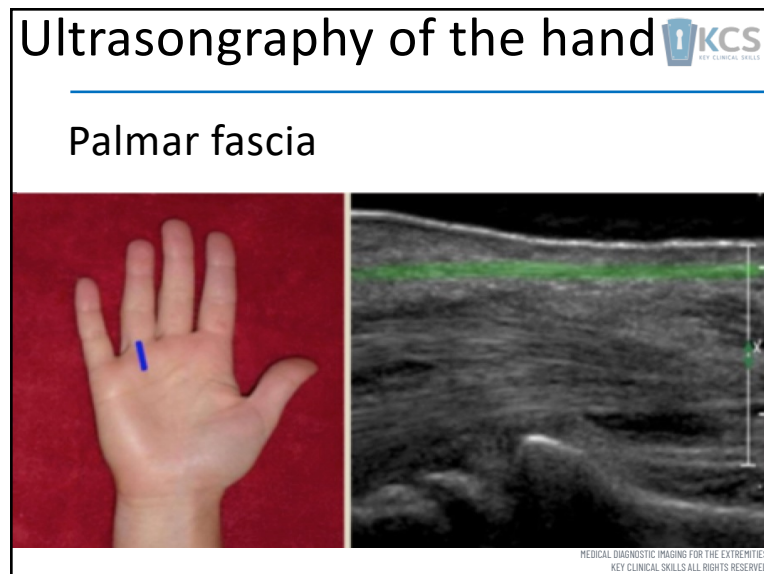
- A2 pulley in transverse view



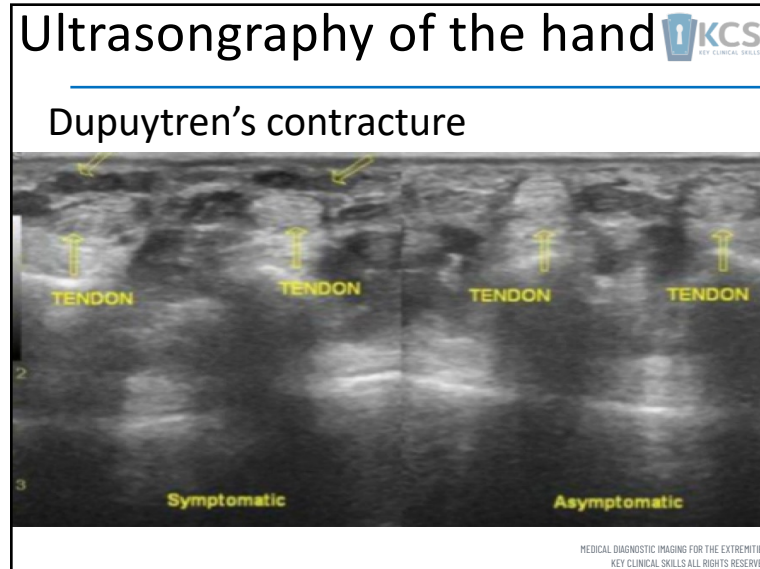
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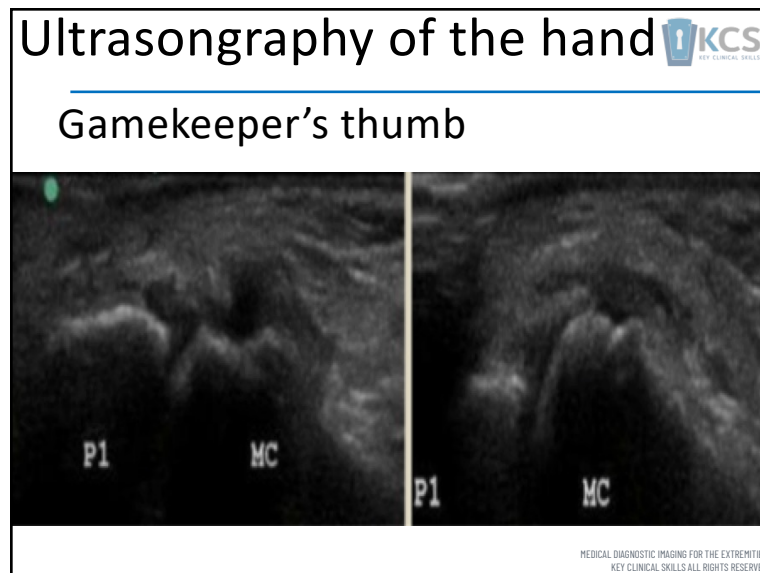
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354



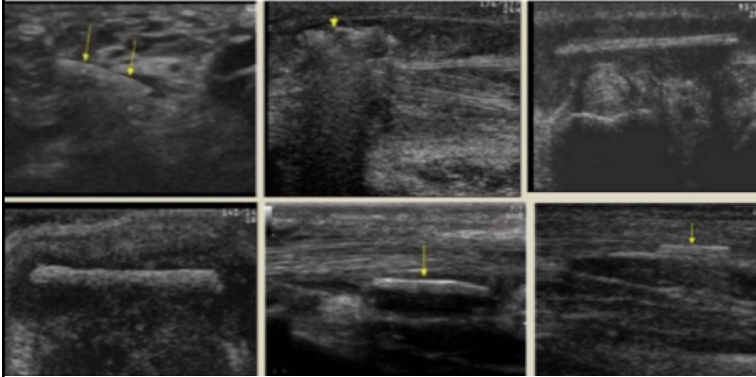
355



356

## Ultrasonography of the hand

### Foreign bodies

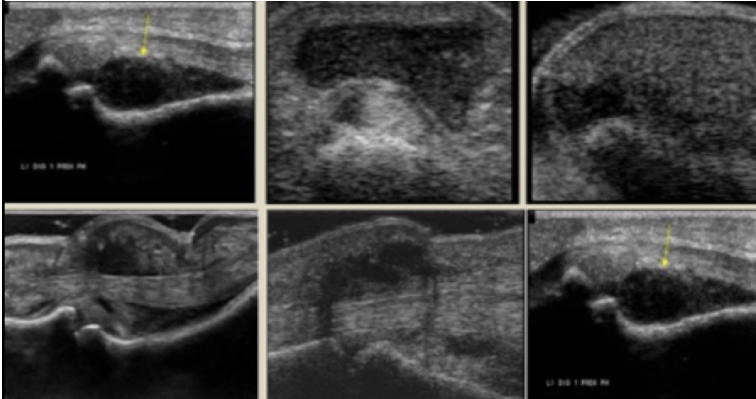


MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
KEY CLINICAL SKILLS ALL RIGHTS RESERVED

