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Applied Radiology in Orthopaedics 1

Ortho Made Simple

Mok Ying Ren

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How to Maximise My Lecture Series

- You will be given 2 sets of notes
  - **OMS Master Summary** (Helicopter view of entire lecture)
  - **Lecture slides** for annotation
    - Applied Radiology
    - Approach Frameworks
    - Shoulder and Elbow Exam
- Suggested **3 Pronged Method**
  - Open **OMS Master Summary** - ensure visibility throughout lecture
  - Annotate on **lecture slides**
  - Separate Pen and Paper to write down questions → Ask on Slido immediately
    - Safe space to ask questions - if you are thinking about it, someone is too! Please please ask!
- Post lecture quizzes for each lecture in slides

Summary Slide For this lecture:

Summary Table of XRs

Region *(Lines)*	Orthogonal Sets	Special Views
Shoulder *(Moloney's Arch)*	AP/ Axial	Y-Scapula, Velpeau Zanca (ACJ)
Humerus	AP/ Lateral	
Elbow *(Anterior Humeral, Radiocapitellar Lines)*	AP/ Lateral	Greenspan (Radial head) Internal Oblique (Lateral Condyle #)
Forearm	AP/ Lateral	
Wrist *(Gilula Lines, Radial Parameters)*	PA/ Lateral	Scaphoid Carpal Tunnel
Hand	PA/ Lateral/ Oblique	
Finger	PA/ Lateral/ Oblique	
Pelvis *(Acetabular Lines)*	AP	Inlet/ Outlet Iliac/Obturator Oblique
Sacroiliac Joint	AP Sacrum lateral	

Region *(Lines)*	Orthogonal Sets	Special Views
Hip *(Shenton's Line)*	AP/ Lateral	
Femur	AP/ Lateral	
Knee	AP/ Lateral (Weight bearing for OA)	Skyline (PFJ) Rosenberg (Medial Joint Space) Long Leg (Mech axis)
Tibia	AP/ Lateral	
Ankle	AP/ Lateral/ Mortise	
Foot	AP/ Lateral/ Oblique	Harris, Broden's (Calcaneum)
Toes	AP/ Lateral/ Oblique	
Cervical Spine *(4 Lines for alignment) (Retropharyngeal Swelling 2-6-6-2)*	AP/ Lateral	Open mouth (C2) Swimmer's (C7) Flexion/ Extension
Lumbar Spine	AP/ Lateral	Flexion/ Extension

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Goals in our 3- Part Lecture Series

- Part 1 - Normal XR
  - Review of normal XRs
  - Understand the key principles in ordering XRs
- Part 2 - Abnormal XR
  - Approach to reading common XR - Vocab training
  - Application to Trauma - Fractures
  - Application to Trauma - Dislocations
  - Application to Arthritis
- Part 3 - Abnormal XR + Advanced Imaging
  - Application to Tumor
  - Application to Misc. - Osteomyelitis, Charcot
  - **Advanced Imaging - CT and MRI scans**
    - Basic Principles
    - Ordering of Advanced Imaging
    - Approach to Reading Advanced Imaging

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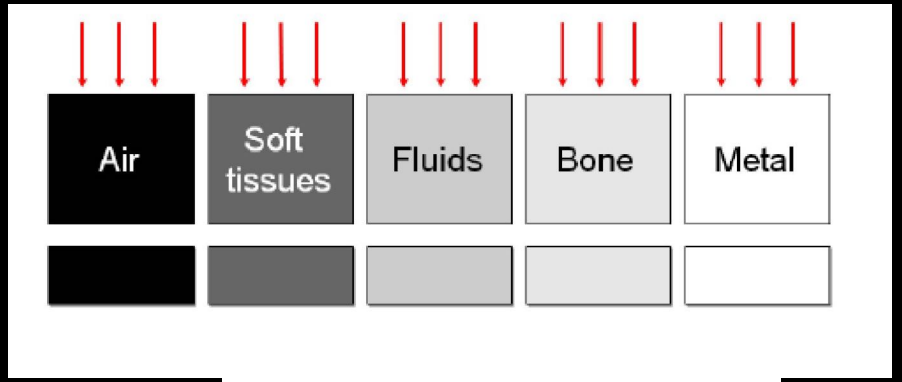
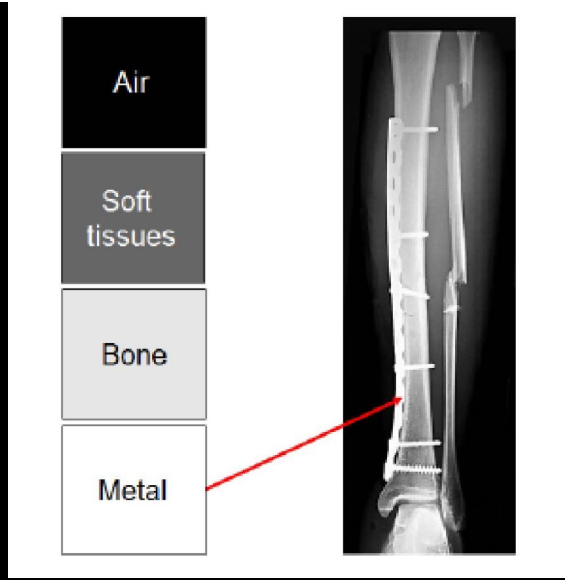
How do X-rays Work?



- Differential absorption of x-rays.
- What you see depends on the tissue the X-rays are passing through
  - No tissue = Complete Black
  - If all absorbed = Complete White
  - If partially absorbed = Shades of grey
- 2D image



Shoulder to Proximal Humerus

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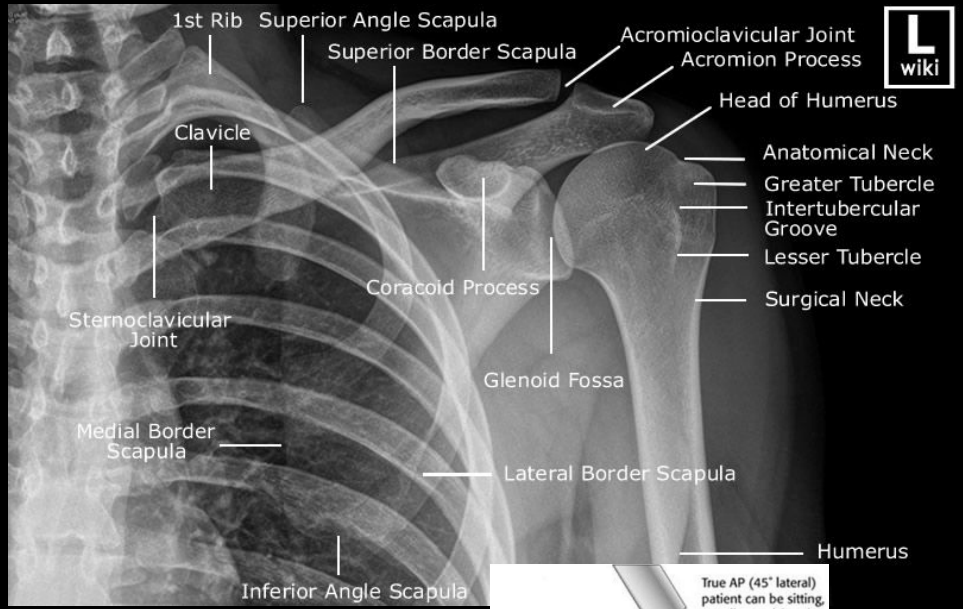
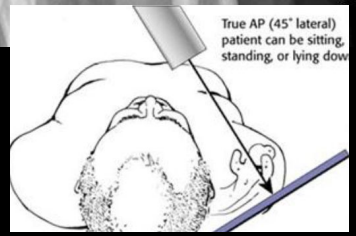
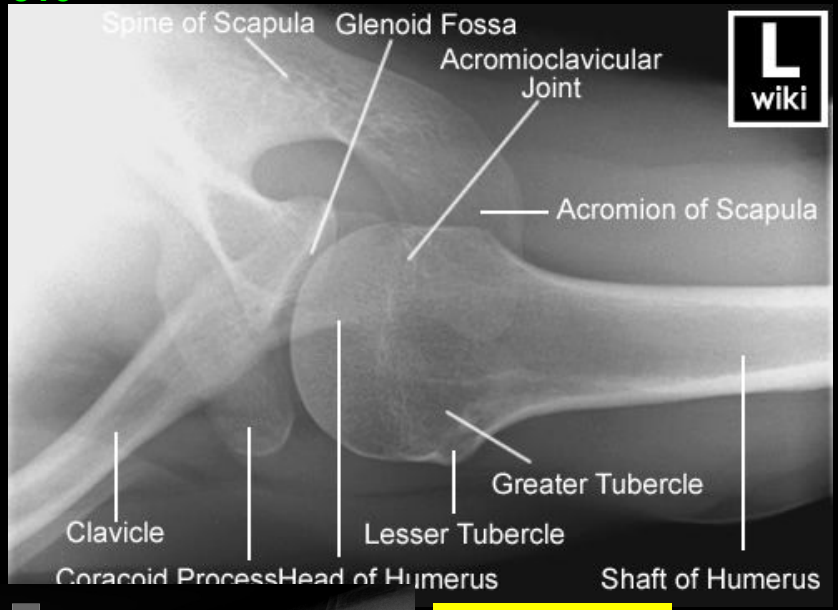
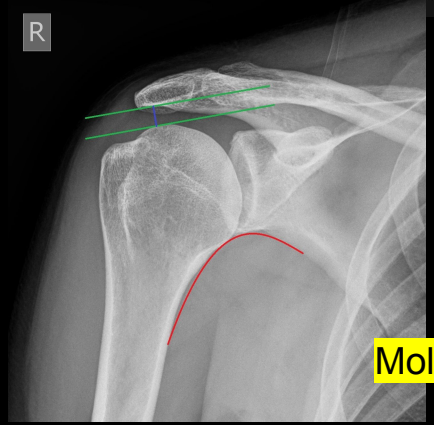
Normal Shoulder XR



Shoulder AP



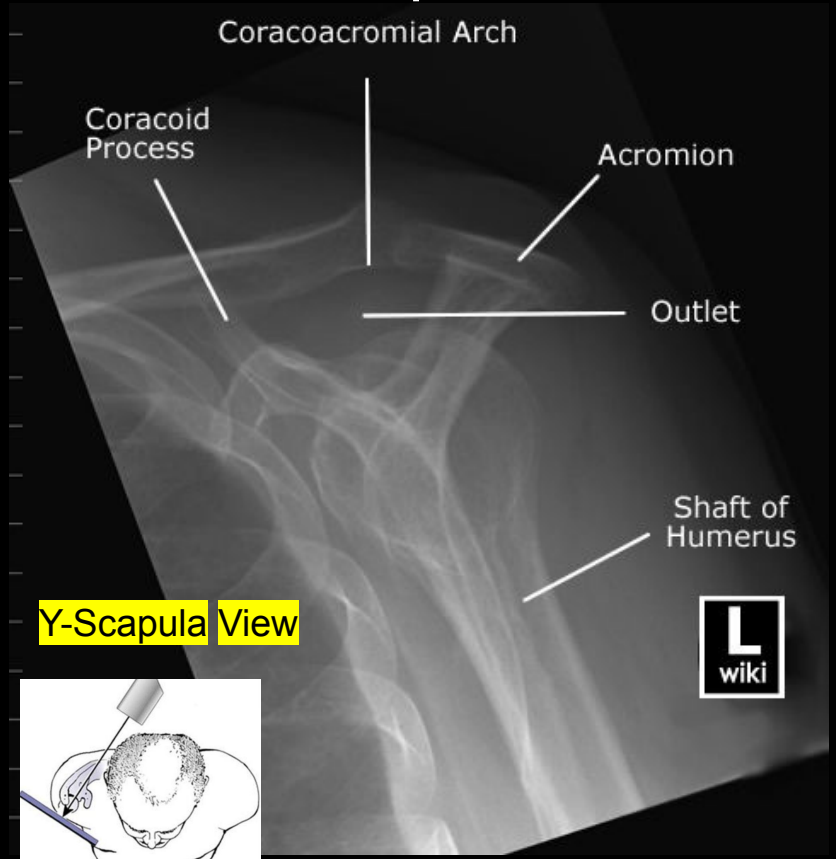




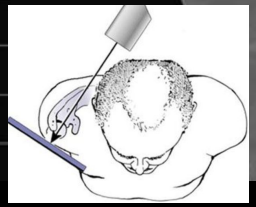
Shoulder Axial (Coracoid determines Anterior)