357

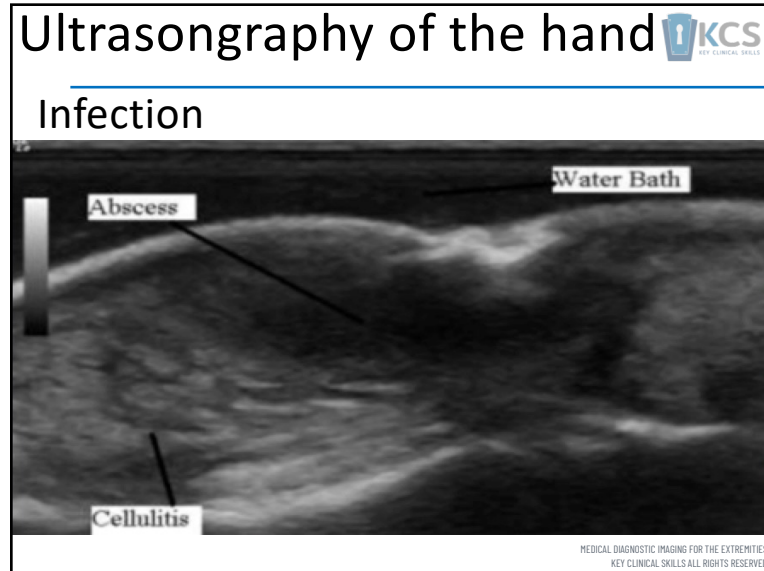
## Ultrasonography of the hand

### Tumors

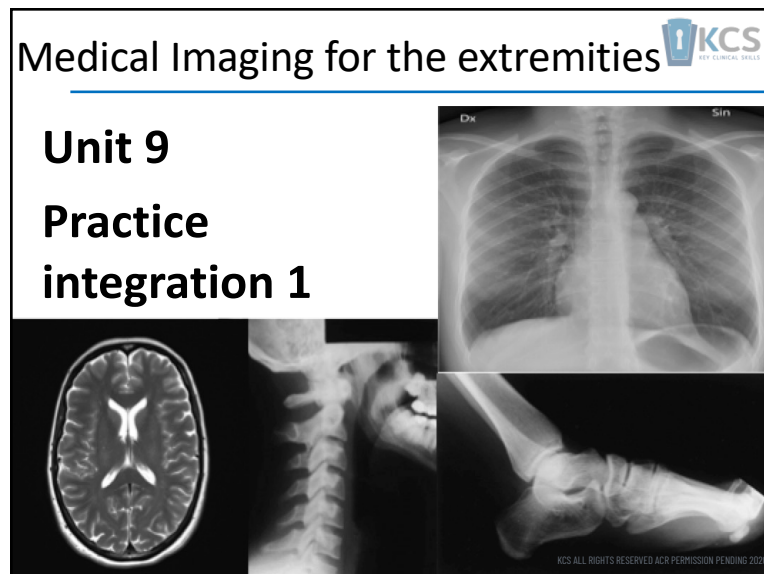


MEDICAL DIAGNOSTIC IMAGING FOR THE EXTREMITIES  
KEY CLINICAL SKILLS ALL RIGHTS RESERVED

358



359




360



## Practice Integration


Where's Waldo?

- Structure identification




Question mark

- Imaging Quiz





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361



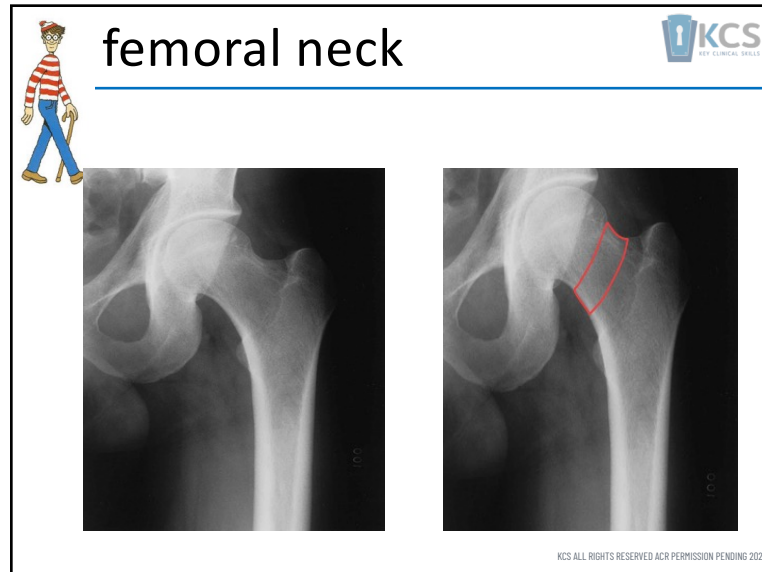
## What's the view?



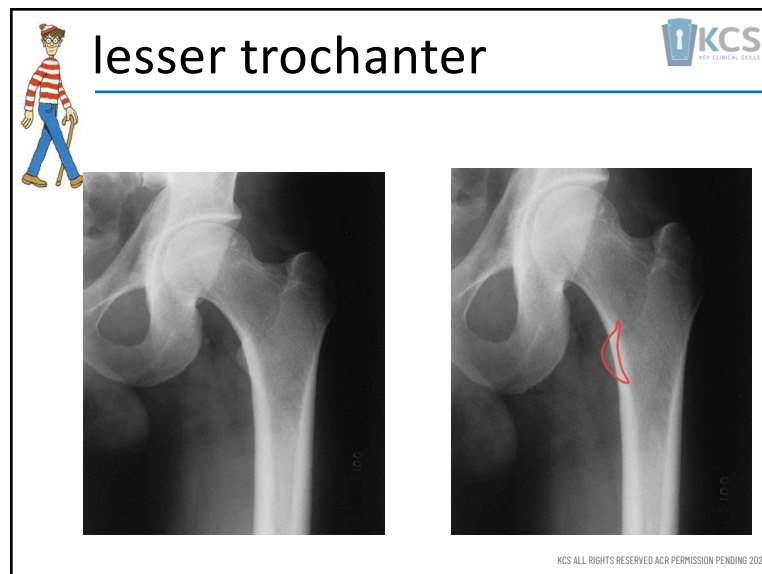
- Antero-postero hip

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363



364

 **What's the view?** 



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- Lateral  
Frog-leg

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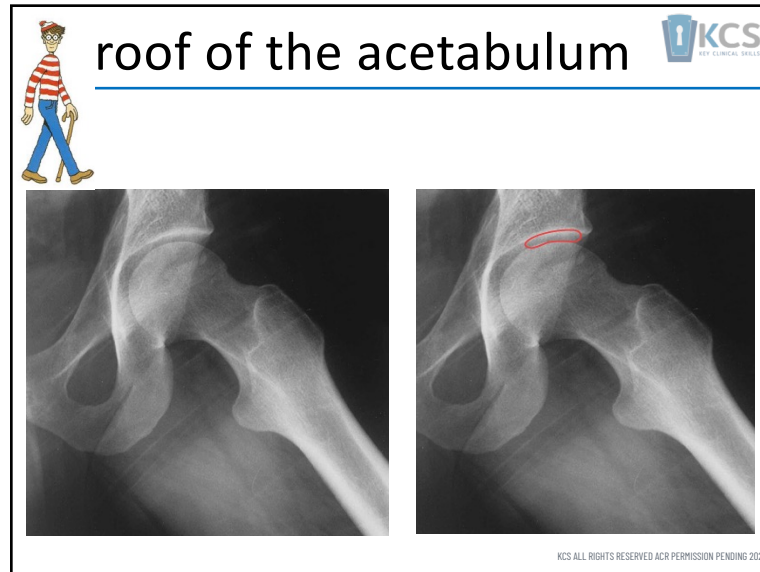
 **lesser trochanter** 

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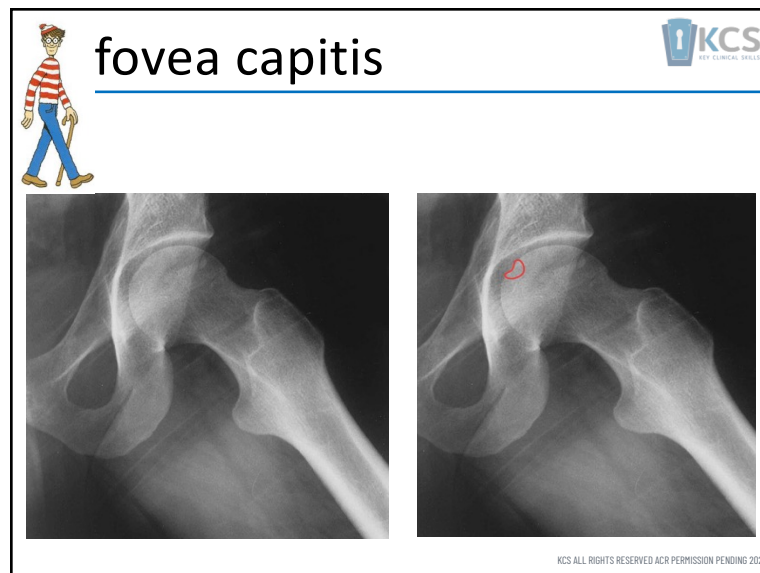
 

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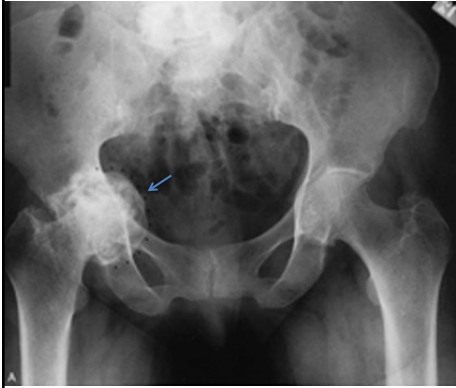
367



368

?

## What view is this?



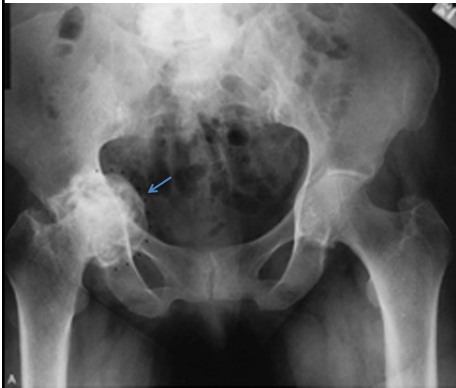
A. antero-posterior pelvis  
B. antero-posterior hip  
C. lateral frog-leg of the hip

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369

?

## What view is this?



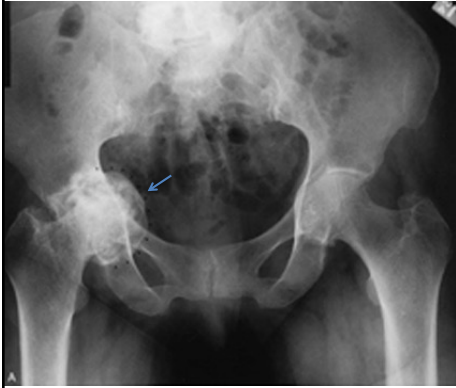
A. antero-posterior pelvis

- The antero-posterior view of the pelvis includes a bilateral view of the hips.

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370

What do the arrows point to on the patient's right hip?

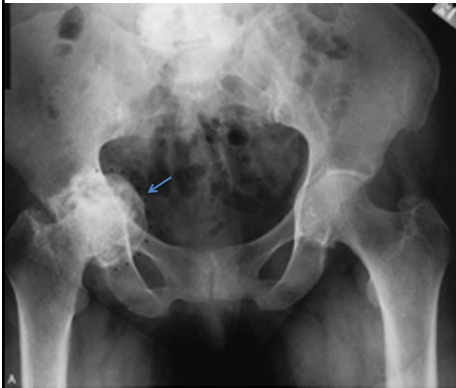


A. degenerative joint disease  
B. acetabular protrusion  
C. autograft bone fusion

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What do the arrows point to on the patient's right hip?





B. acetabular protrusion

- Acetabular protrusion results from axial migration of the femoral head caused by joint destruction as well as osteoporotic bone in the pelvis.


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What's the view?







- Antero-postero right knee



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373

medial tibial plateau




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374



 **intercondylar tubercle** 

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375

 **What's the view?** 

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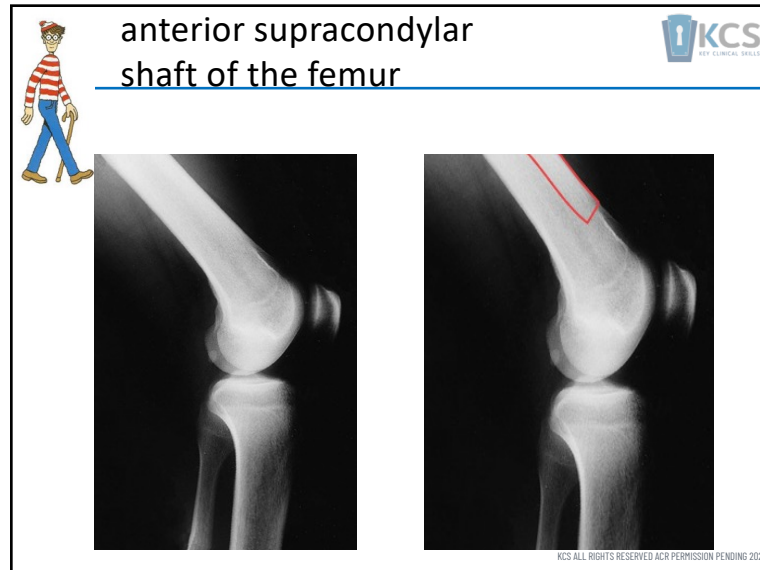