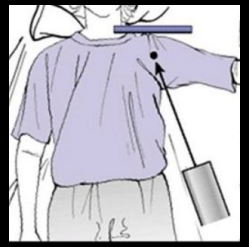
Moloney's Arc

Shoulder Special Views

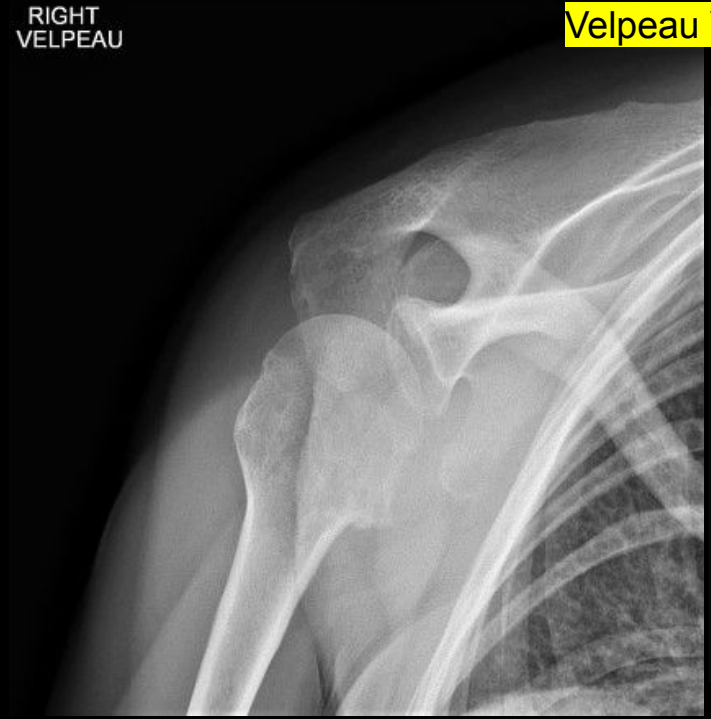


Y-Scapula View



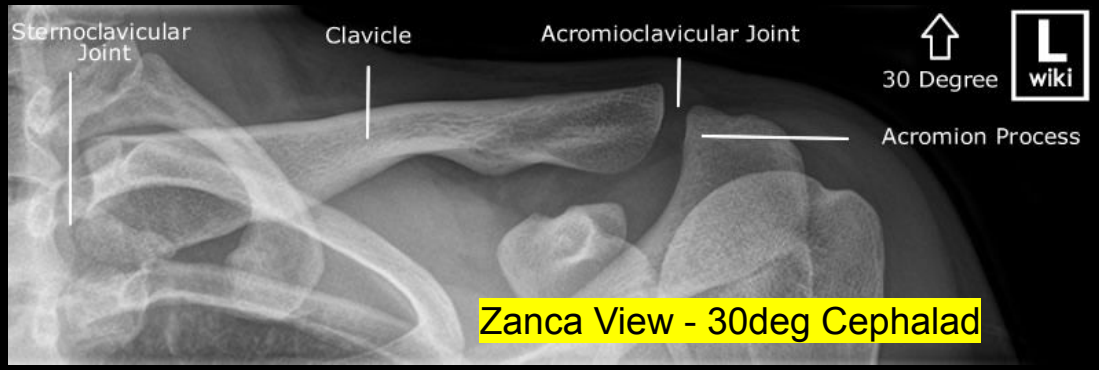


Axial View - requires abduction of arm

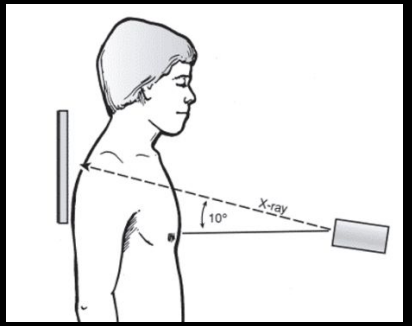


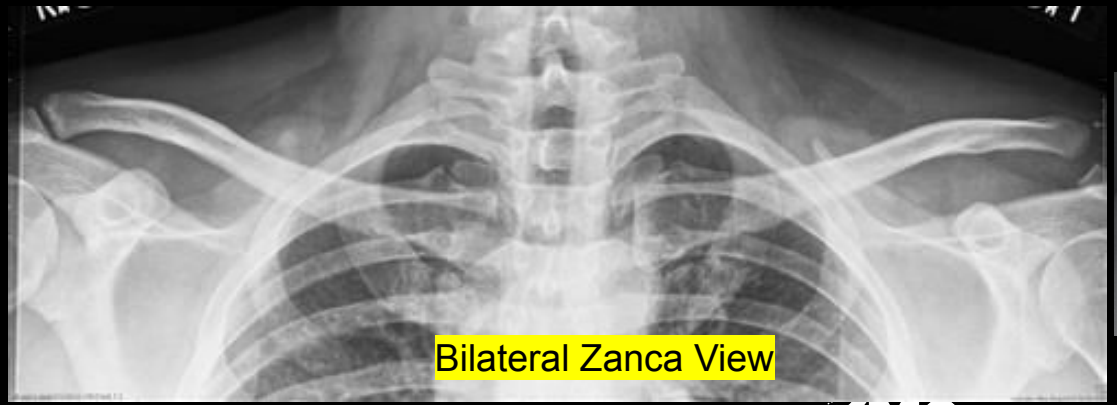
Velpeau View

Shoulder Special Views - Acromioclavicular Joints

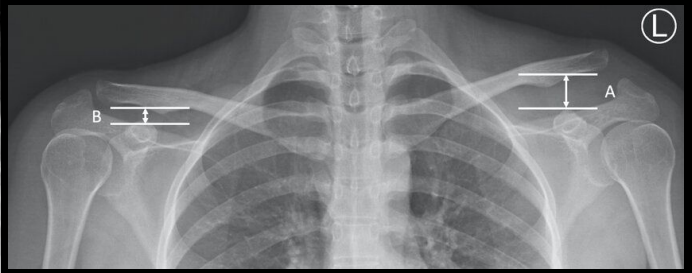


Zanca View - 30deg Cephalad





Bilateral Zanca View



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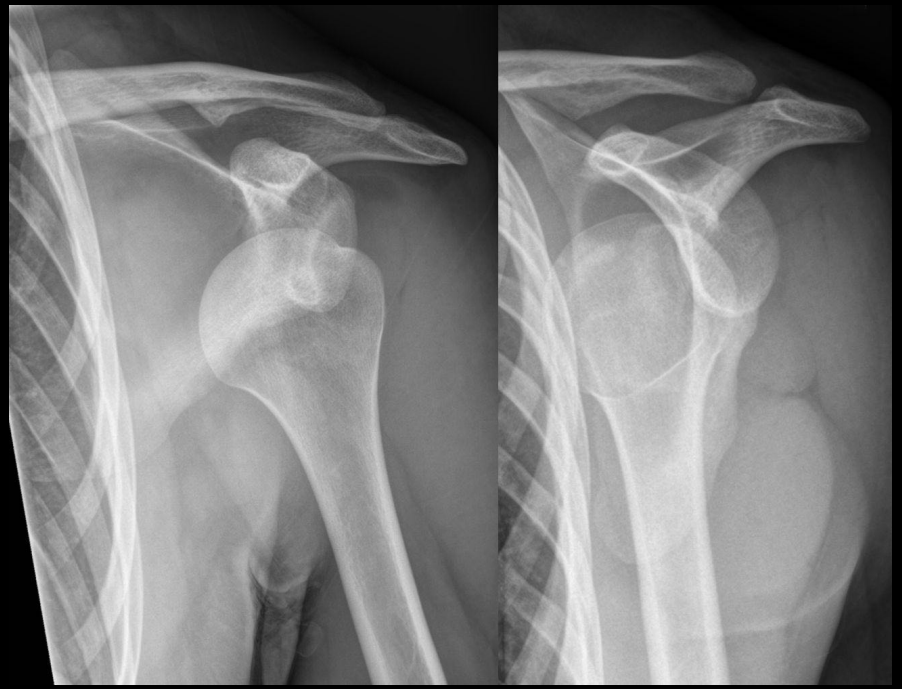
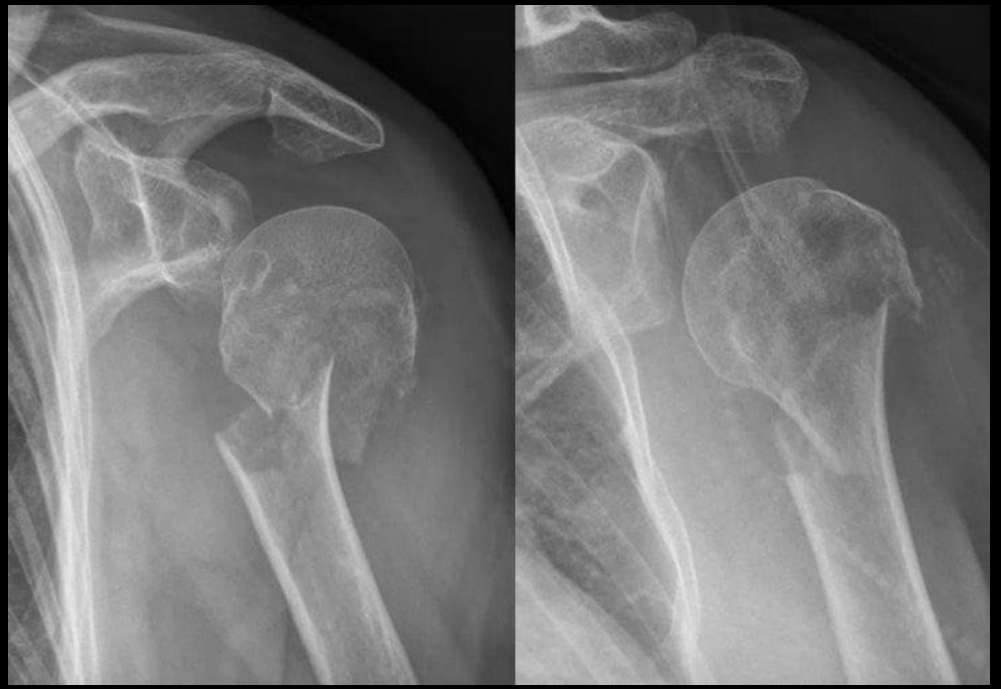
Abnormal Shoulder XRs



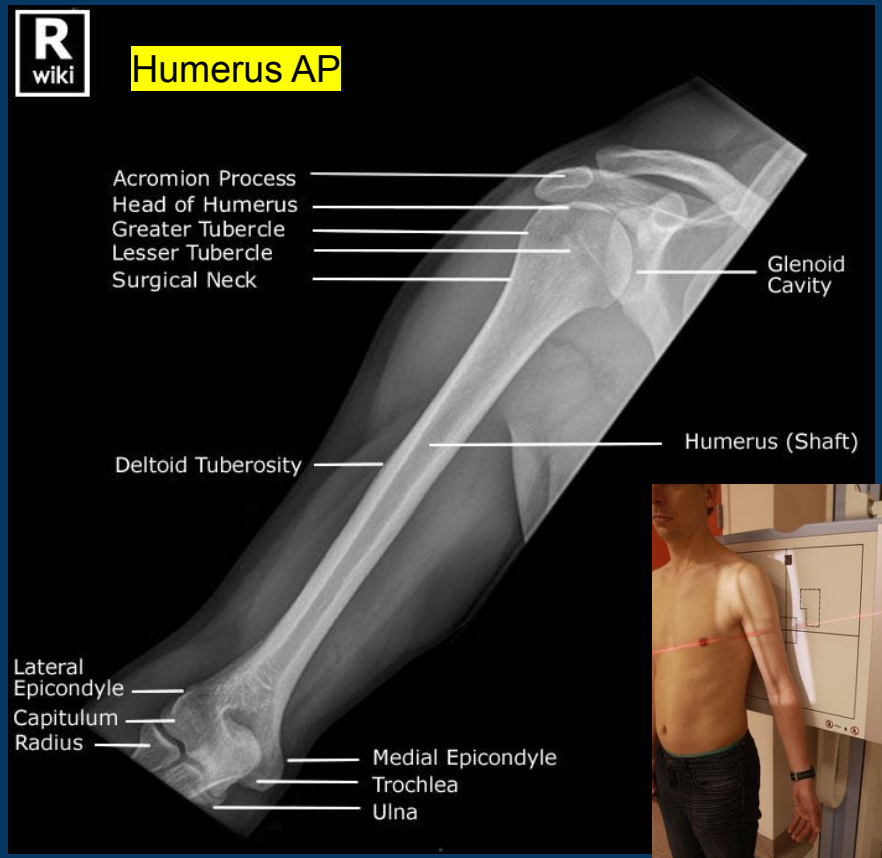
Anterior Shoulder Dislocation

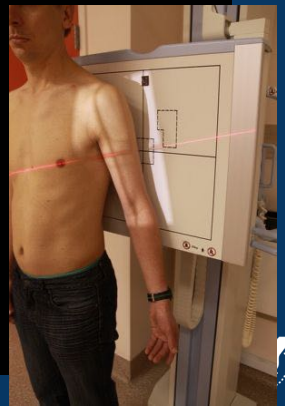


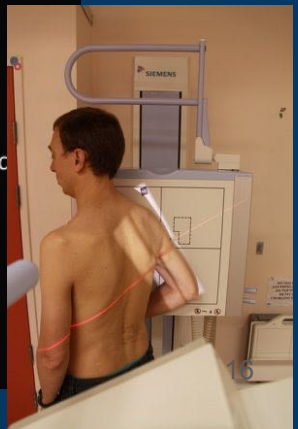
Proximal Humerus #

Humerus Shaft to Elbow

Normal Humerus XR







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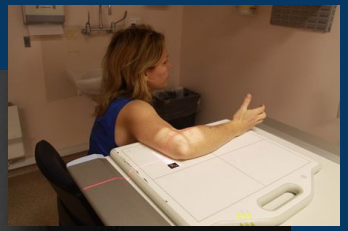
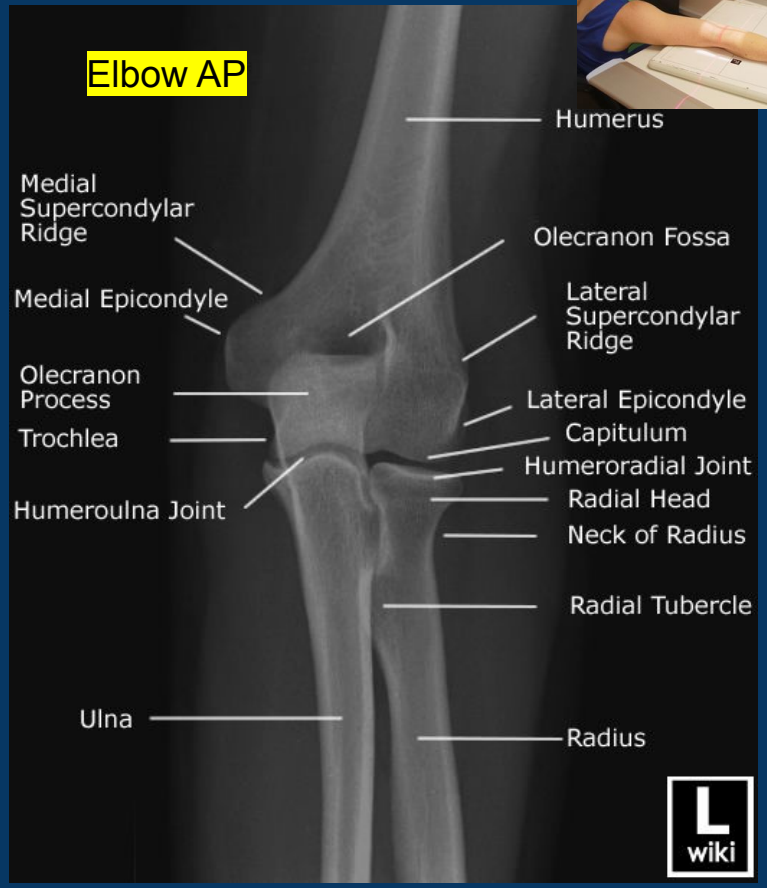
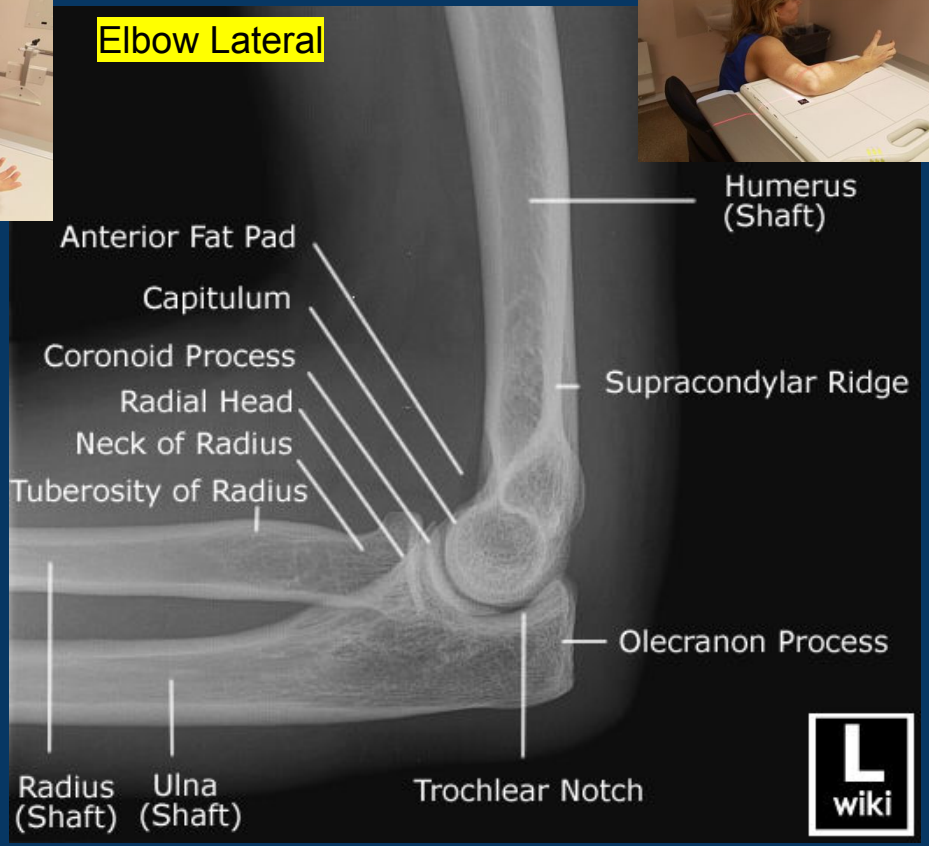
Normal Elbow XR



Elbow AP



Elbow Lateral



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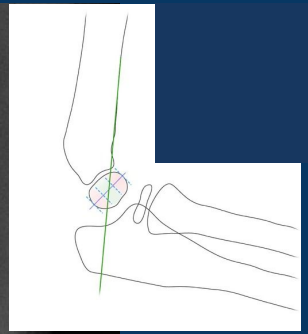
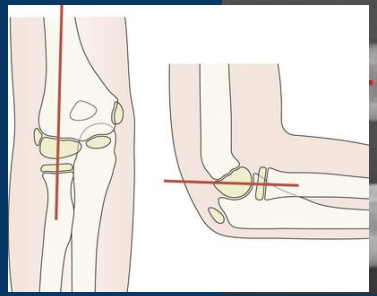
2 Lines for Elbow *(Paeds)*

Anterior Humeral Line

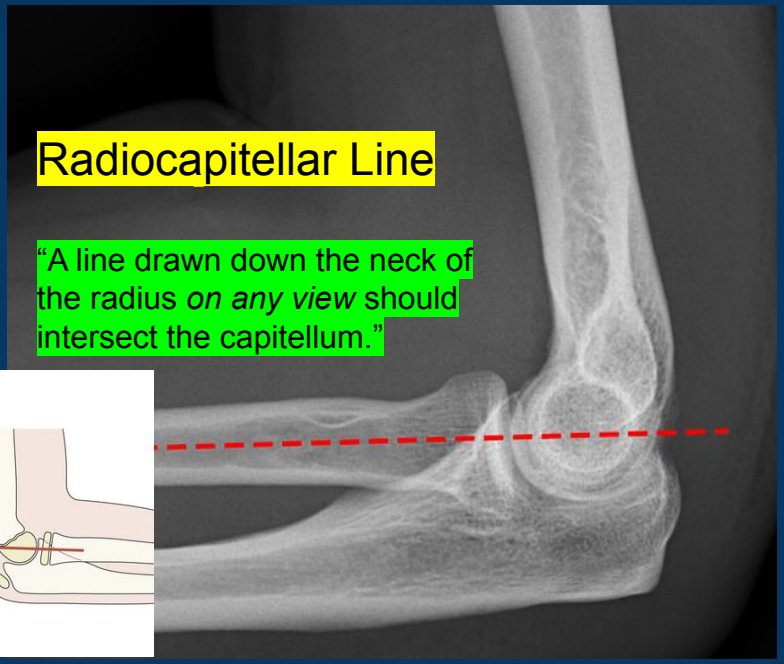
"A line drawn down the anterior surface of the humerus should intersect the middle third of the capitellum."

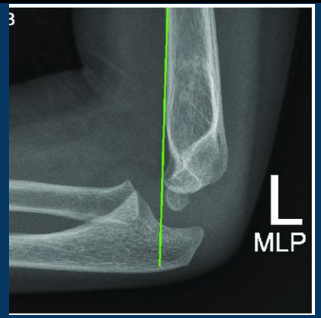


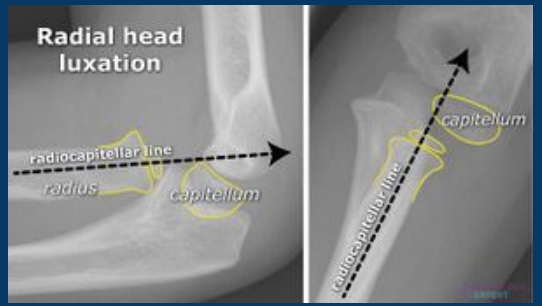


Radiocapitellar Line

"A line drawn down the neck of the radius *on any view* should intersect the capitellum."