- Lateral knee

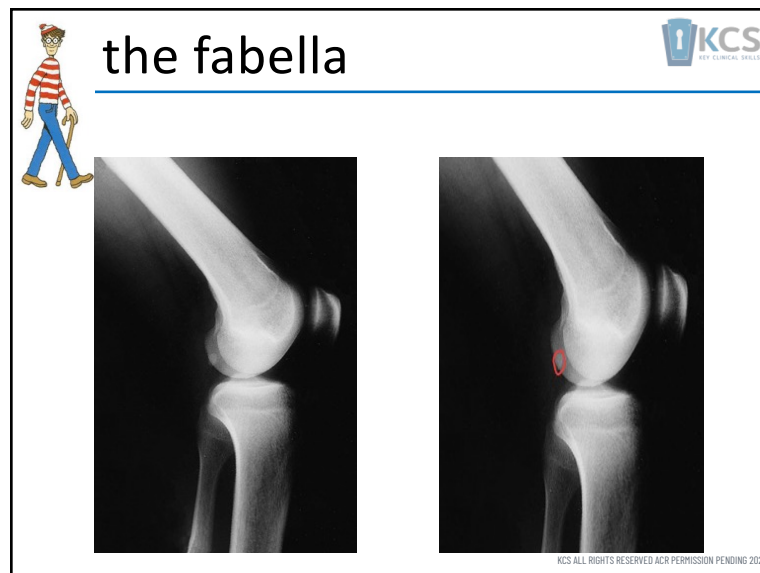
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376





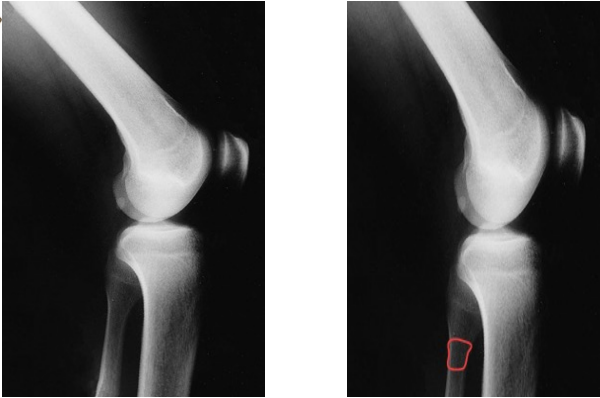


377





378


 fibular neck 



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379

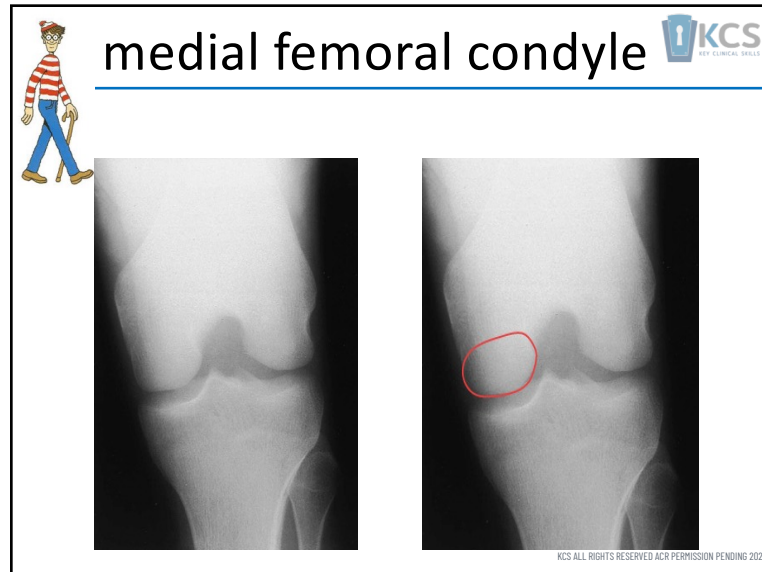
 What's the view? 



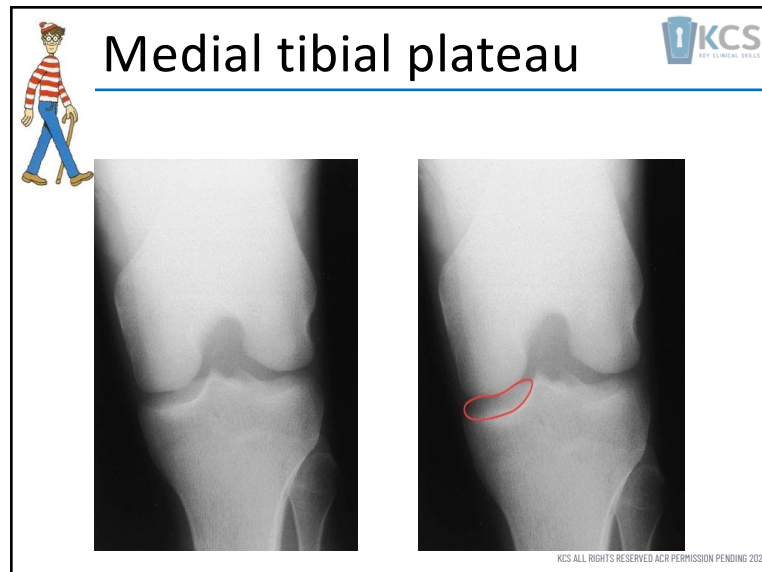
- Tunnel view  
left knee

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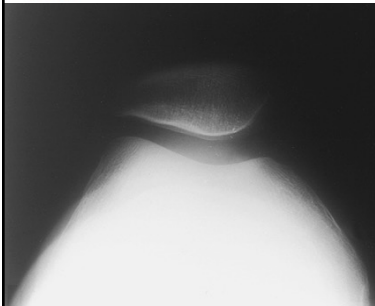



381




382

## What's the view?




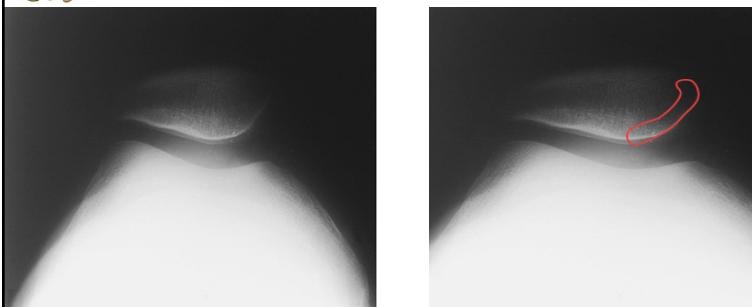

- Tangential Patellofemoral Joint
- “sunrise view”



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383


## Medial patellar condyle



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**?** What view is this? 




A. antero-posterior knee  
B. lateral knee  
C. postero-anterior axial inter-condylar fossa

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**?** What view is this? 



B. lateral knee

- A lateral view represents a sagittal plane through the body.

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386



 What do all the arrows point to? 




**C**

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 What do all the arrows point to? 



**C**

**E. osteophytes**

- All the arrows point to bony spurs.

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388



## What is the pathology?



- A. rheumatoid arthritis
- B. degenerative joint disease
- C. osteochondral fractures

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389



## What is the pathology?





B. degenerative joint disease

- The radiologic hallmarks of degenerative joint disease are decreased joint space, subchondral sclerosis, and osteophytosis


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What's the view?







- Antero-postero ankle



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391

tibiotalar joint






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392






### lateral malleolus



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393



### What's the view?




- Antero-posterior
- Oblique Mortise

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394


 lateral malleolus 



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395



 What's the view? 





- Lateral ankle

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396



 anterior tubercle of the tibia 

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397

 body of the talus 



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398

What's the view?







- Antero-postero foot



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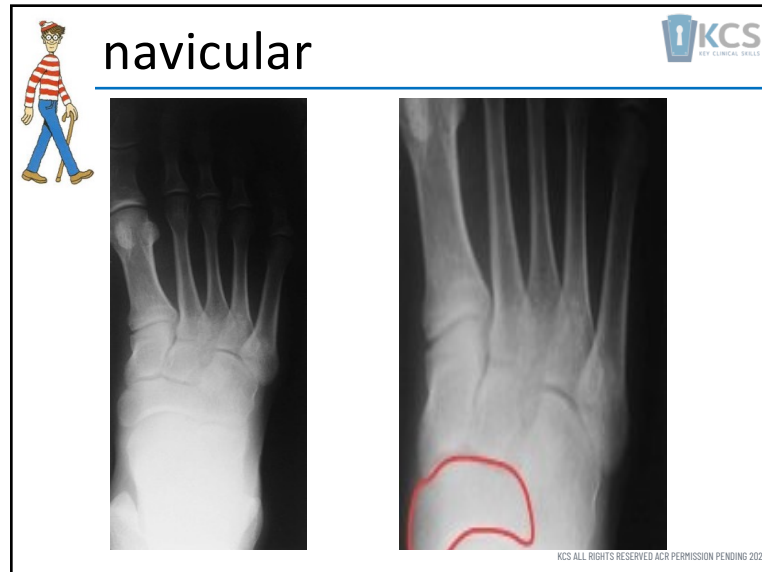
399

first cuneiform

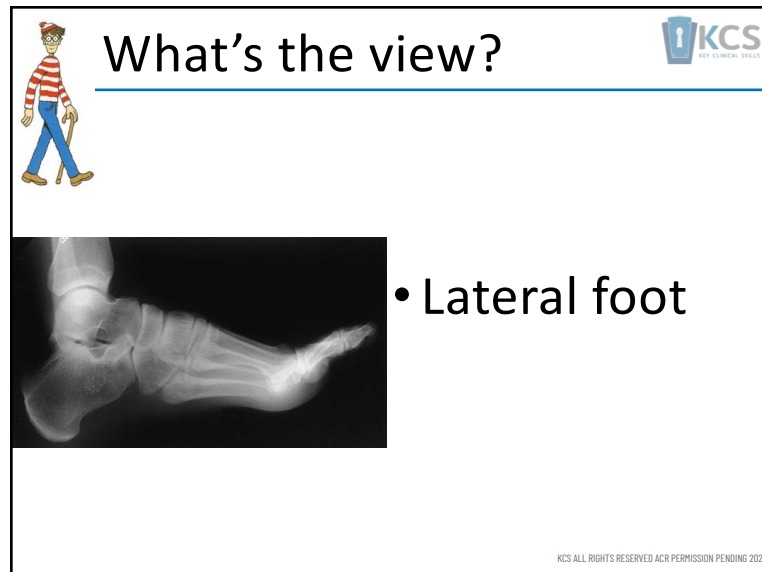


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400





401



402



 **navicular** 

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403

 **tarsal sinus** 

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404



## What view is this?



- A. lateral foot
- B. antero-posterior oblique mortise view
- C. lateral ankle

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## What view is this?




C. lateral ankle

- This sagittal view of anatomy makes it a lateral projection; the inclusion of the lower half of the leg, and exclusion of the distal half of the foot, designates this as an ankle, not foot, examination.

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406

What do the black arrows point to?




A. displaced fibular fragment  
B. fracture of the anterior rim of the tibia  
C. fracture of the posterior rim of the tibia

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407

What do the black arrows point to?



A. displaced fibular fragment


- This is an oblique fracture of the fibular shaft at the junction of the middle and distal thirds of the shaft. It is oblique, not transverse, because the fracture line is diagonal to the long axis of the shaft. The fracture is complete, not incomplete, because the distal fragment is posteriorly displaced and therefore all the cortices must be fractured.

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408



What do the white arrows point to?




A. displaced fibular fragment  
B. fracture of the anterior rim of the tibia  
C. fracture of the posterior rim of the tibia

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What do the white arrows point to?




C. fracture of the posterior rim of the tibia

- The posterior rim of the tibia is often referred to as the "third malleolus" and is often fractured in conjunction with the medial malleolus, lateral malleolus, or fibular shaft.

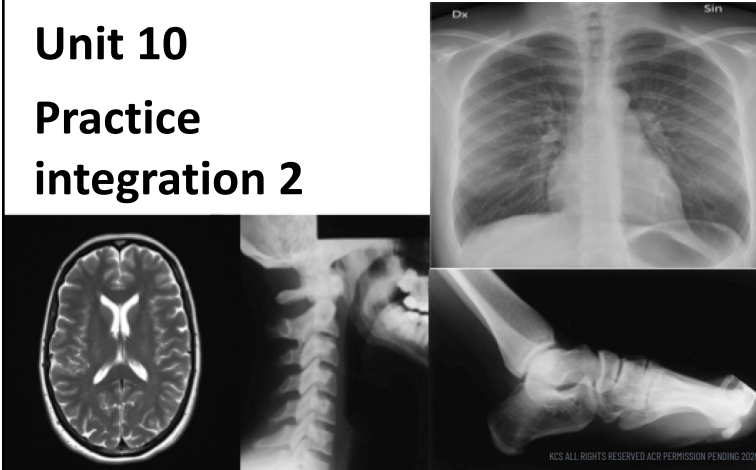
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410

Medical Imaging for the extremities 



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**Unit 10**  
**Practice integration 2**