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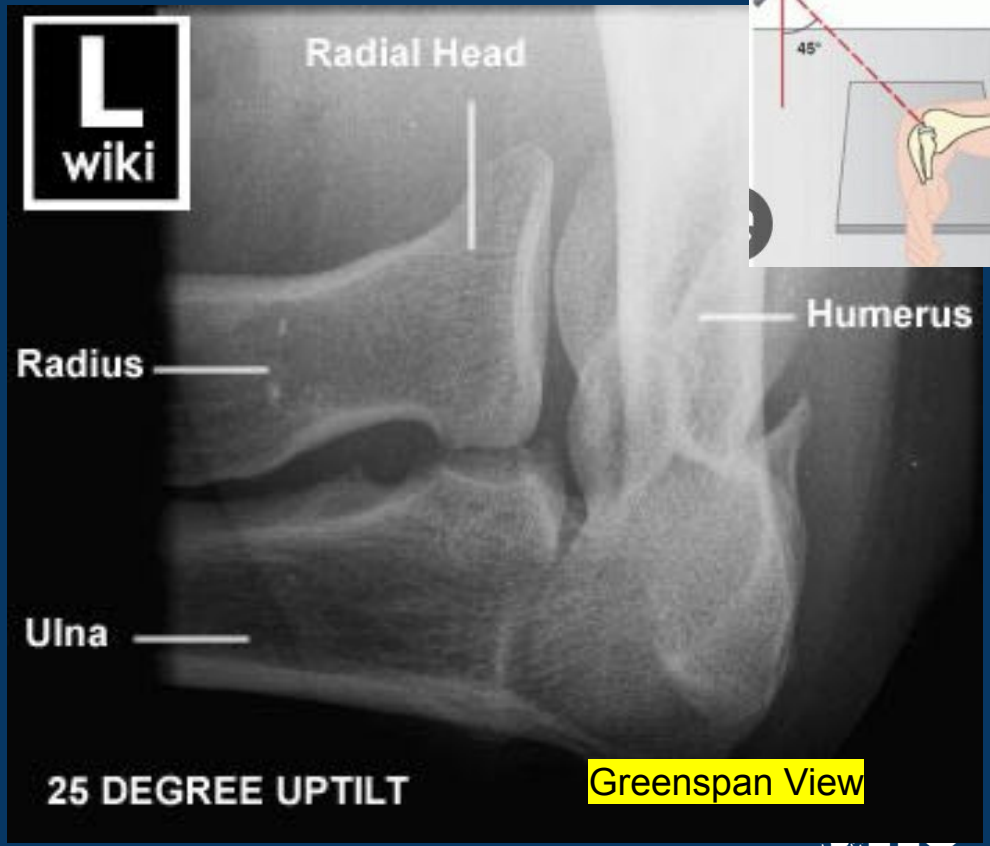
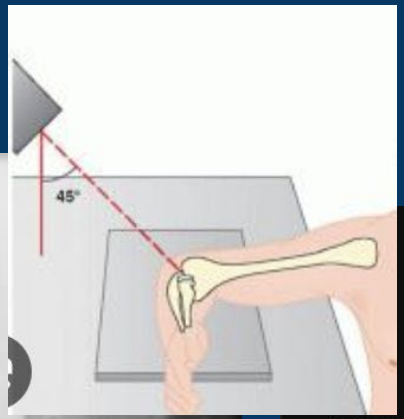
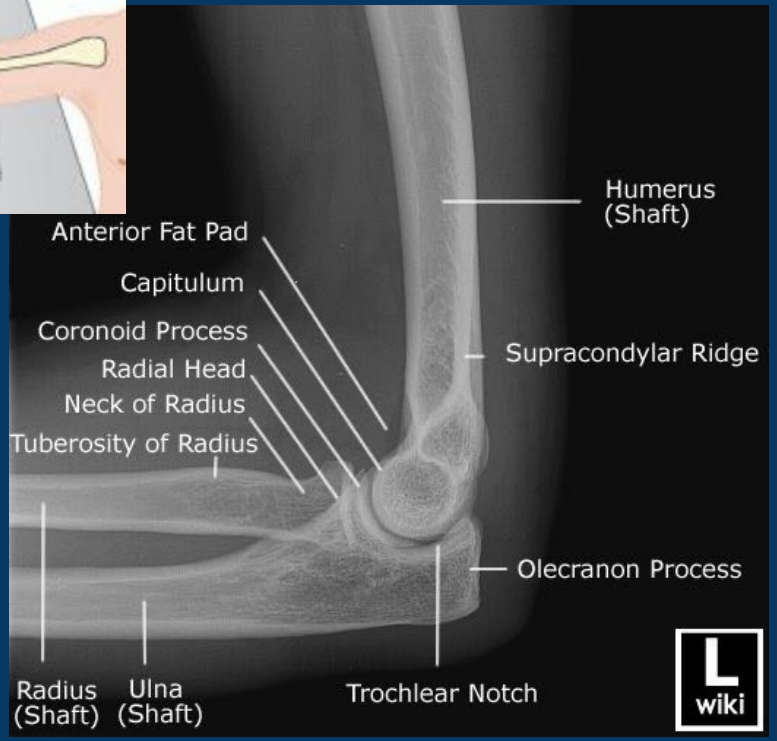
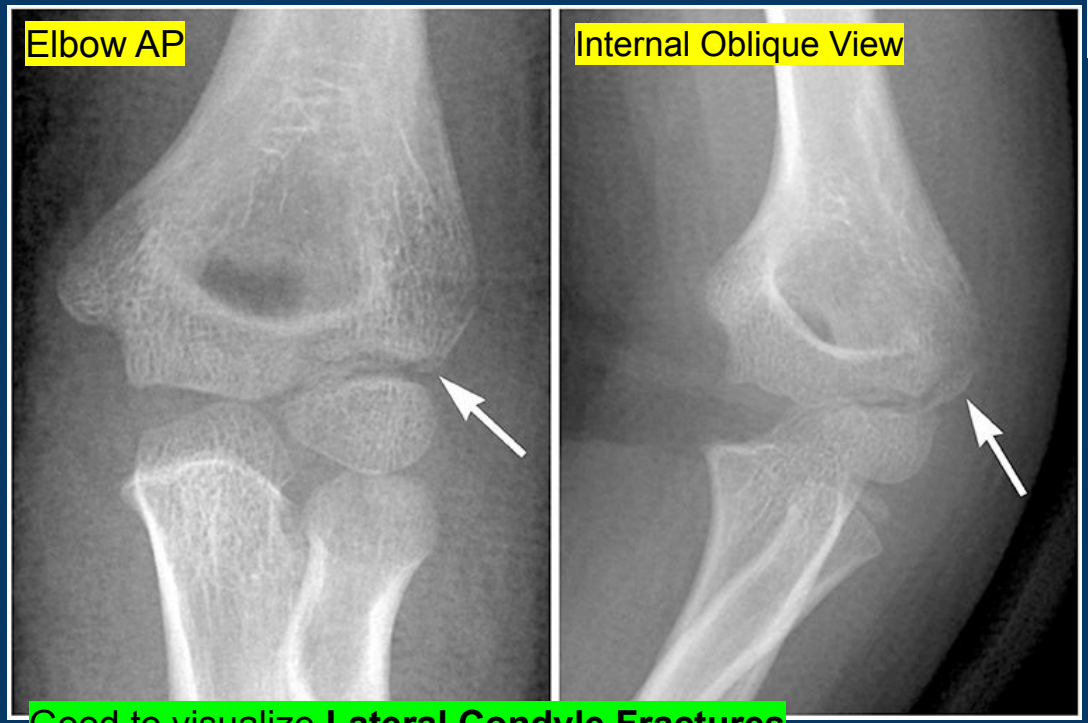
Elbow Special XR



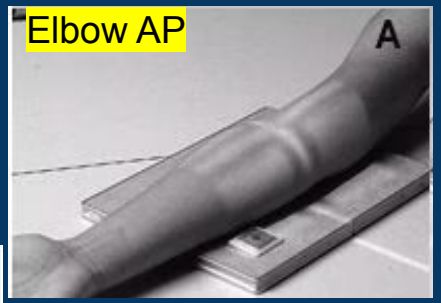


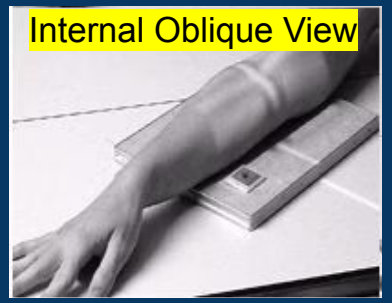


Elbow Special XR (Paeds)



Good to visualize **Lateral Condyle Fractures**
(**#2** Most common Paediatric Elbow Fracture)





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Abnormal Humerus/ Elbow XRs

Humeral Shaft #

Humeral Shaft #

Distal humerus #

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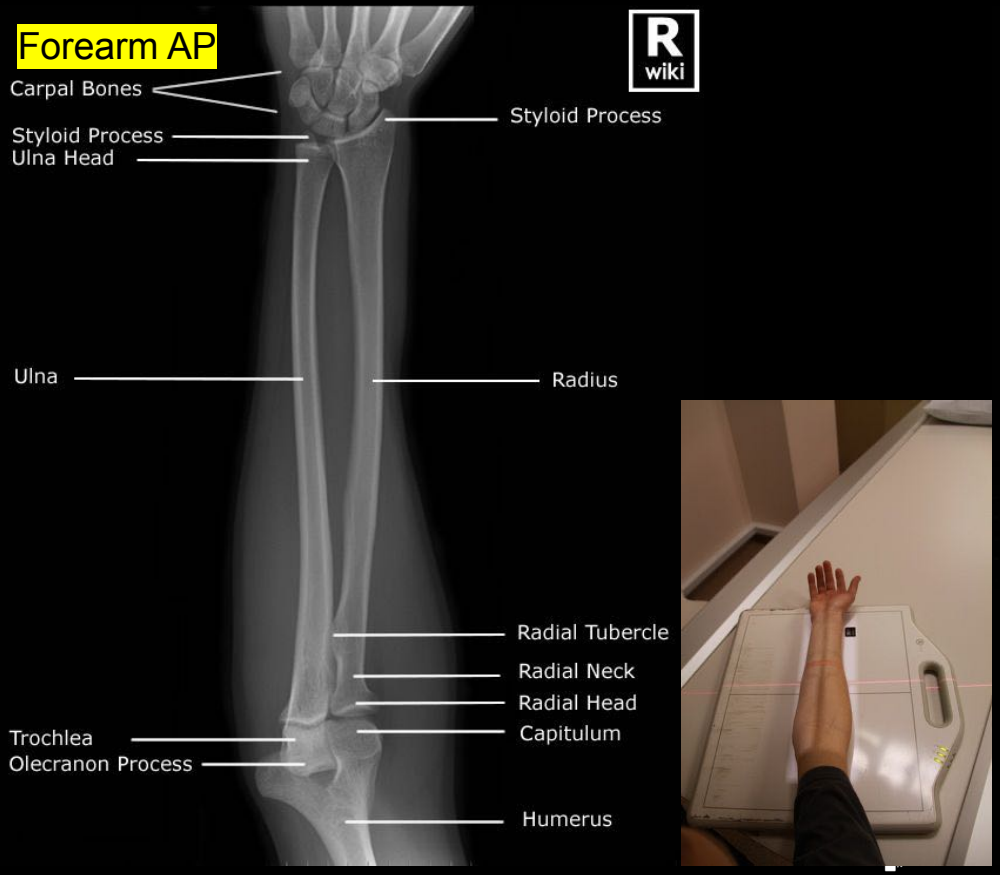
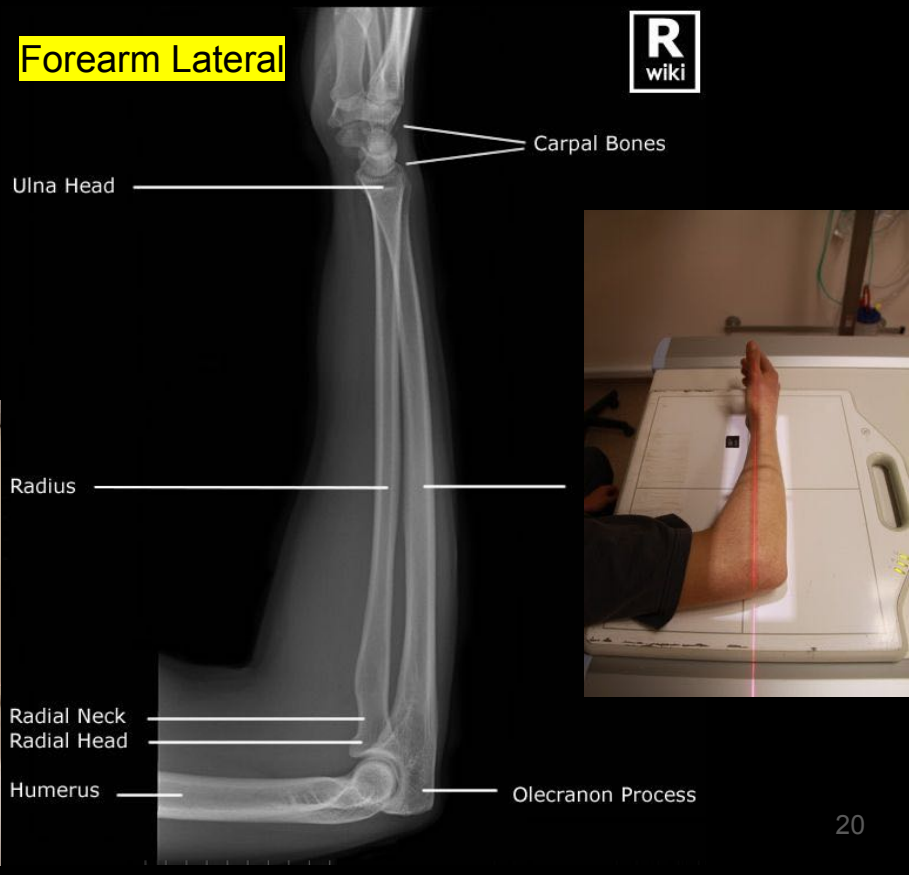
Normal Forearm XR

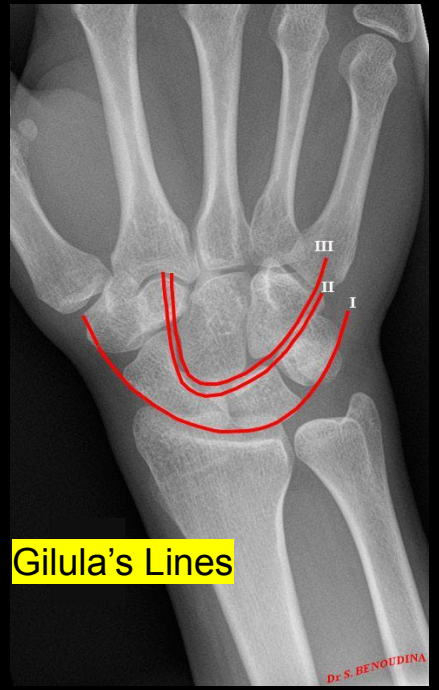
Forearm AP



Forearm Lateral



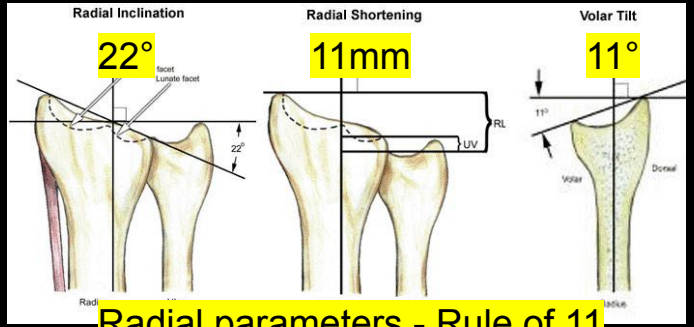
Normal Wrist XR



Gilula's Lines

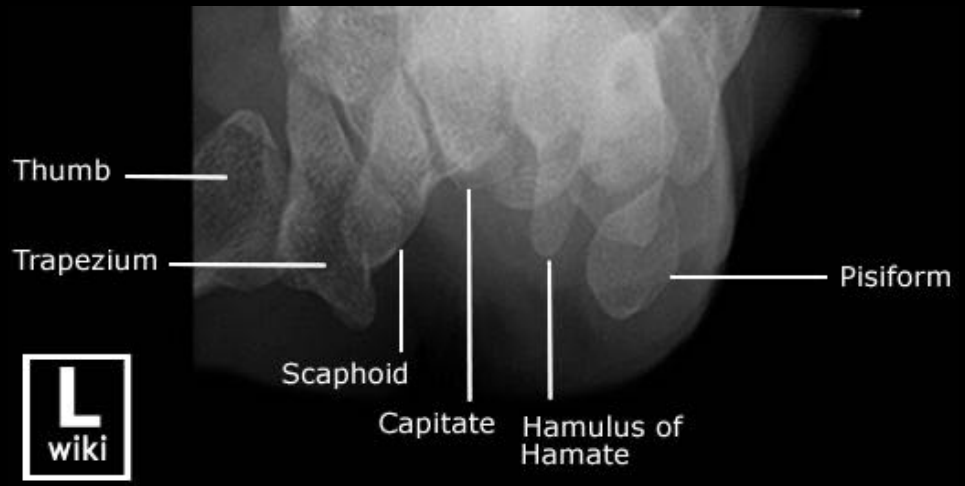
Wrist PA

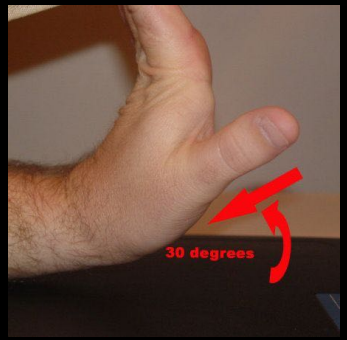
Wrist Lateral



Radial parameters - Rule of 11

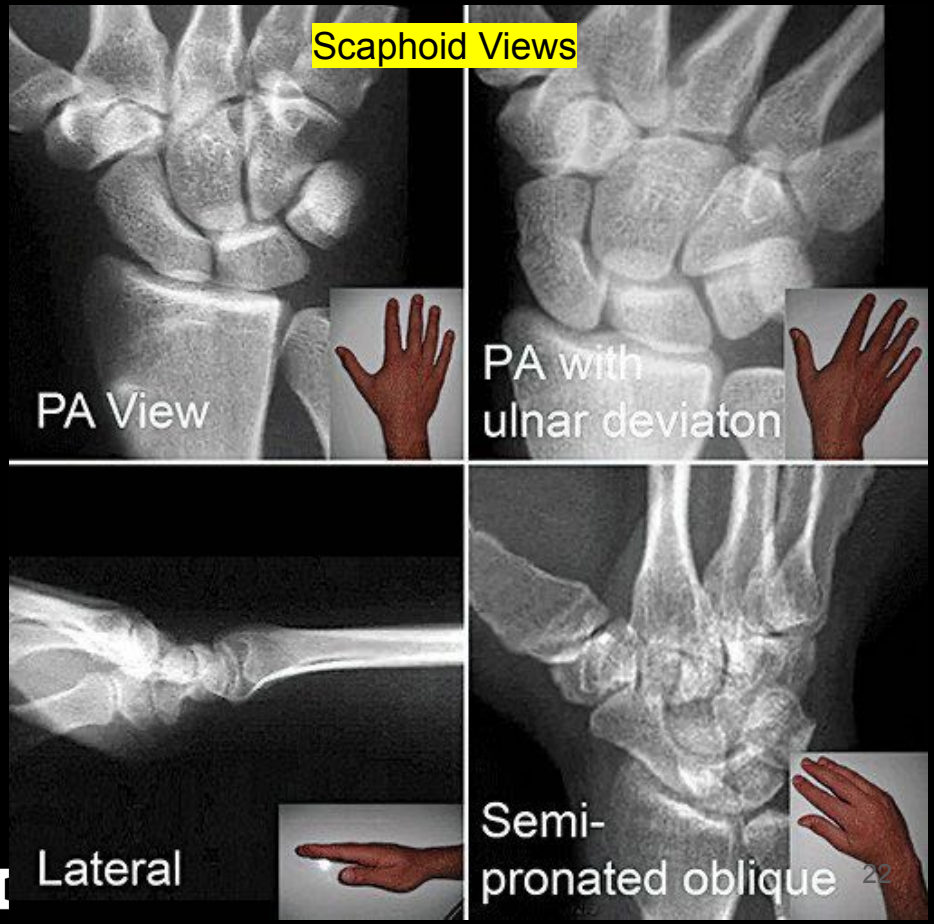
Wrist Special Views





Carpal Tunnel View

Scaphoid Views



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Normal Hand XR

Hand PA

Hand Oblique

Hand Lateral

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Normal Finger XR

PA

Oblique

Lateral

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Abnormal Forearm/ Wrist/ Hand XRs

Both Forearm # with
Posterior Elbow Dislocation

Distal Radius #

Bony Mallet Finger

Summary Table of XRs

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Region *(Lines)*	**Orthogonal Sets**	**Special Views**
Shoulder ***(Moloney's Arch)***	AP/ Axial	Y-Scapula, Velpeau Zanca (ACJ)
Humerus	AP/ Lateral	
Elbow ***(Anterior Humeral, Radiocapitellar Lines)***	AP/ Lateral	Greenspan (Radial head) Internal Oblique (Lateral Condyle #)
Forearm	AP/ Lateral	
Wrist ***(Gilula Lines, Radial Parameters)***	PA/ Lateral	Scaphoid Carpal Tunnel
Hand	PA/ Lateral/ Oblique	
Finger	PA/ Lateral/ Oblique	

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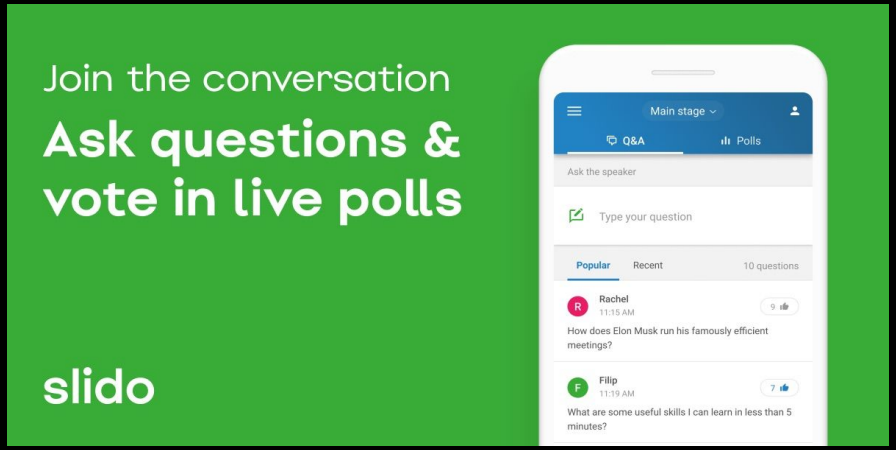
Quiz Time!

- **Live Audience** – Submit your answer on SLIDO to enhance your learning through immediate feedback.

- **Recording Audience** – Refer to the slides for the exact questions and options.



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Normal XR Quiz Q1

15 **Which line should you be able to recognise in a Shoulder AP XR?**

- Shenton's Line
- Moloney's Arc
- Radiocapitellar Line
- Anterior Humeral Line

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Normal XR Quiz Q2

18

What bone is labelled A?

- Lunate
- Capitate
- Scaphoid
- Hamate

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Normal XR Quiz Q3

18 **Which special XR is useful to evaluate the acromioclavicular joint (ACJ)?**

- Bilateral Zanca View
- Shoulder Y-scapular View
- Shoulder Axial View
- Internal Oblique View

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Normal XR Quiz Q4

18 **Which line(s) should you be able to recognise in a Wrist PA XR?**

- Shenton's Line
- Gilula's Lines
- Moloney's Arch
- Anterior Humeral Line

Pelvis and Acetabulum

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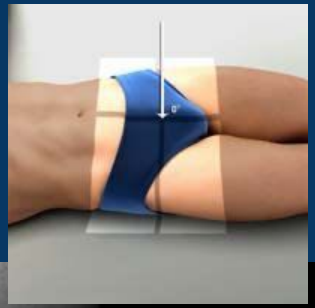
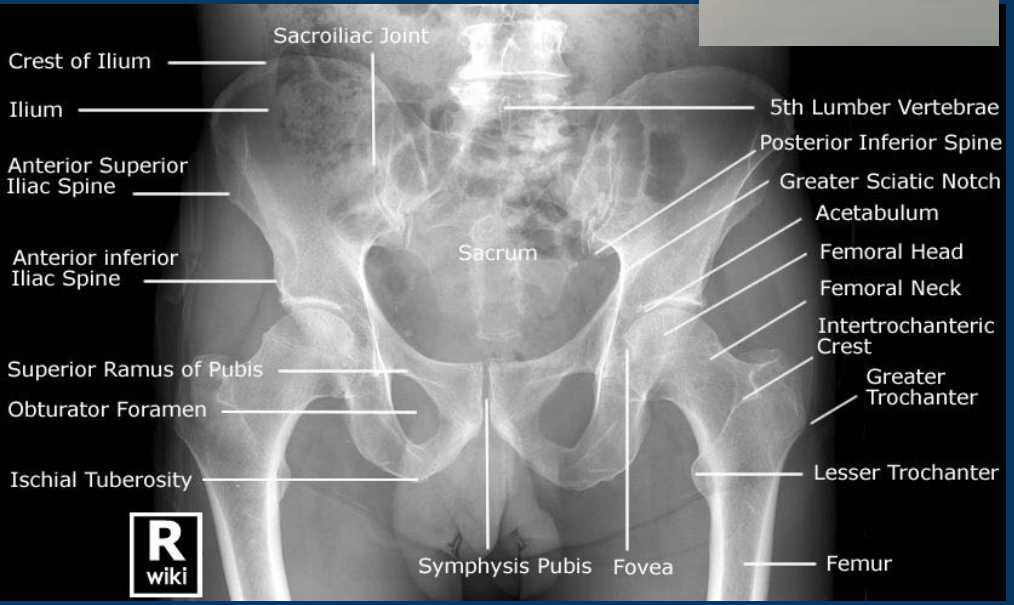
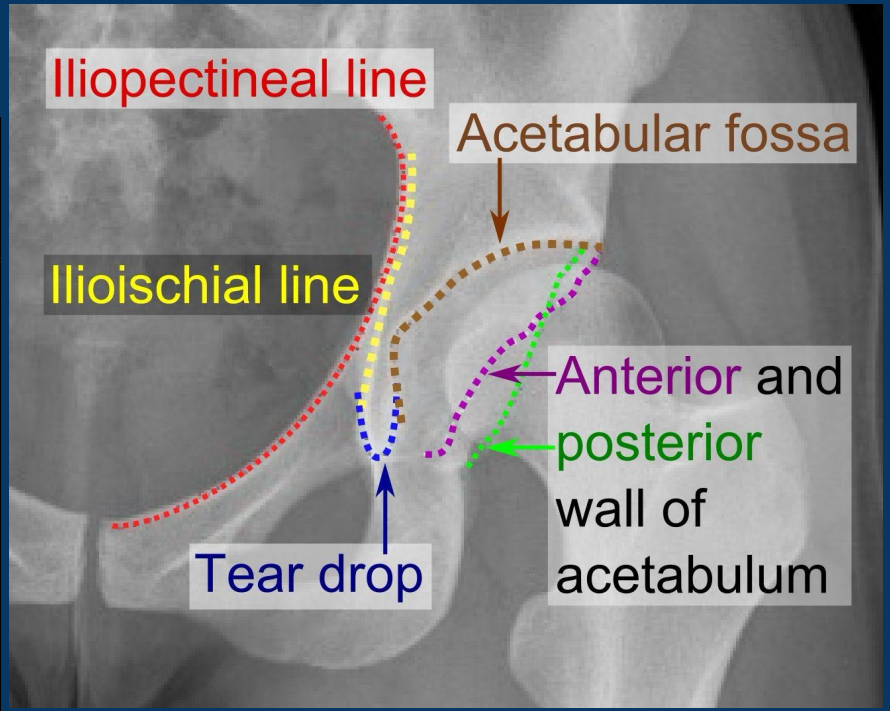
Normal Pelvis XR





Pelvis AP



Acetabular Lines

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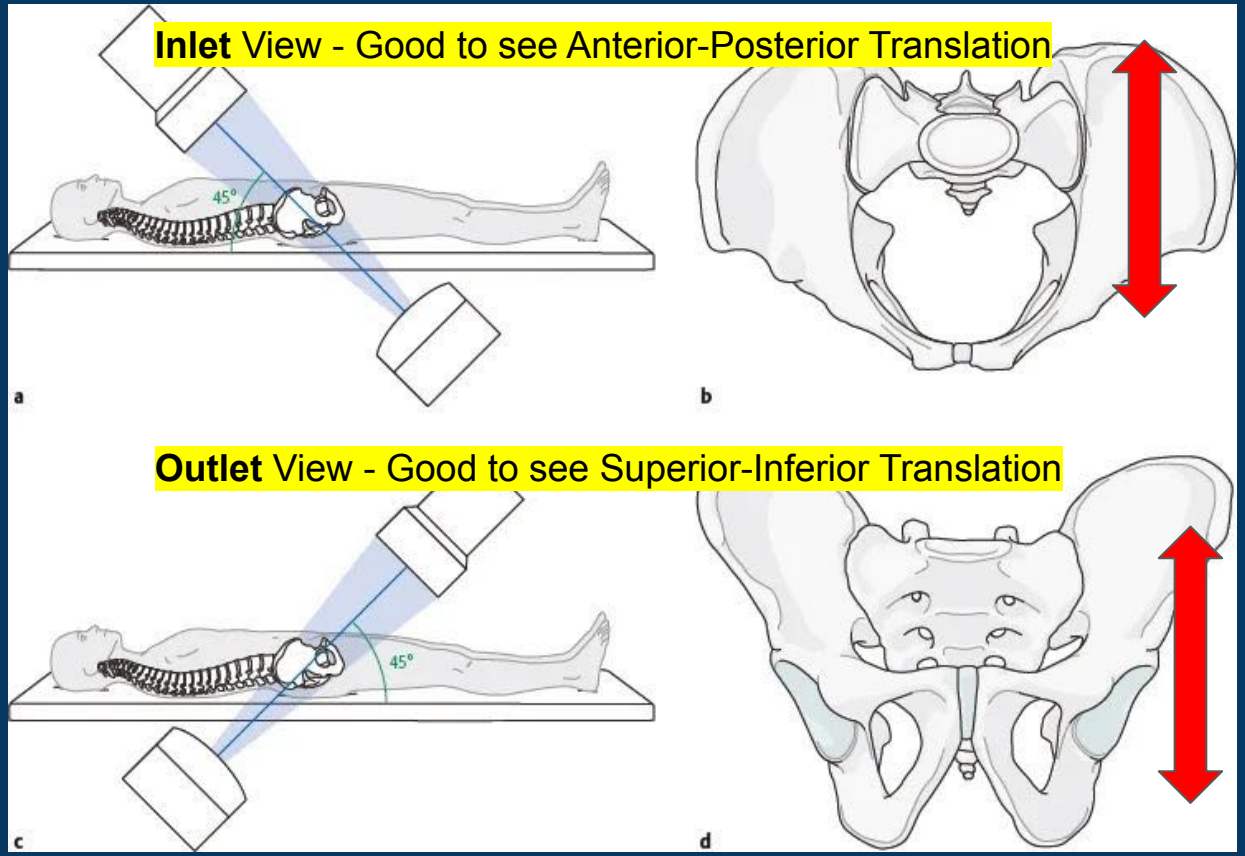
Pelvis Special XR

Inlet View - Good to see Anterior-Posterior Translation



Acetabular Special XR

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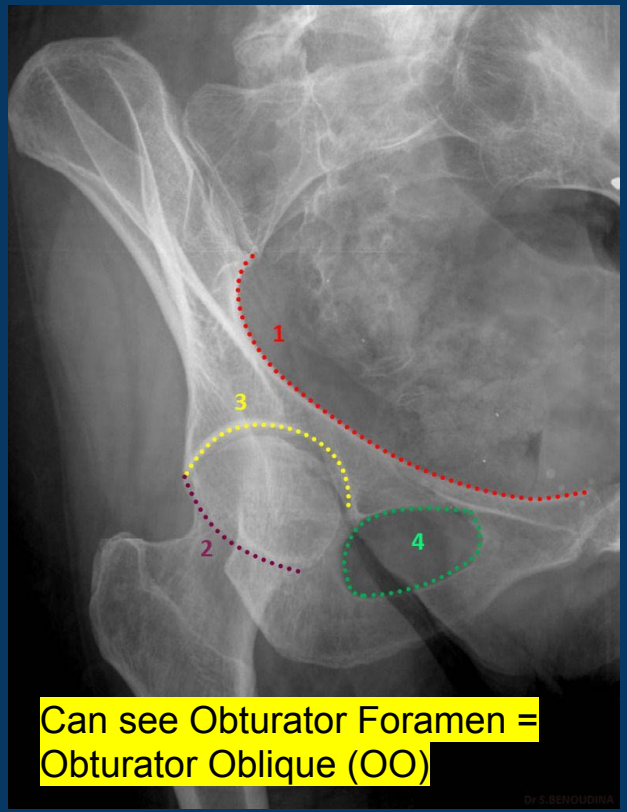
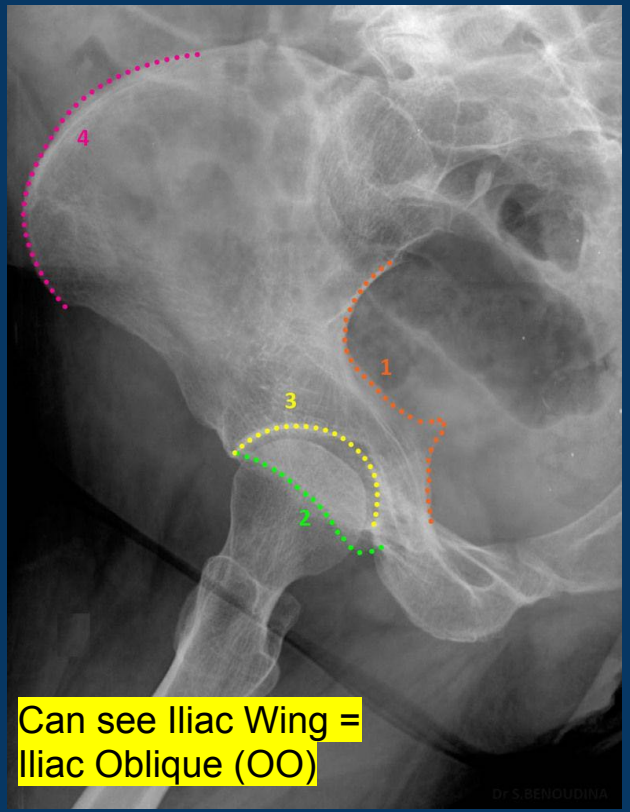
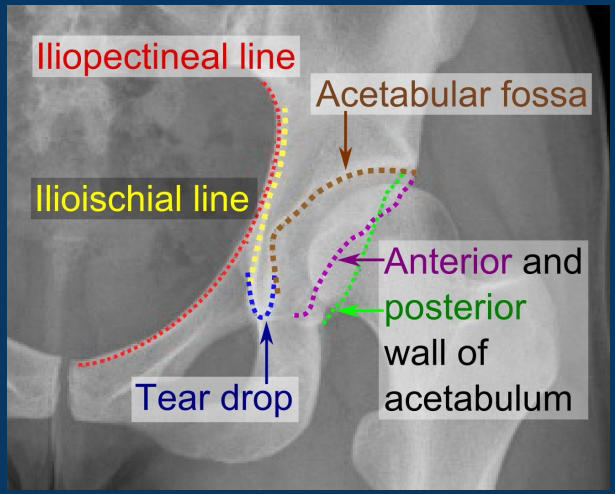
PICO = **P**osterior **C**olumn (+ Anterior Wall) in Iliac Oblique
OO = Opposite: Anterior Column + Posterior Wall

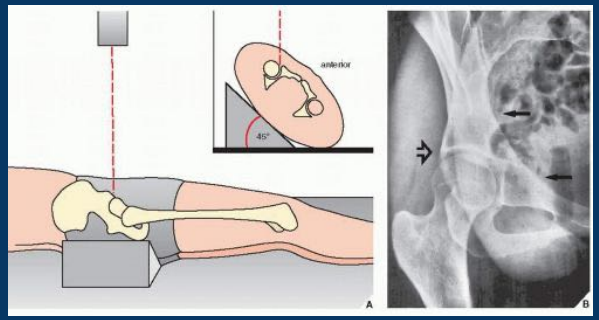


Can see Obturator Foramen = Obturator Oblique (OO)



Can see Iliac Wing = Iliac Oblique (OO)





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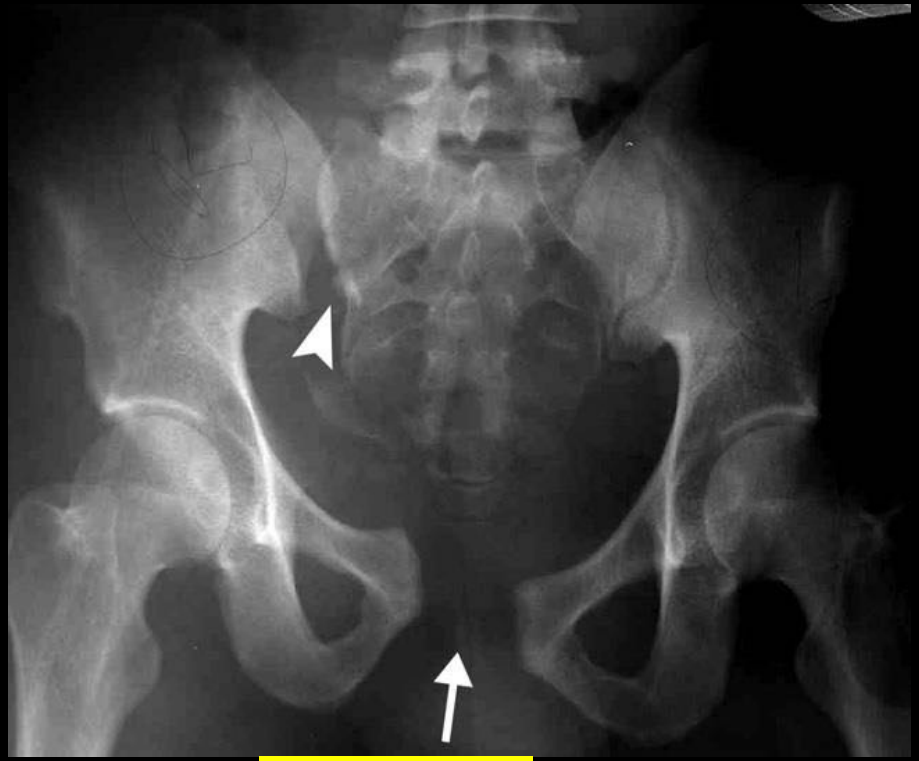
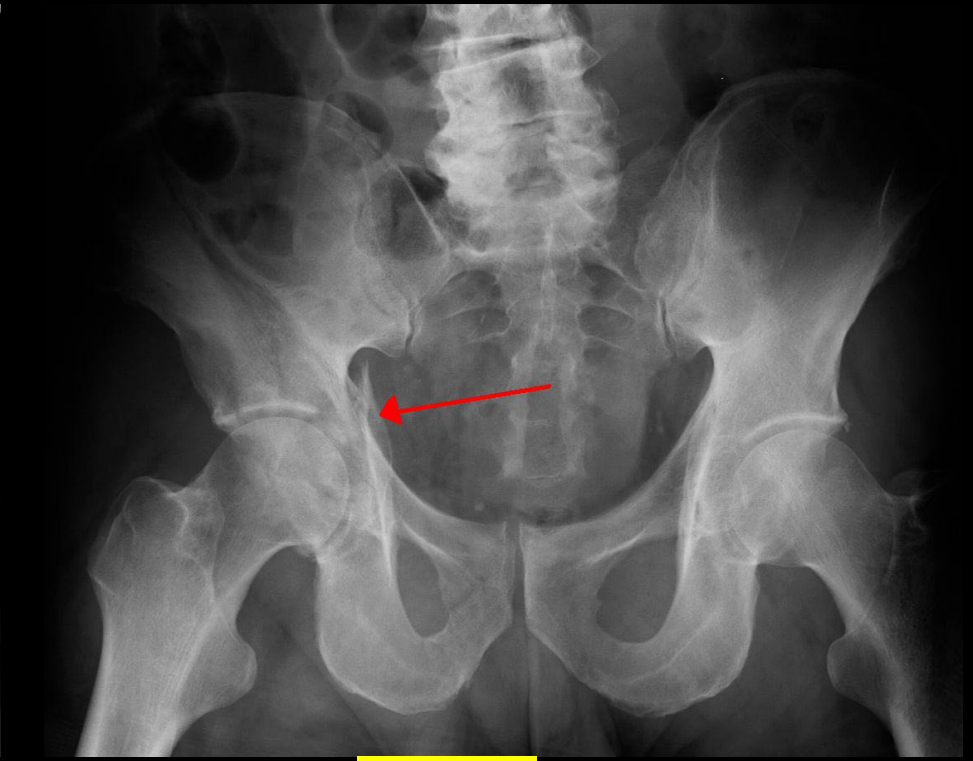
Abnormal Pelvis XRs