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411

 **What's the view?** 

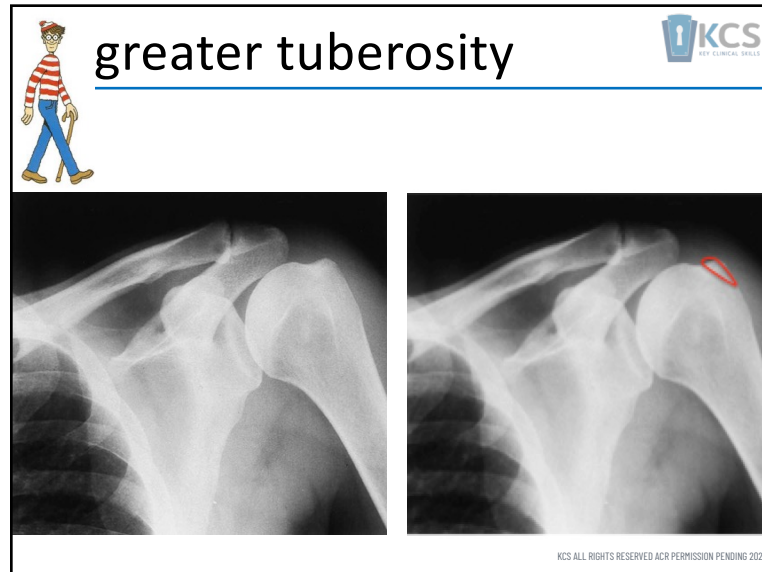
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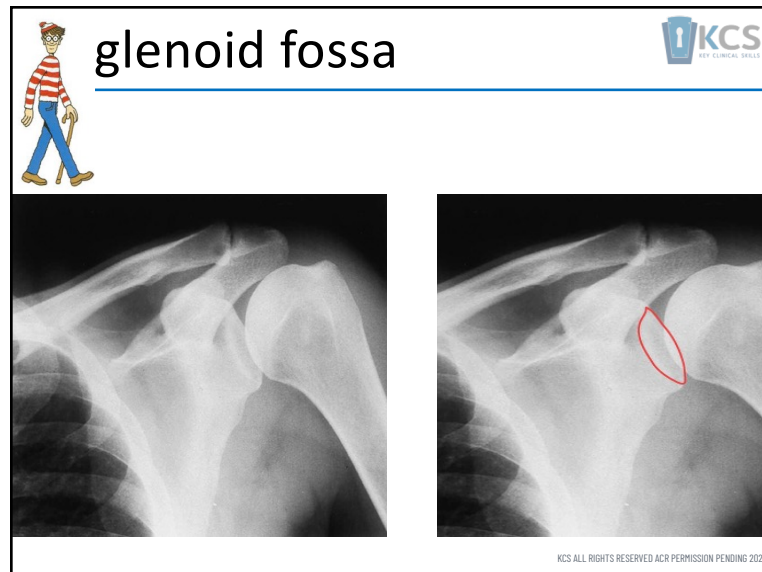
- Antero-postero external rotation

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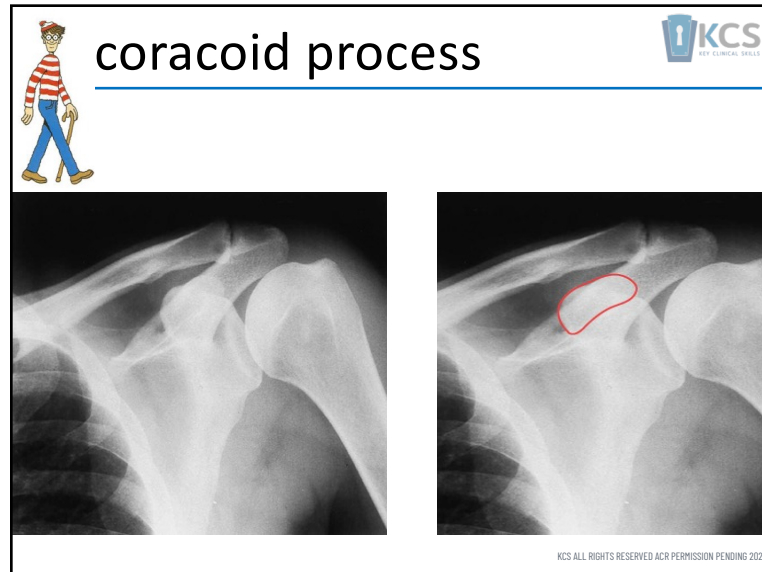
412



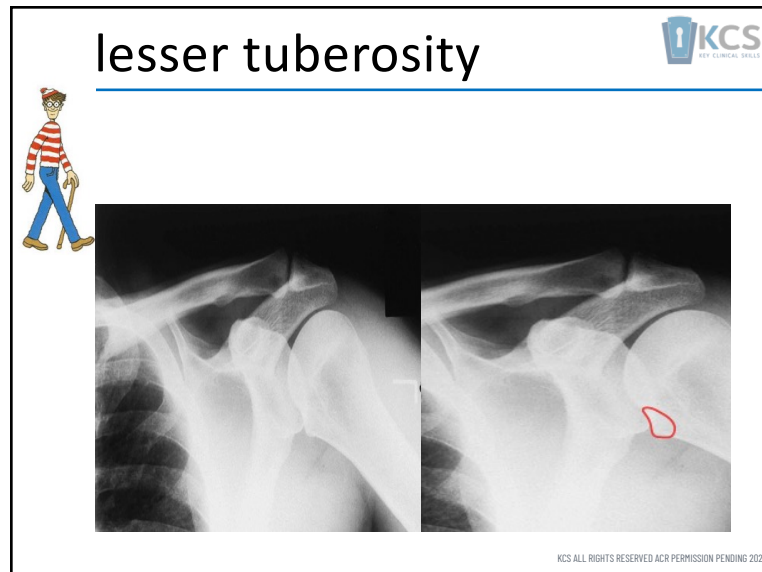
413



414

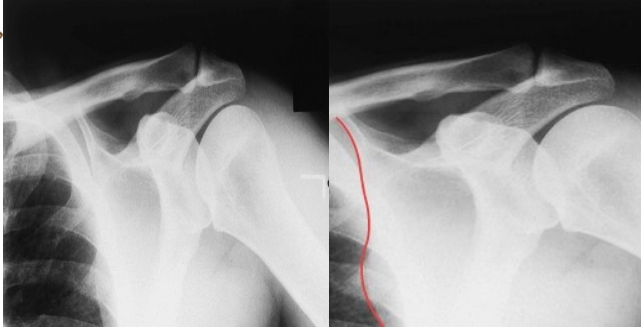



415



416

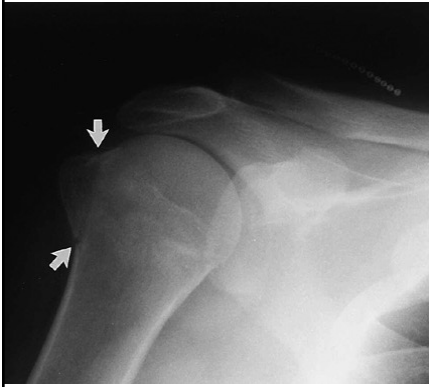
vertebral border  
of the scapula



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417


? What view is this?