Open book pelvic #



Acetabular #

Hip and Femur

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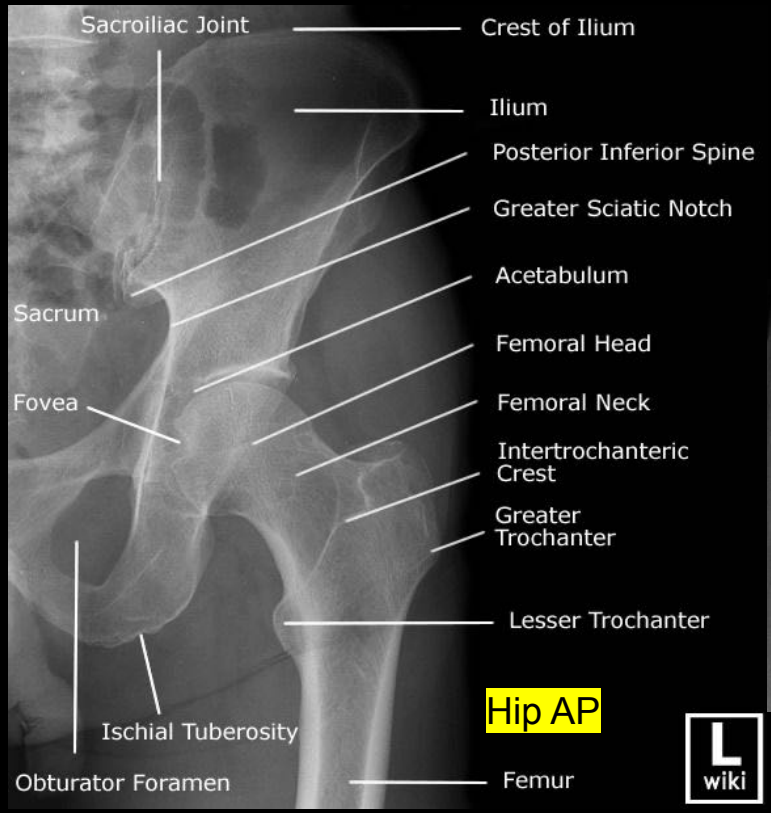
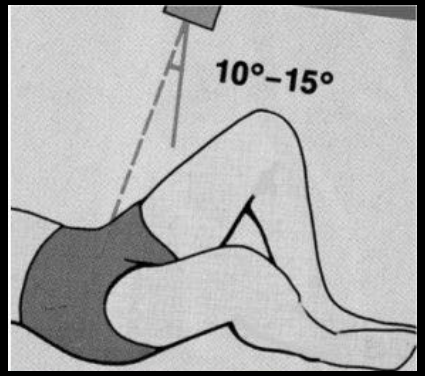
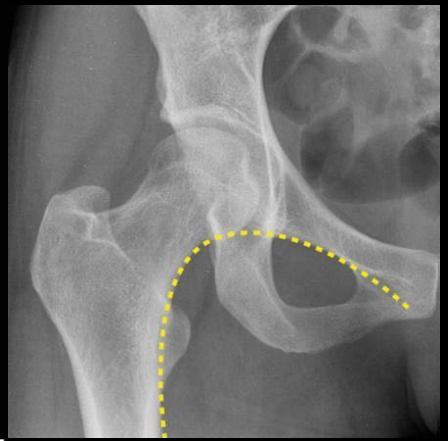
Hip XR



Hip AP

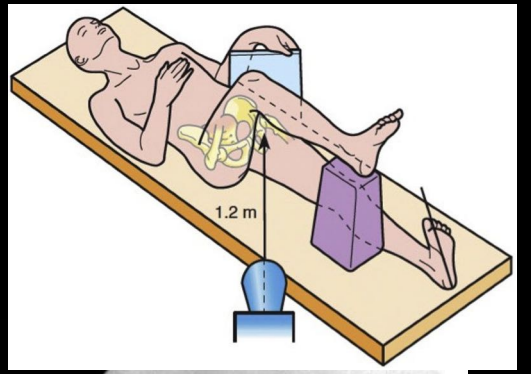


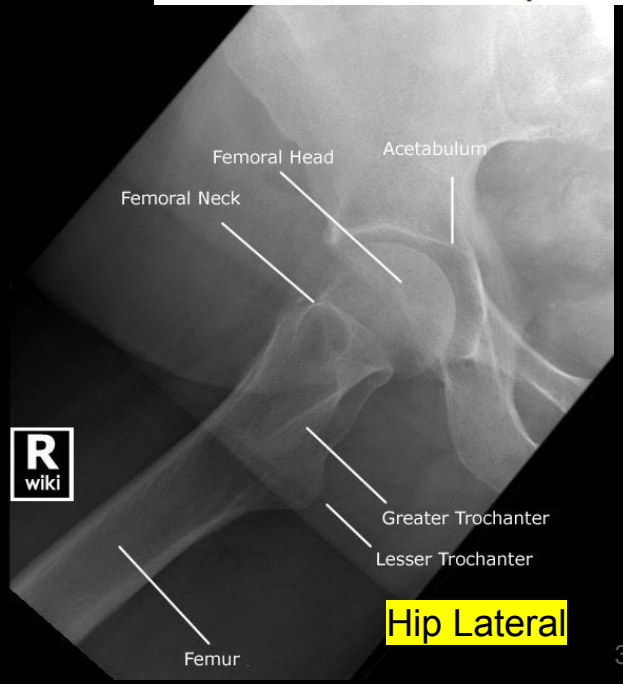


L wiki

Shenton's Line

YMS





Hip Lateral

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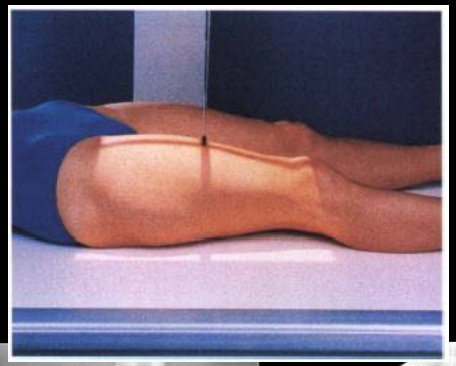
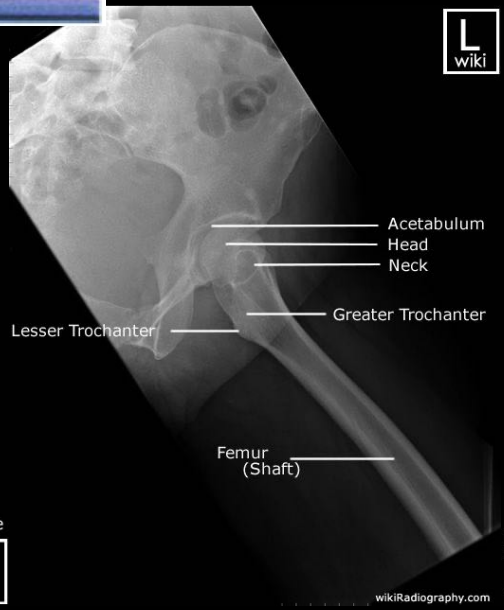
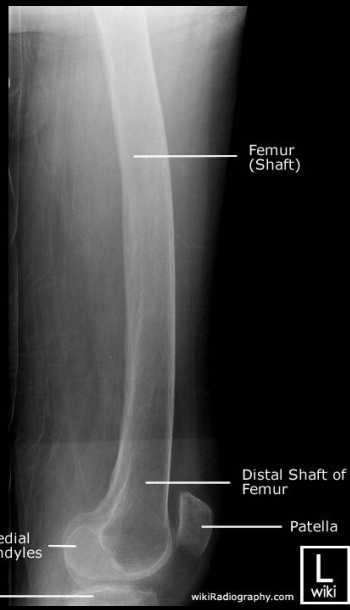
Femur Normal XR







Femur AP

Femur Lateral

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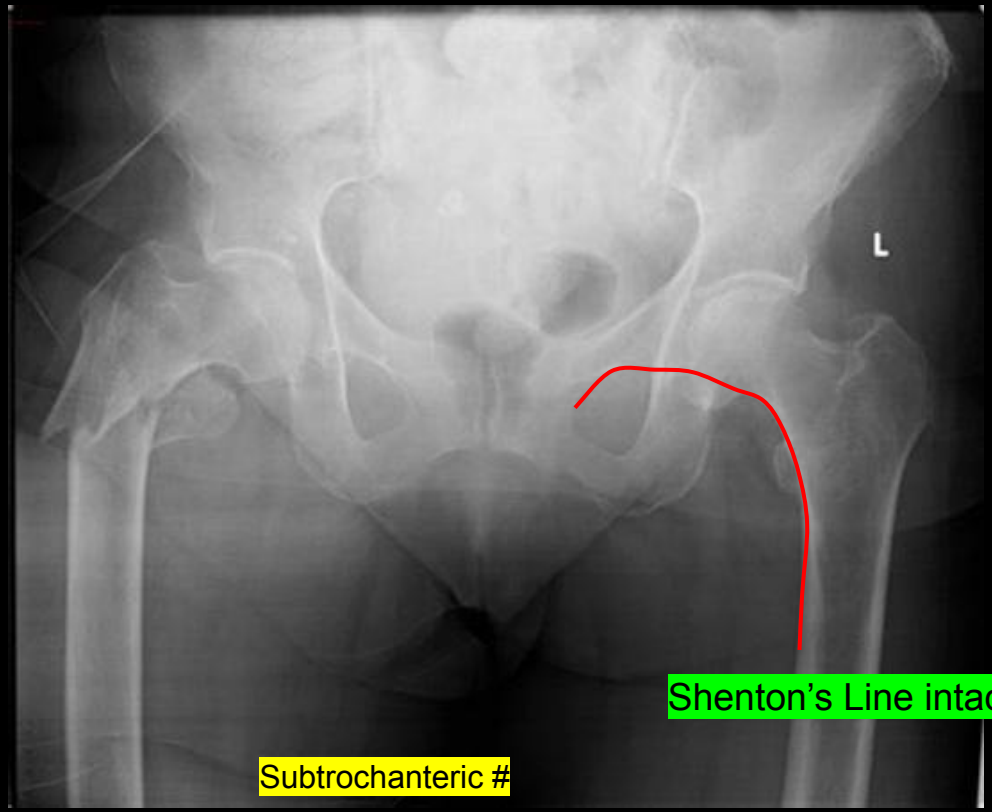
Abnormal Hip/ Femur XRs



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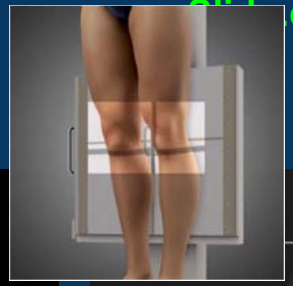
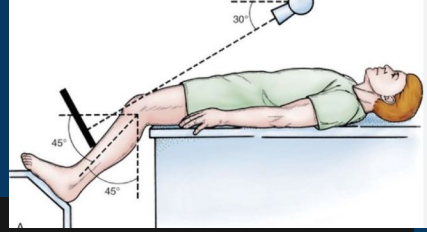
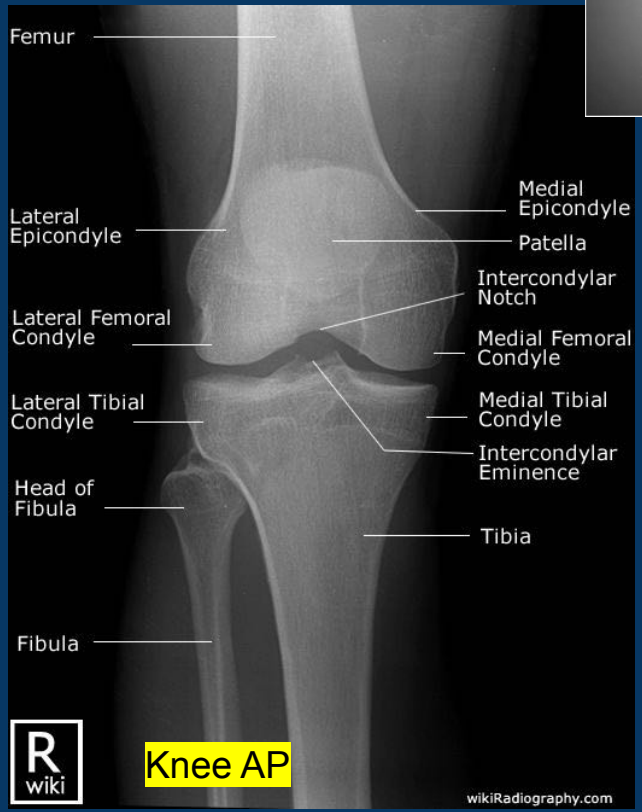
Knee

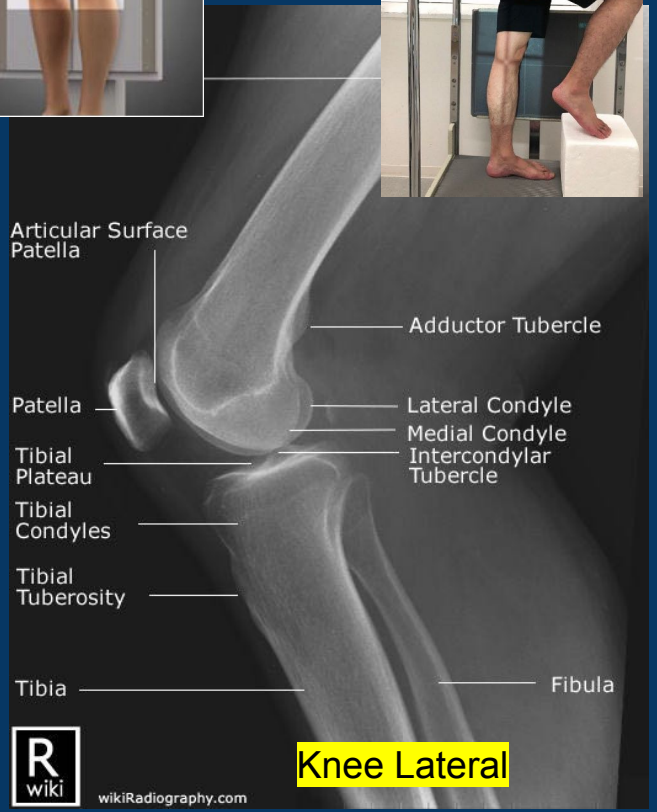
Normal Knee XR



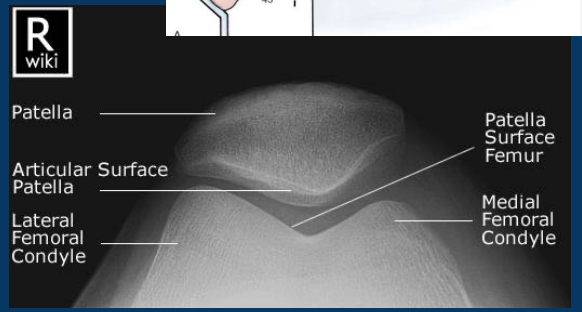




Knee AP



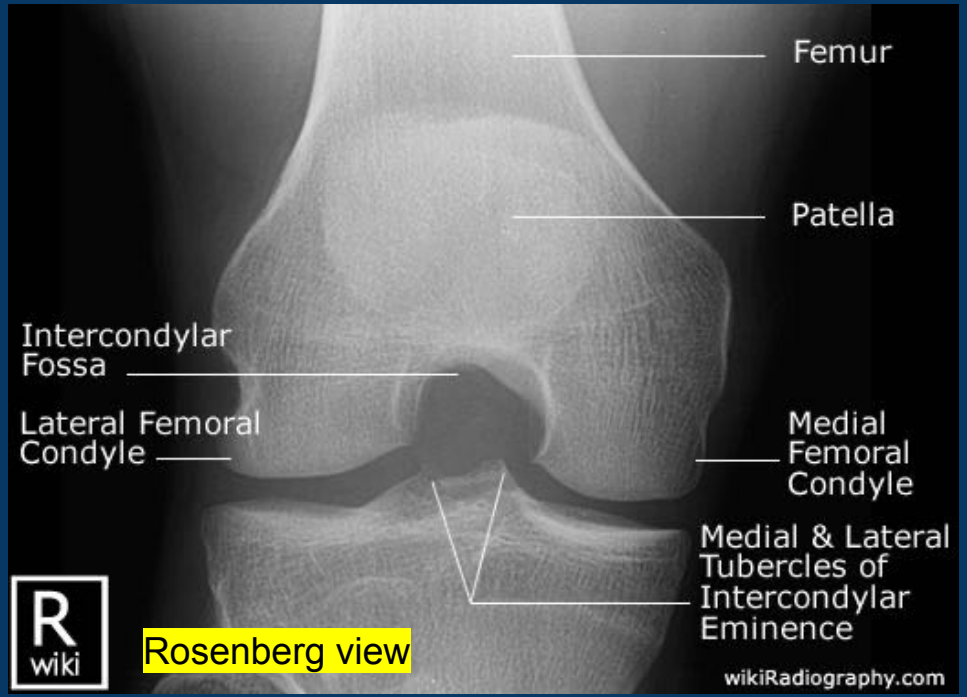
Knee Lateral



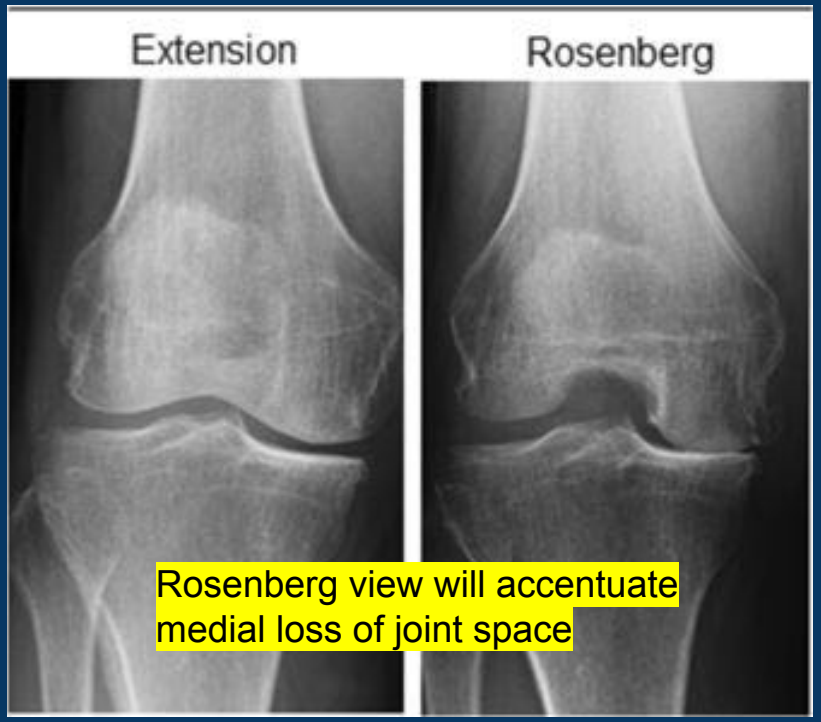
Skyline

Weight bearing will reveal loss of joint space better

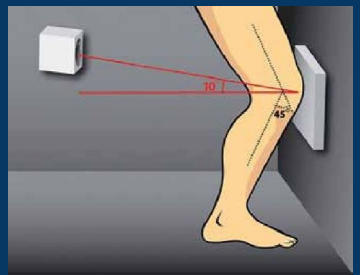
Knee XR Special Views



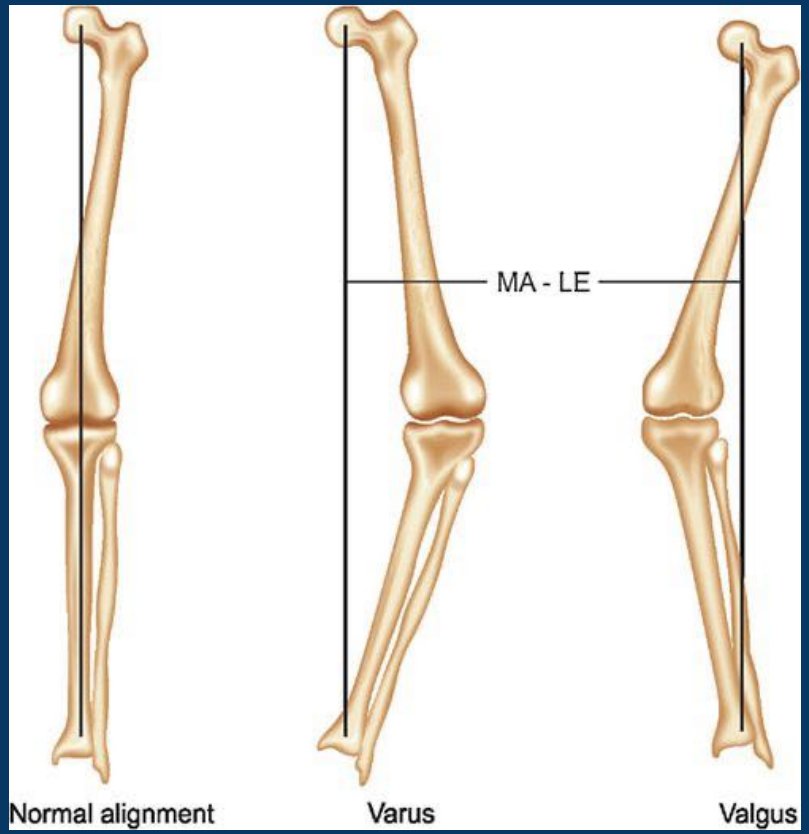
Rosenberg view

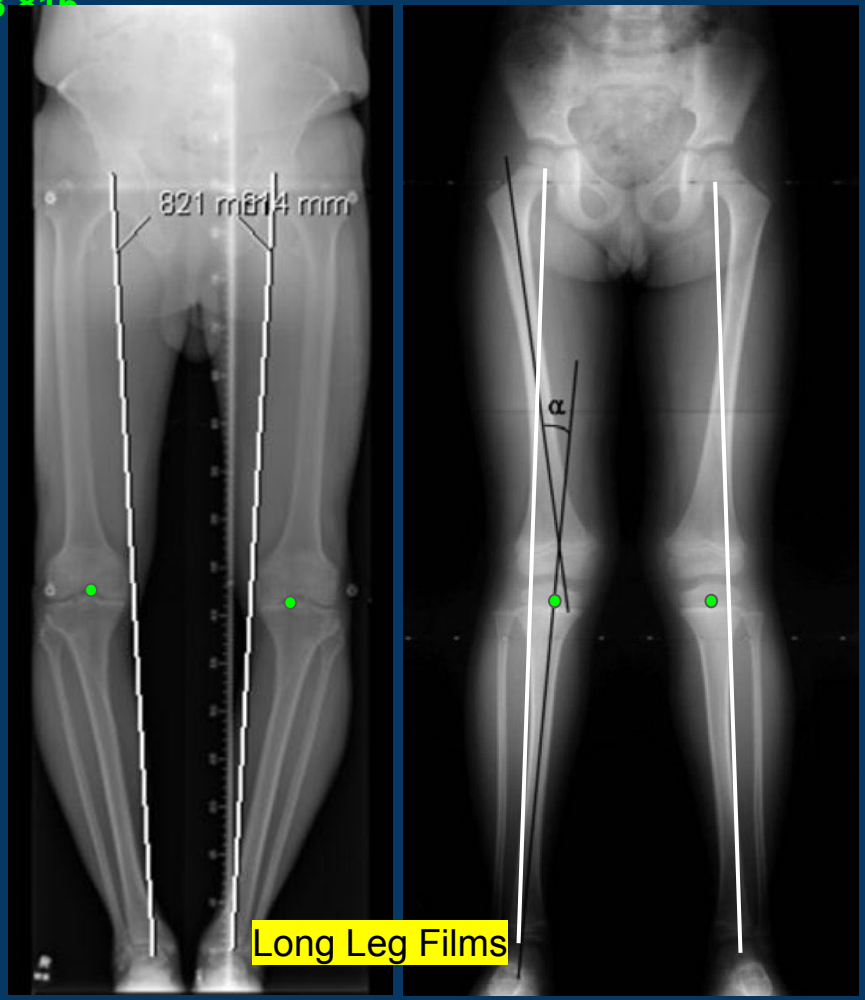


Rosenberg view will accentuate medial loss of joint space



Knee XR Special Views





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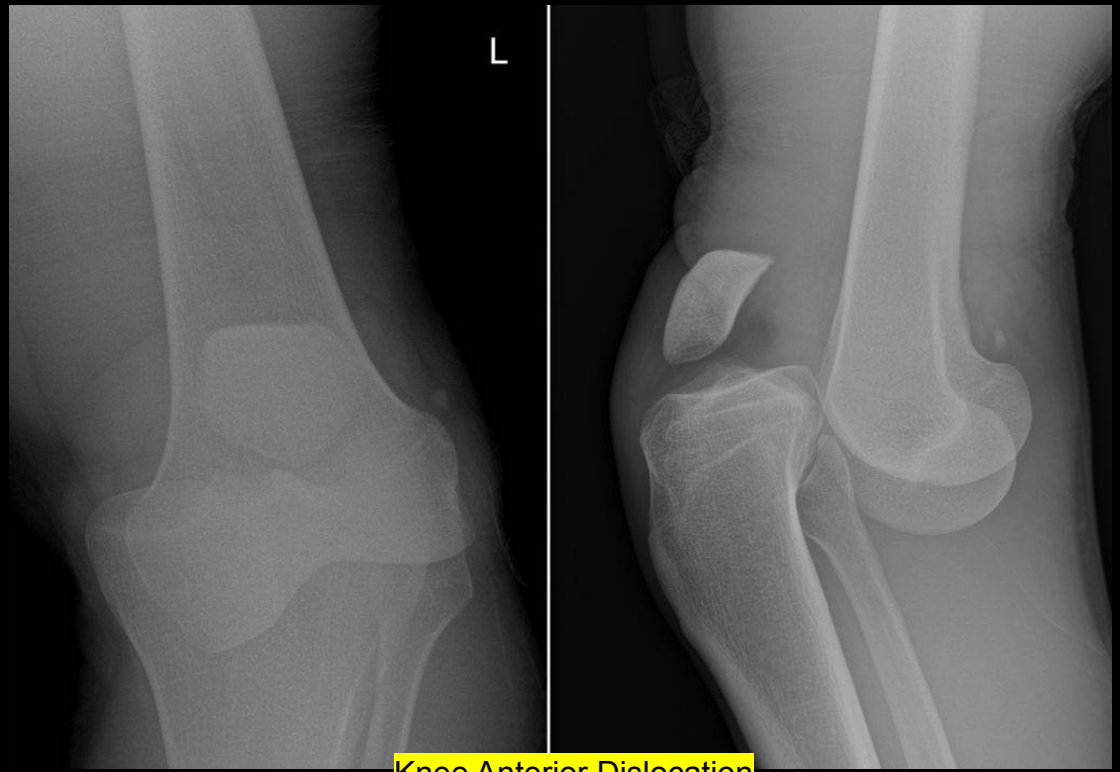
Abnormal Knee XRs

Distal Femur #



Knee Anterior Dislocation

Tibia to Ankle

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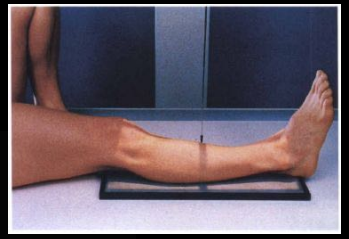
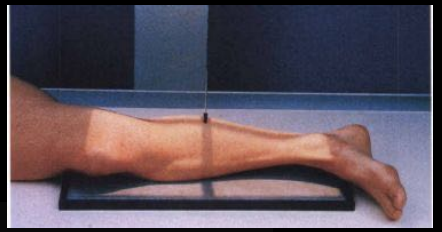
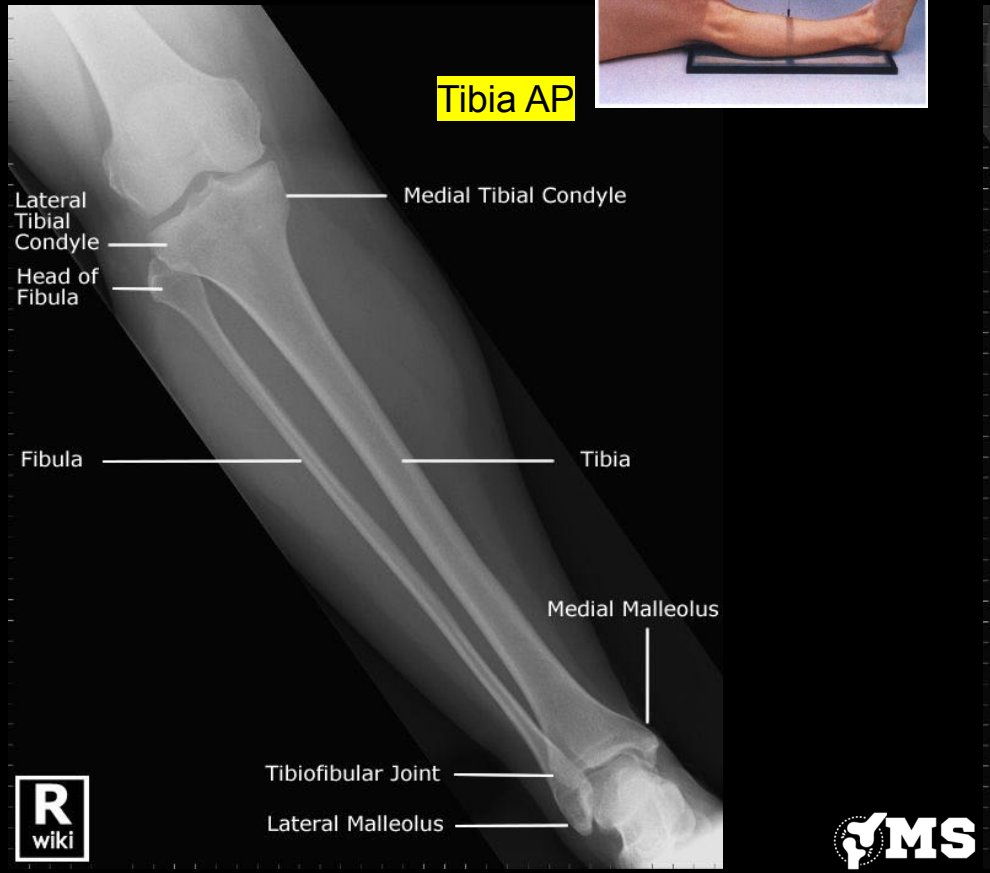
Normal Tibia XR





Tibia AP



Tibia Lateral

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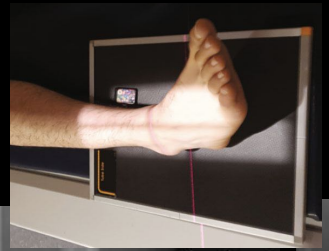
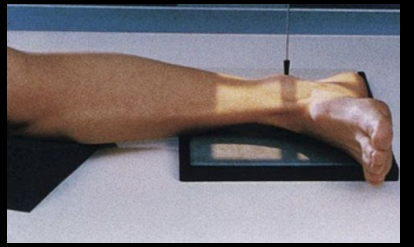
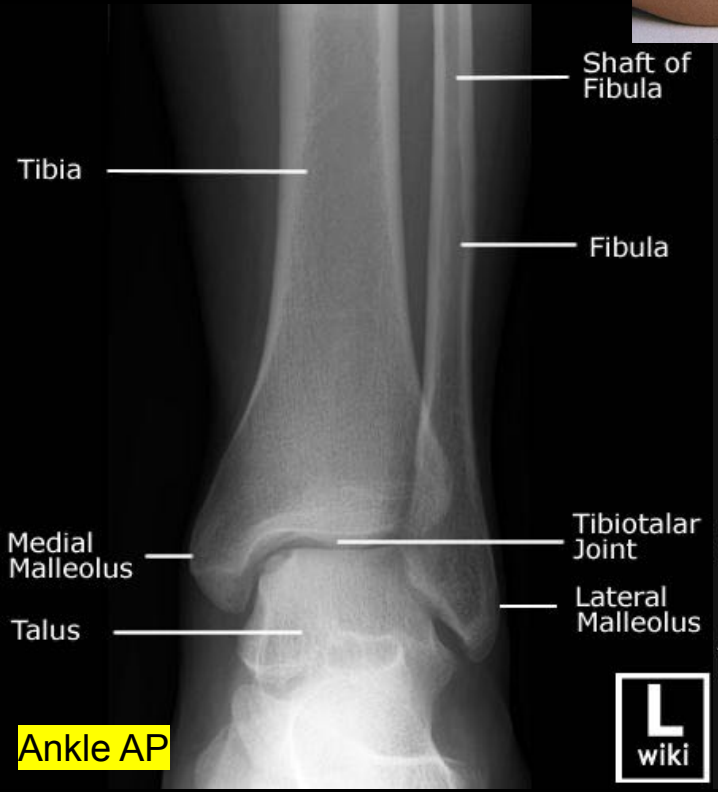
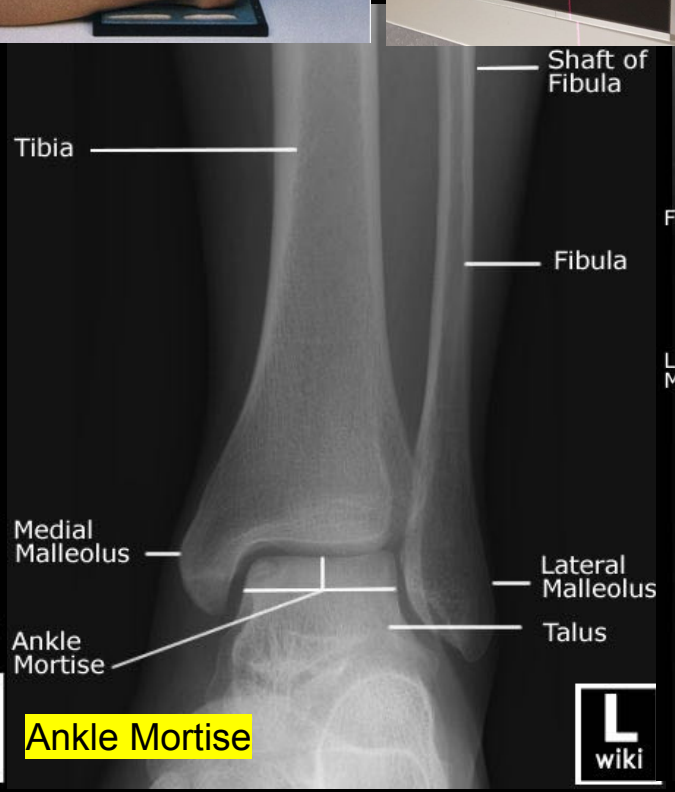
Normal Ankle XR









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Abnormal Tibia/ Ankle XRs

Tibia plateau #

Tibia Shaft Comminuted #

Distal Tibia Comminuted #

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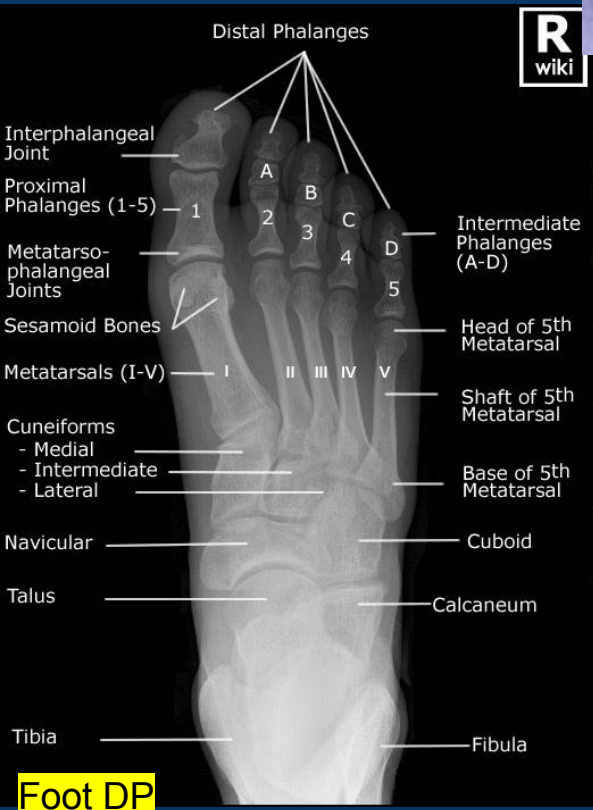
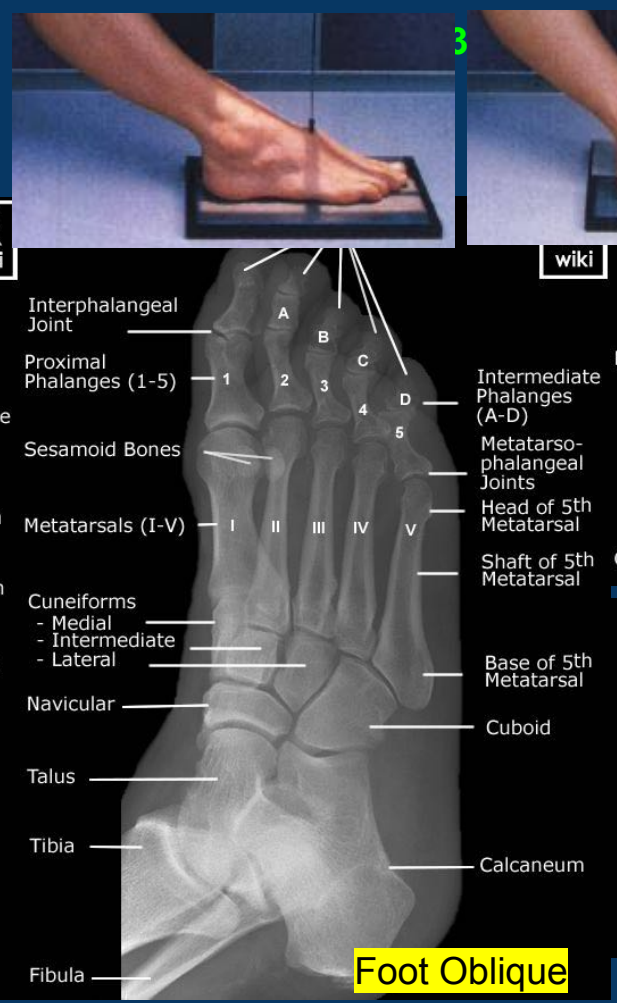
Foot