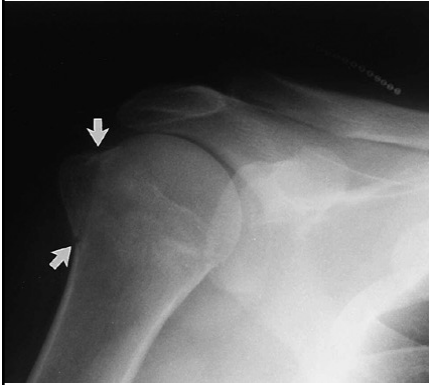


A. antero-posterior external rotation  
B. antero-posterior internal rotation

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418

**?** What view is this? 




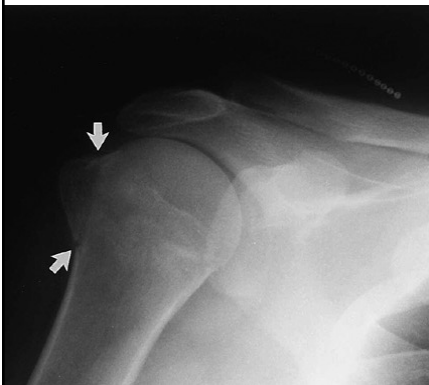
A. antero-posterior external rotation

- The image of the greater tuberosity, and not the lesser tuberosity, determines that this is an external-rotation view.

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419


**?** What do the arrows point to? 

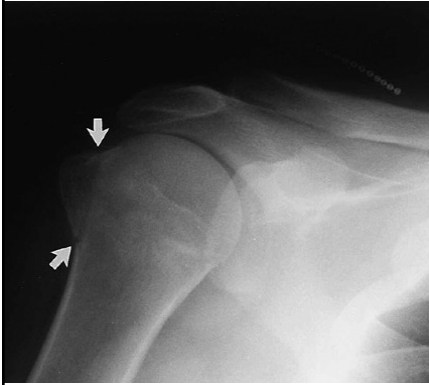


A. surgical neck fracture  
B. greater tuberosity fracture  
C. lesser tuberosity fracture

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420

**?** What do the arrows point to? 




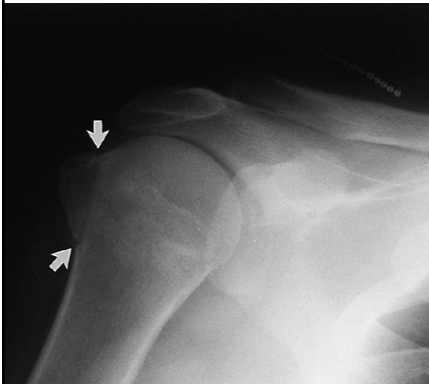
B. greater tuberosity fracture

- A complete, vertically oriented fracture line is evident through the greater tuberosity.

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421



**?** What can be said about the subacromial joint? 

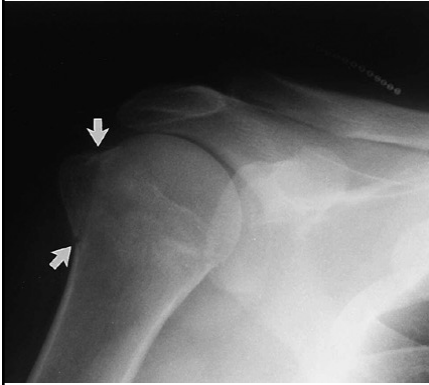


A. The joint space appears normal.  
B. The joint space appears decreased.  
C. The joint surface has also been fractured.

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 What can be said about the subacromial joint? 






B. The joint space appears decreased.

- The joint space appears abnormally decreased. There are no signs of osteoarthritis at present, such as Subchondral sclerosis or spurring. It is not clear why the joint space is decreased. Possibilities include a spasm of the deltoid that would pull the head of the humerus superiorly, or simply error in patient positioning due to the fact that this is a trauma exam and positioning is not always perfect.

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423

What's the view? 

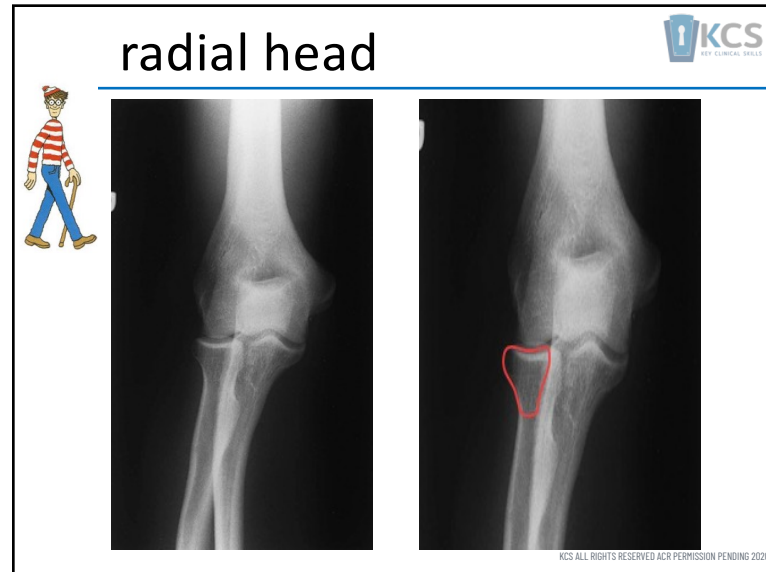



- Antero-postero elbow

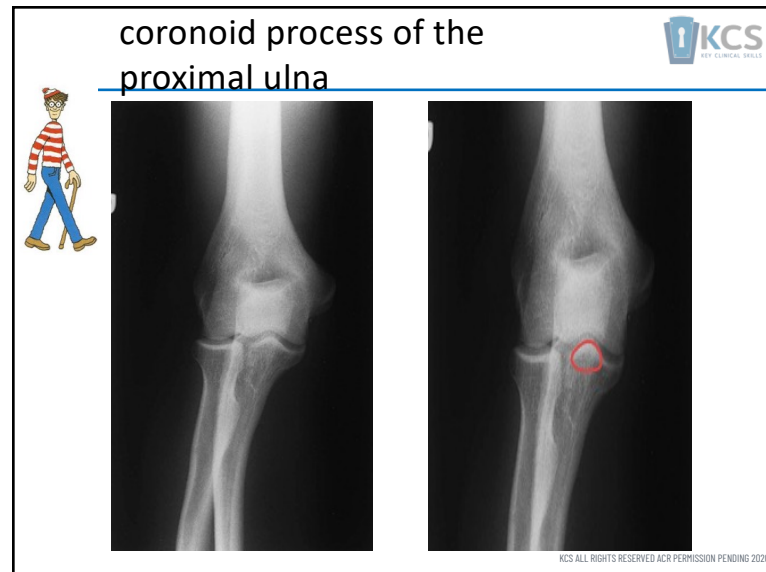
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424