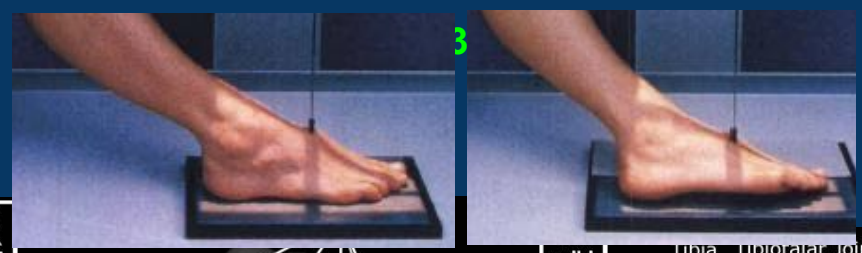
Normal Foot XR

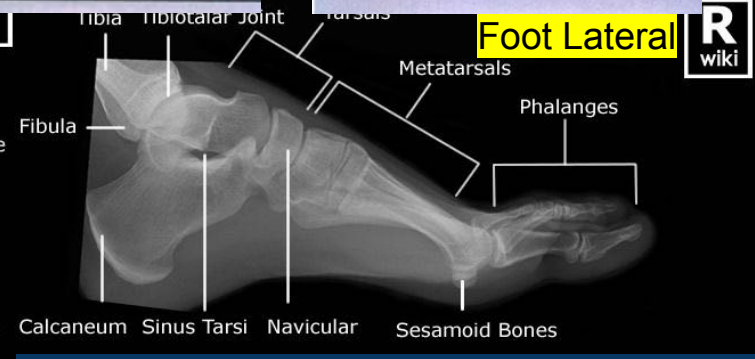


Foot DP



Foot Oblique

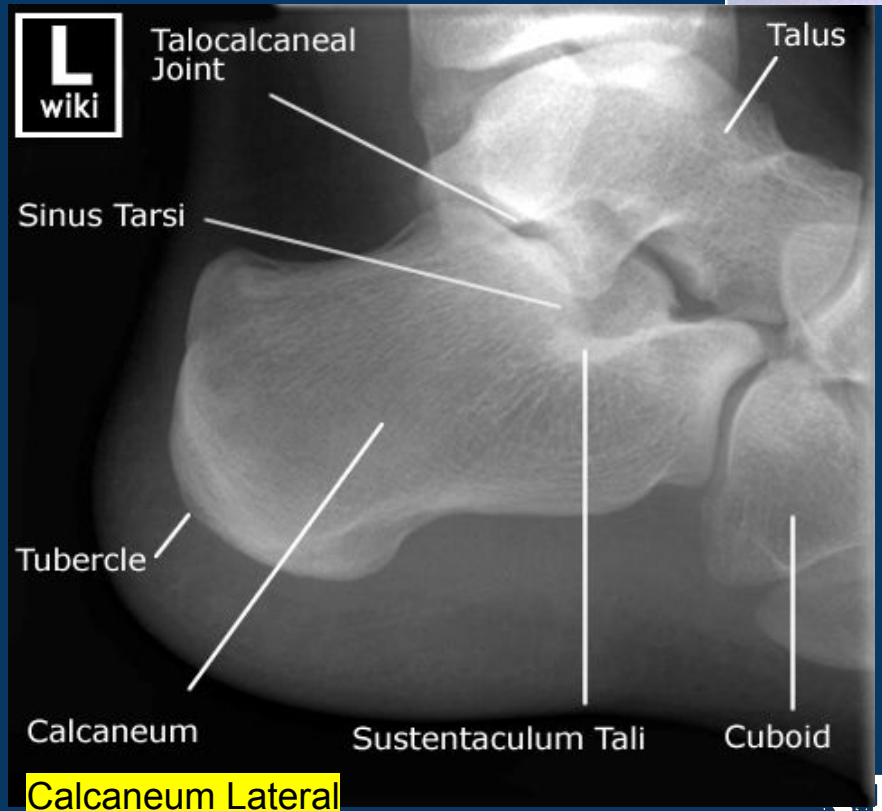




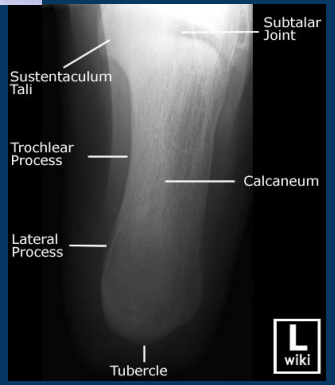
Foot Lateral

Foot Lateral weight bearing

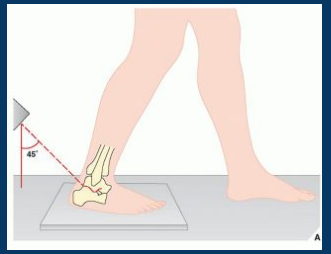
Normal Calcaneus XR



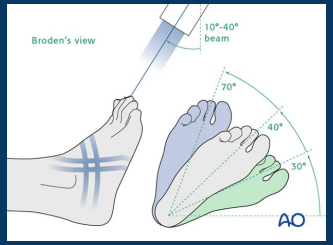
Calcaneum Lateral



Calcaneum Axial Harris View



Calcaneum Oblique Borden's View



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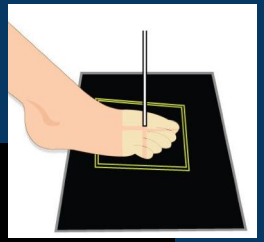
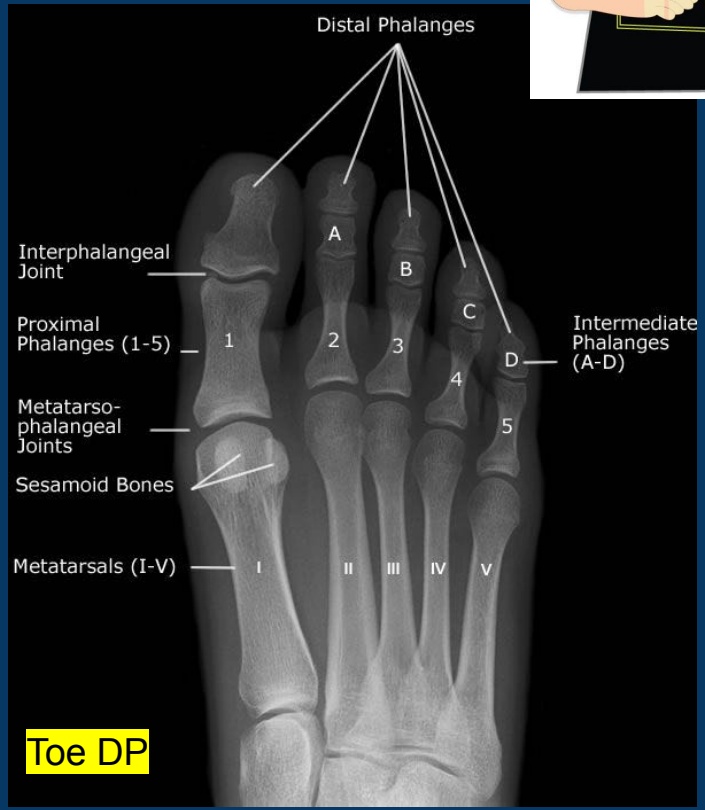
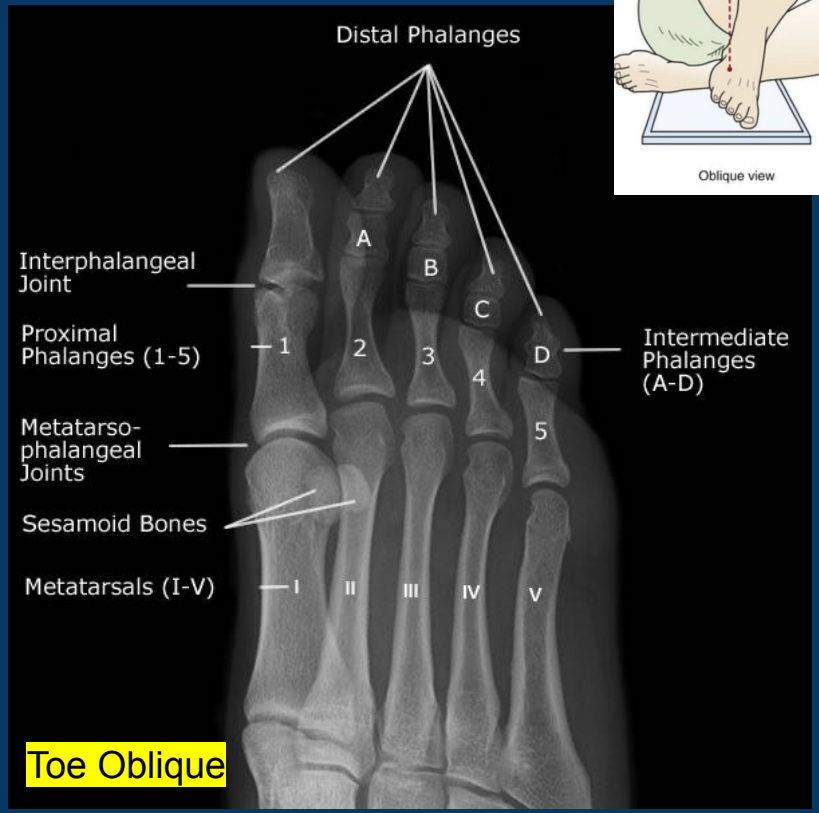
Normal Toe XR

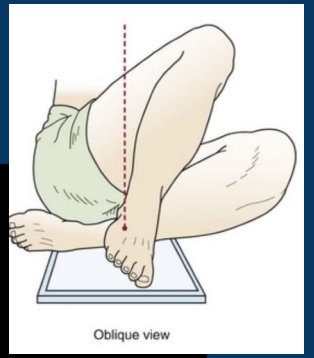




Toe DP



Toe Oblique



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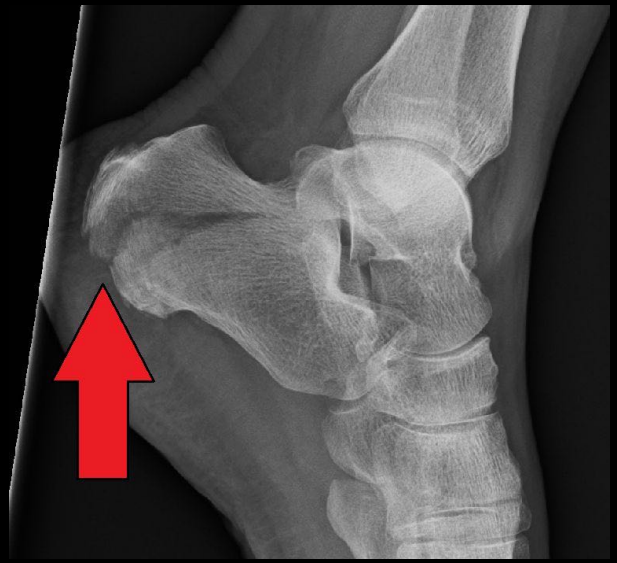
Abnormal Foot XRs

5th Metatarsal Fracture

Talus #



Calcaneum #

Summary Table of XRs

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Region *(Lines)*	Orthogonal Sets	Special Views
Shoulder ***(Moloney's Arch)***	AP/ Axial	Y-Scapula, Velpeau Zanca (ACJ)
Humerus	AP/ Lateral	
Elbow ***(Anterior Humeral, Radiocapitellar Lines)***	AP/ Lateral	Greenspan (Radial head) Internal Oblique (Lateral Condyle #)
Forearm	AP/ Lateral	
Wrist ***(Gilula Lines, Radial Parameters)***	PA/ Lateral	Scaphoid Carpal Tunnel
Hand	PA/ Lateral/ Oblique	
Finger	PA/ Lateral/ Oblique	
Pelvis ***(Acetabular Lines)***	AP	Inlet/ Outlet Iliac/Obturator Oblique
Sacroiliac Joint	AP Sacrum lateral	

Region *(Lines)*	Orthogonal Sets	Special Views
Hip ***(Shenton's Line)***	AP/ Lateral	
Femur	AP/ Lateral	
Knee	AP/ Lateral (Weight bearing for OA)	Skyline (PFJ) Rosenberg (Medial Joint Space) Long Leg (Mech axis)
Tibia	AP/ Lateral	
Ankle	AP/ Lateral/ Mortise	
Foot	AP/ Lateral/ Oblique	Harris, Broden's (Calcaneum)
Toes	AP/ Lateral/ Oblique	

YMS

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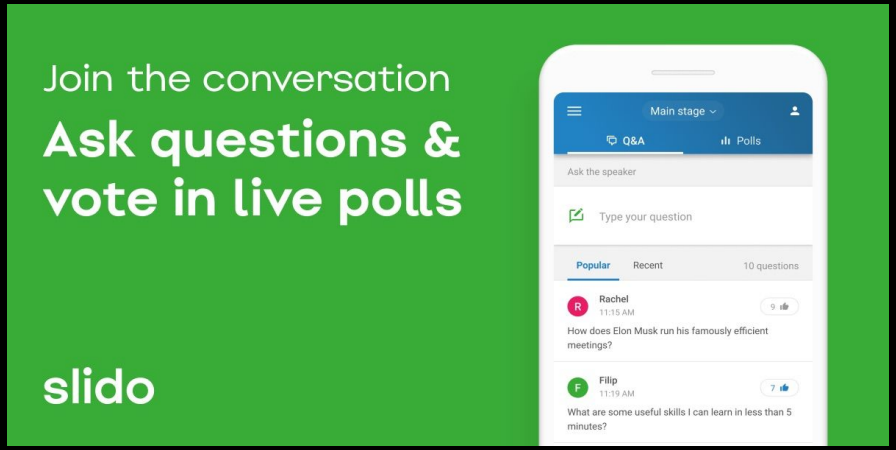
Quiz Time!

- **Live Audience** – Submit your answer on SLIDO to enhance your learning through immediate feedback.

- **Recording Audience** – Refer to the slides for the exact questions and options.



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Normal XR Quiz Q5

⏱ 16 **Which line(s) should you be able to recognise in a Hip AP XR?**

- Moloney's Arc
- Mechanical Axis
- Shenton's Line
- Medial Clear Space

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Normal XR Quiz Q6

19 **Which Special XR will evaluate the patellofemoral joint?**

- Rosenberg View
- Skyline View
- Judet Views
- Inlet View

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Normal XR Quiz Q7

17

What Bone is labelled A?

- Talus
- Navicular
- Calcaneum
- Cuboid

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Normal XR Quiz Q8

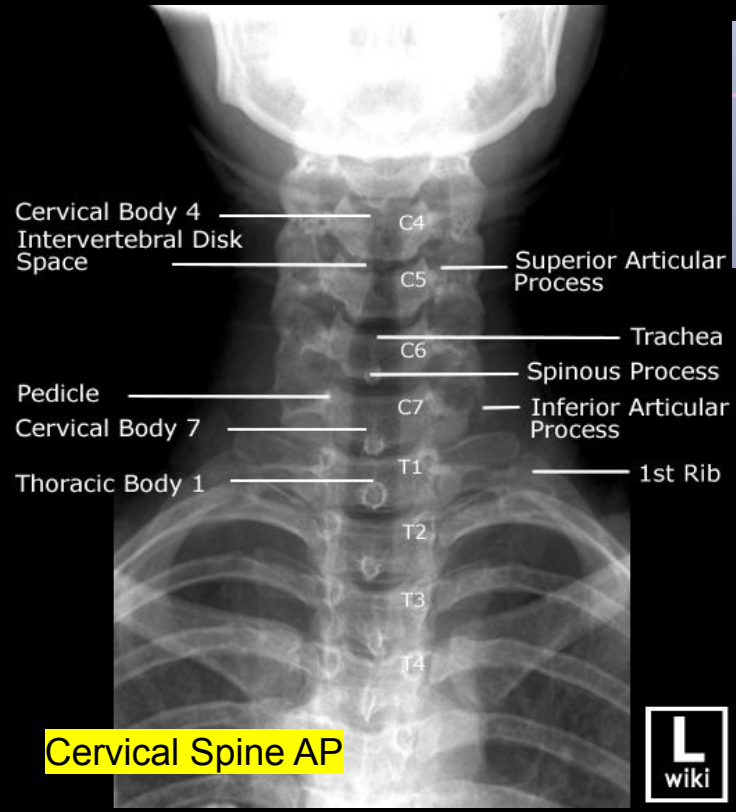
18

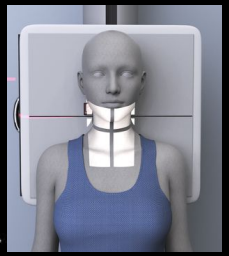
Some anatomical areas will benefit from an added view other than the standard AP/ Lateral. Which are they?