425



426



# radial tuberosity



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427

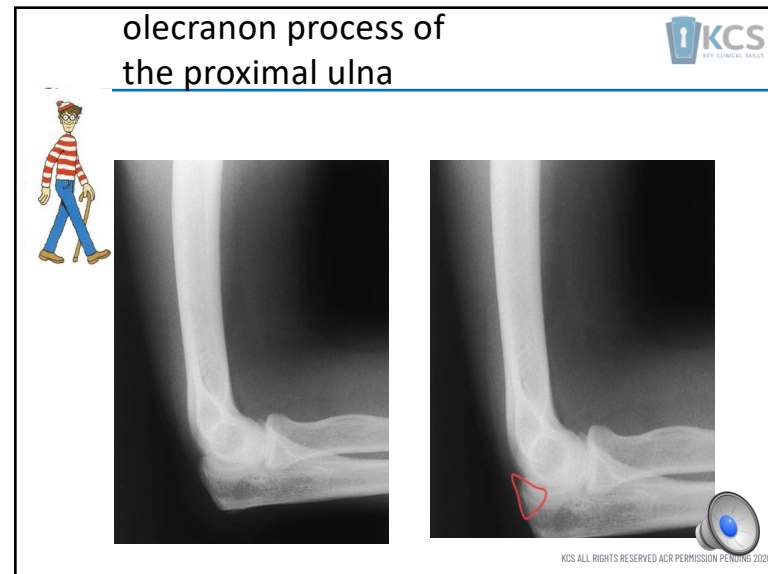
# What's the view?



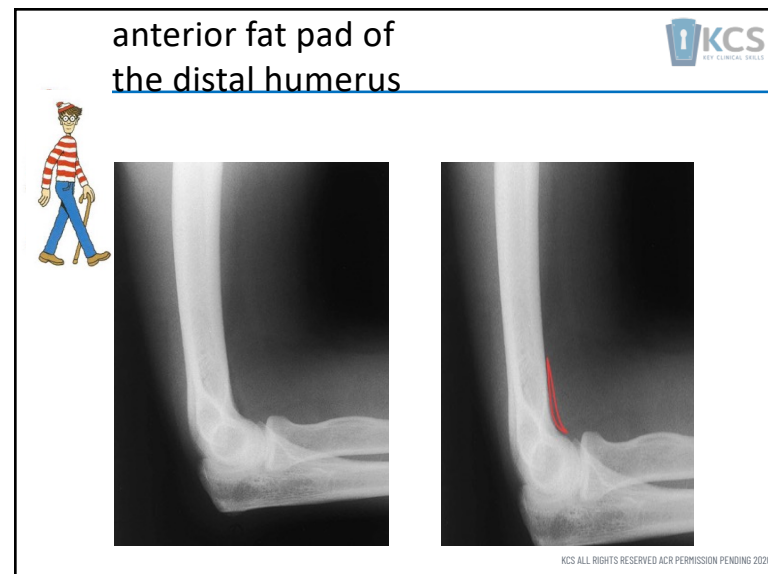
- Lateral elbow

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428




429



430


**?** What view is this? 




A. antero-posterior  
B. lateral  
C. internal oblique  
D. external oblique

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431

**?** What view is this? 





D. external oblique

- The elbow is in extension and is in anatomic position. This slightly superimposes a portion of the proximal radius in front of the proximal ulna, which is how an anteroposterior view looks.

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432


What do the arrows indicate? 




A. fracture of the capitulum  
B. fracture of the coronoid process  
C. fracture of the radial head

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433

What do the arrows indicate? 





C. fracture of the radial head

- The arrows mark the extent of the fracture line through the radial head. The fracture fragment is minimally displaced and depressed inferiorly.

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434

# What's the view?





- Postero-antero wrist

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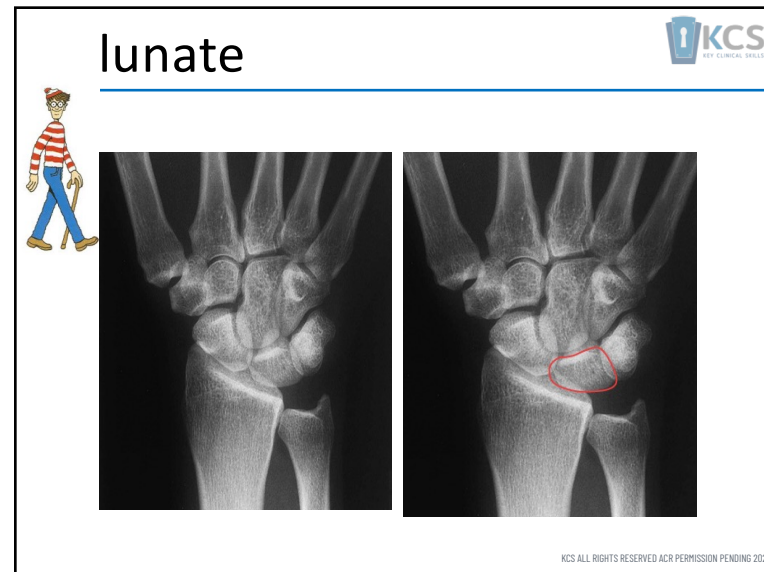
435

# scaphoid

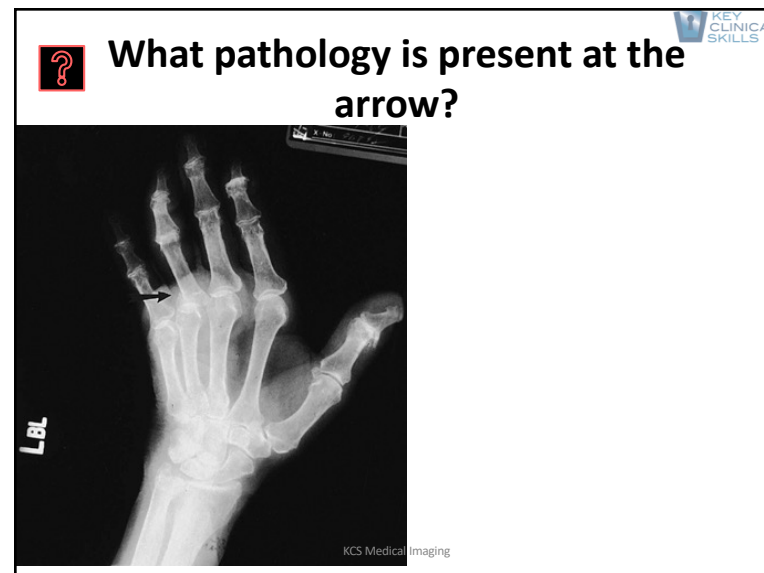


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436




437



438

What pathology is present at the arrow?




A. fracture of the metacarpal base  
B. fracture of the proximal phalanx base  
C. fracture-dislocation of the metacarpal head

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What pathology is present at the arrow?



B. Fracture of the proximal phalanx base



- The ring finger metacarpophalangeal joint looks dislocated at first glance, but closer inspection reveals the fracture at the base of the proximal phalanx.

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440



### What's the view?






- Postero-antero hand

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441



### articular surface of the radius



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442

# What's the view?






- Oblique hand

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443



# first carpo-metacarpal joint



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444



proximal inter-phanlangeal joint of the third digit



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base of the fifth metacarpal



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