- Hip: Oblique
- Ankle: Mortise
- Knee: Oblique
- Tibia: Oblique
- Foot: Oblique

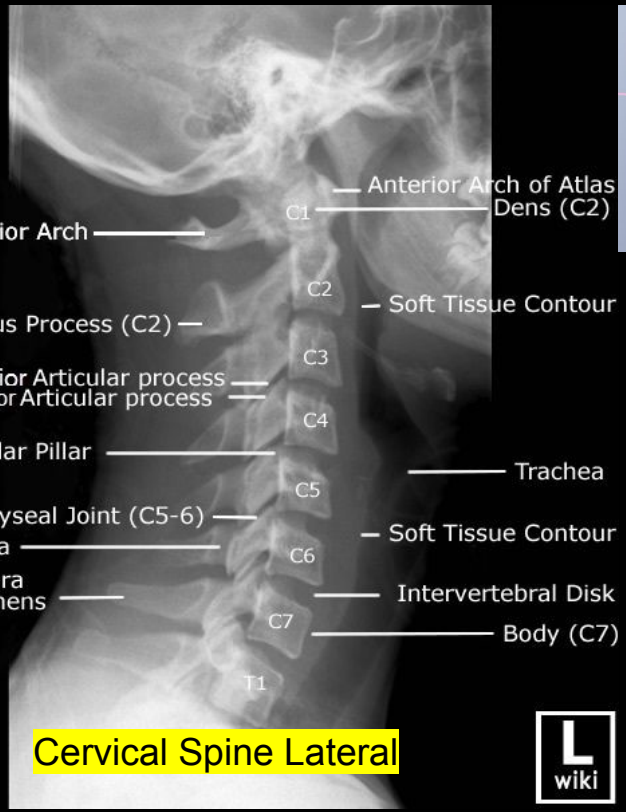
Cervical Spine

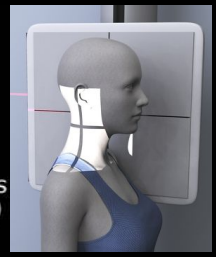
Cervical Spine Normal XR





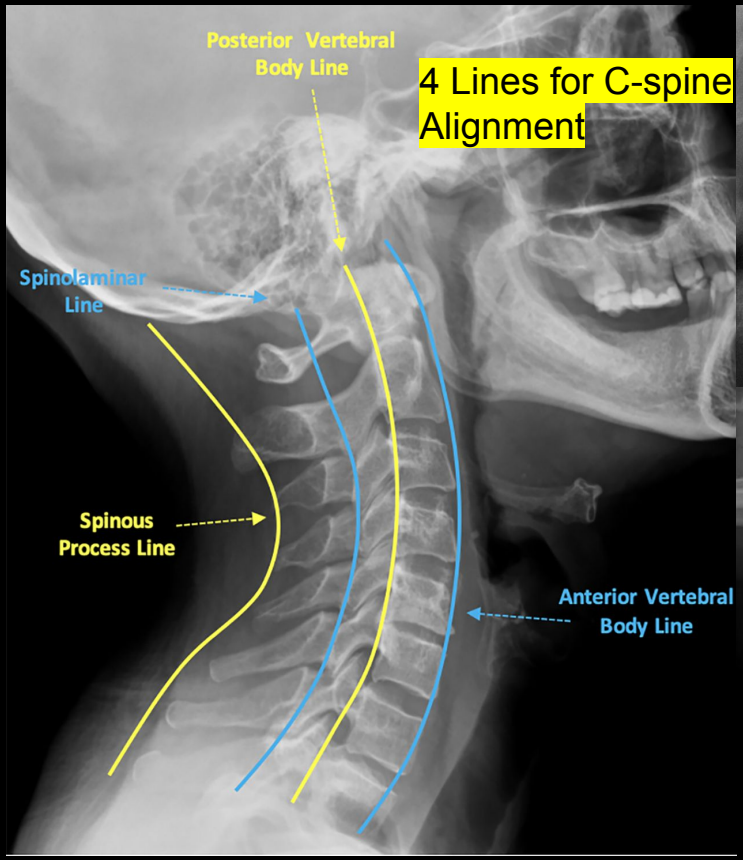
Cervical Spine AP

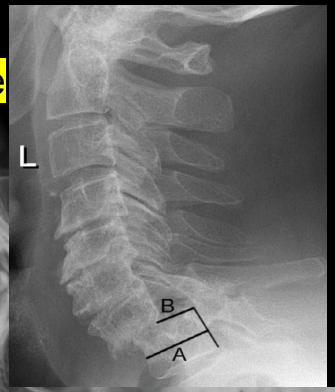




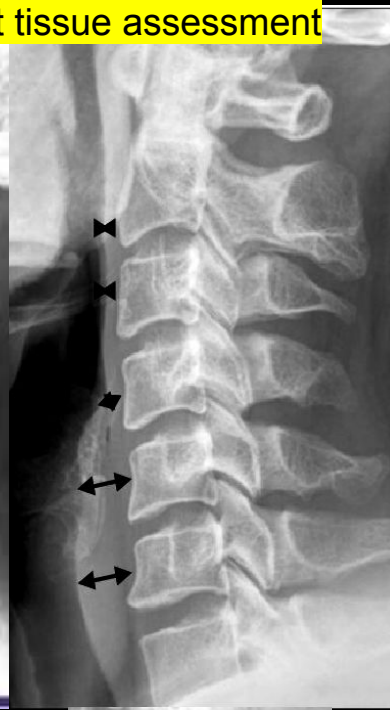
Cervical Spine Lateral

Important Lines for Cervical Spine





Retropharyngeal Soft tissue assessment
2-6-6-2 Rule



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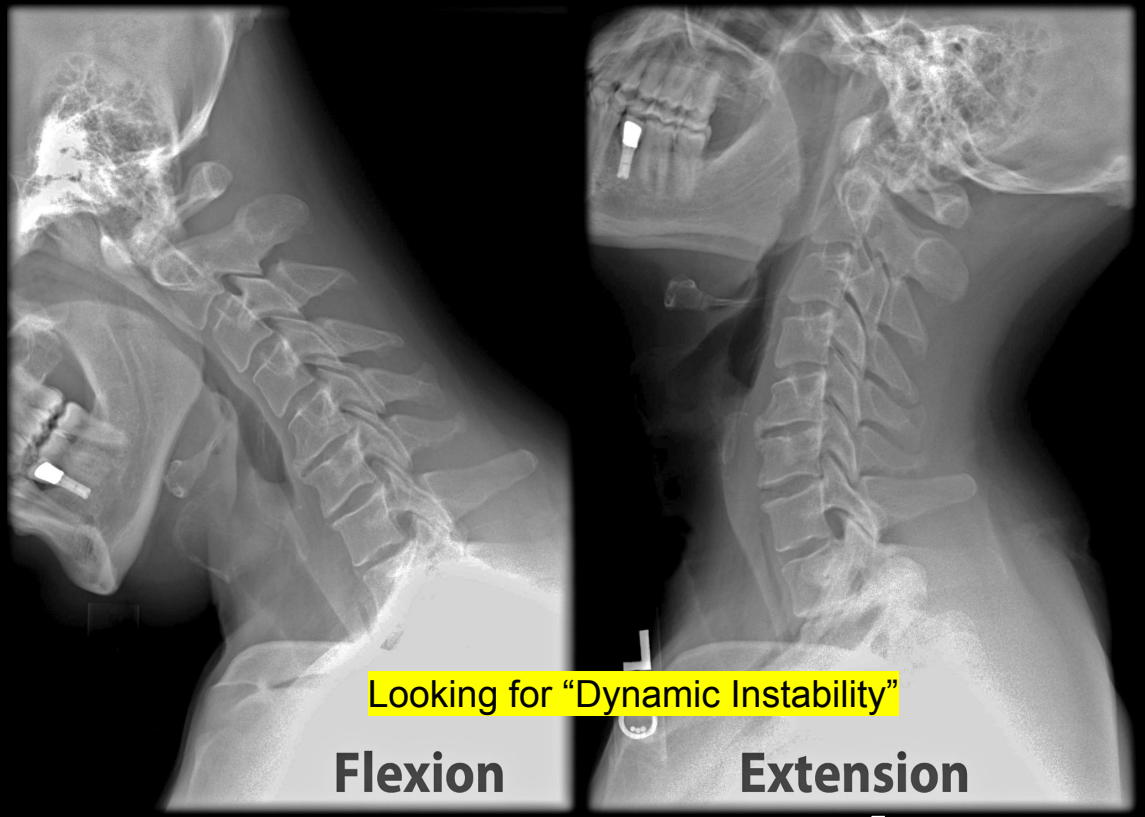
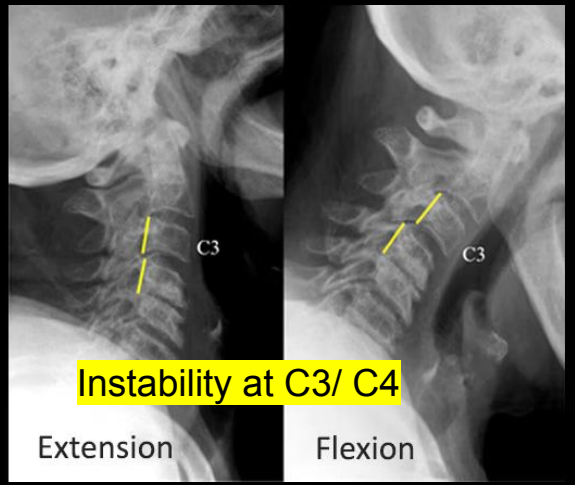
Cervical Spine Flexion/ Extension views





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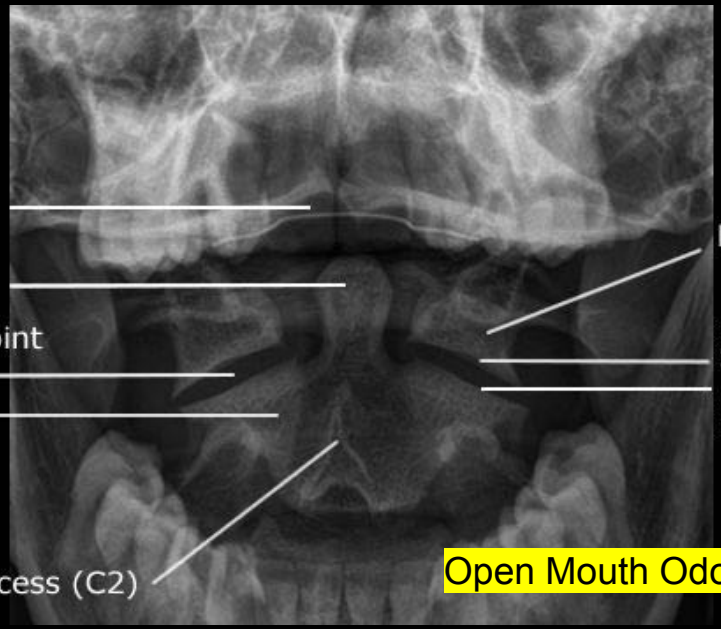
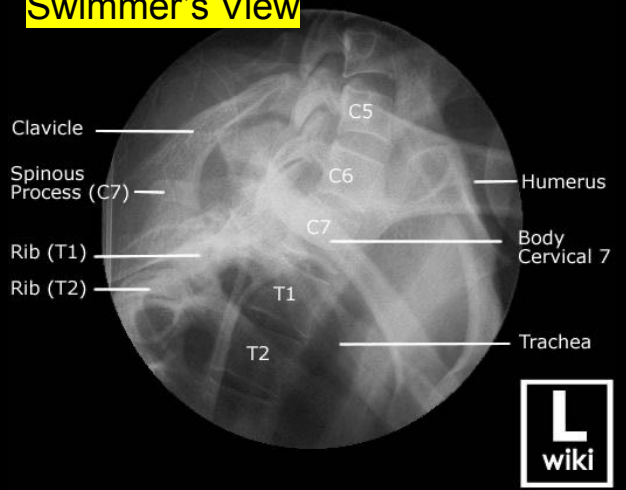
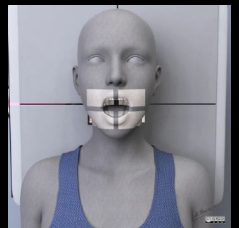
Cervical Special XR (Largely replaced with CT scan)



Open Mouth Odontoid View

Swimmer's View





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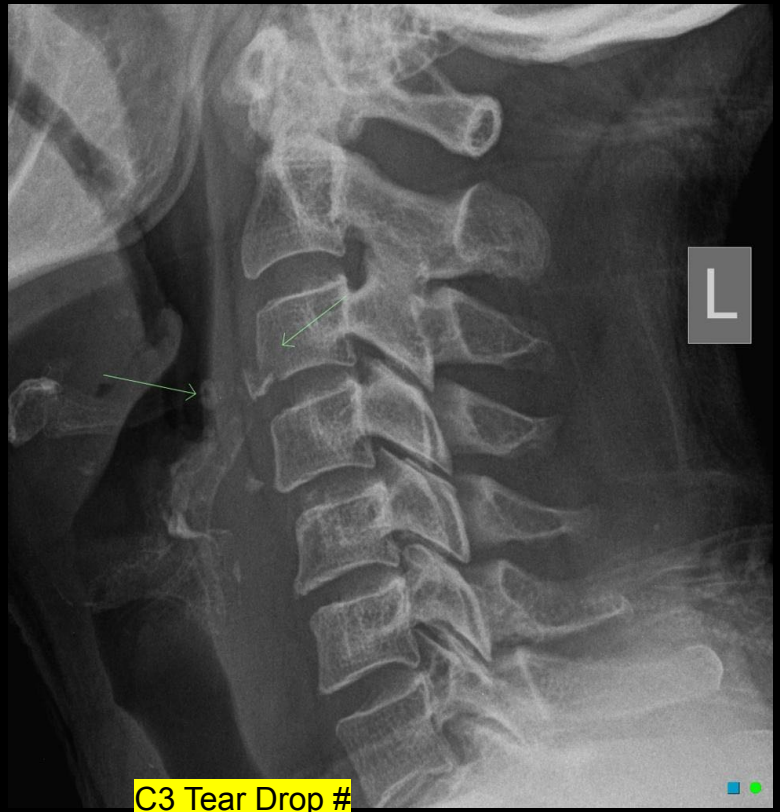
Abnormal Cervical XRs



C3 Tear Drop #

Cervical spondylosis

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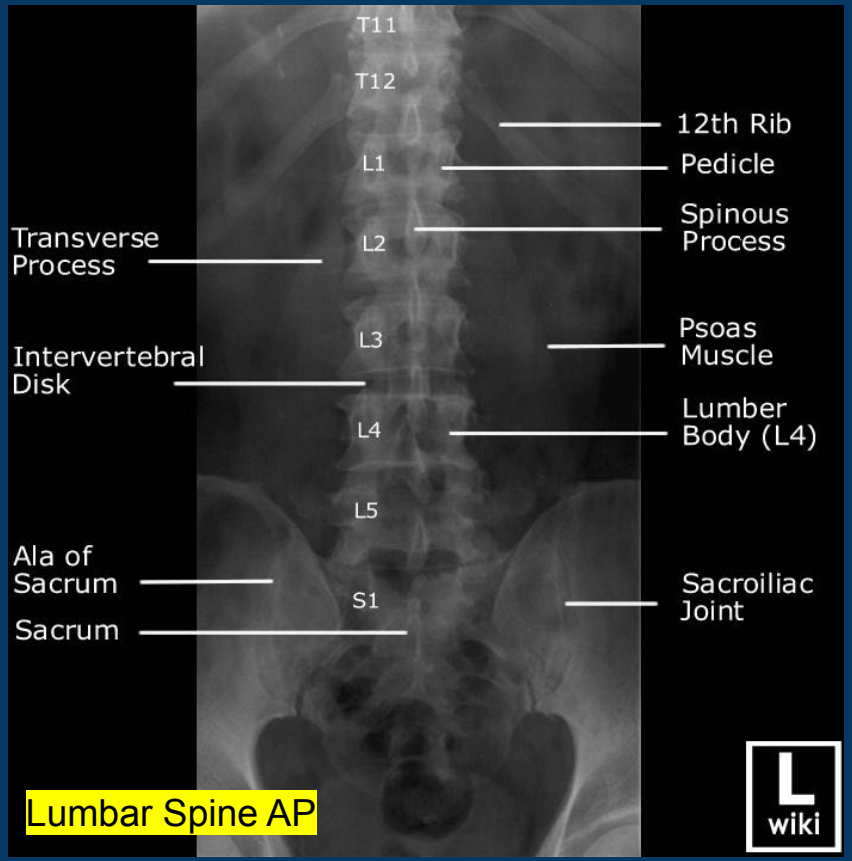
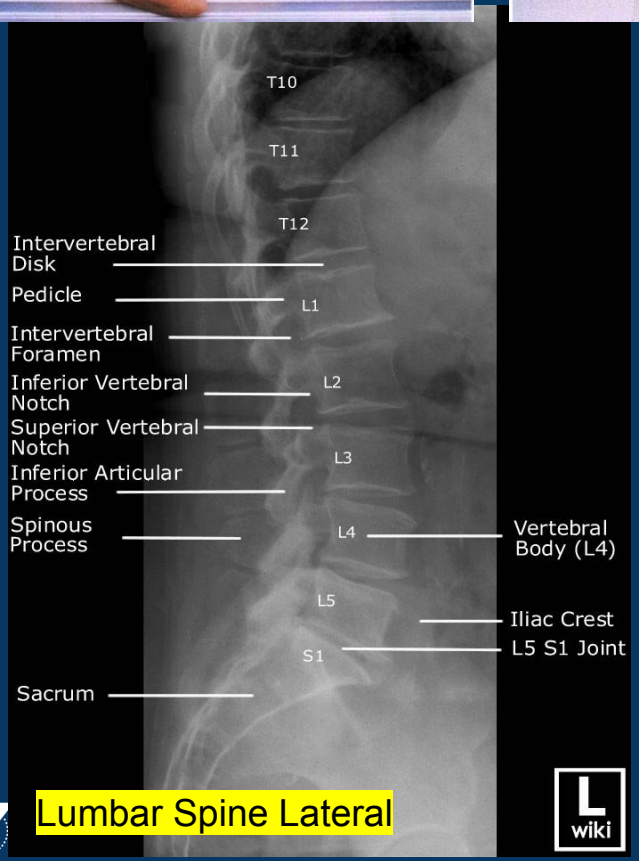
Lumbar Spine

Lumbar Spine Normal XR



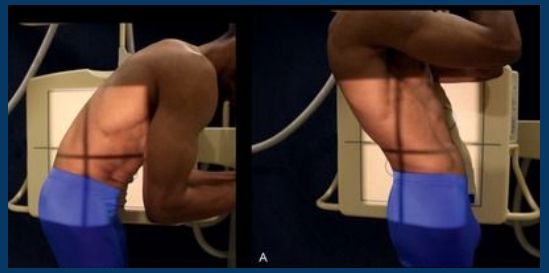
Lumbar Spine AP

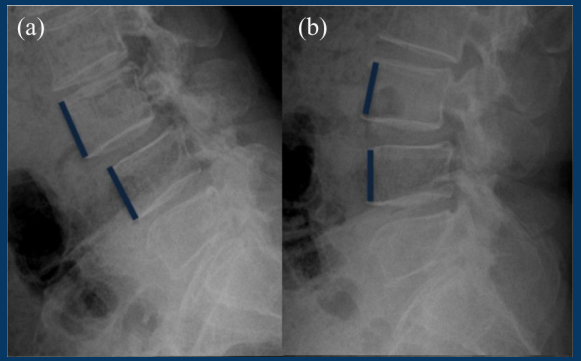


Lumbar Spine Lateral

Lumbar Spine Flexion/ Extension Views

Looking for “Dynamic Instability”





Instability at L3/ L4

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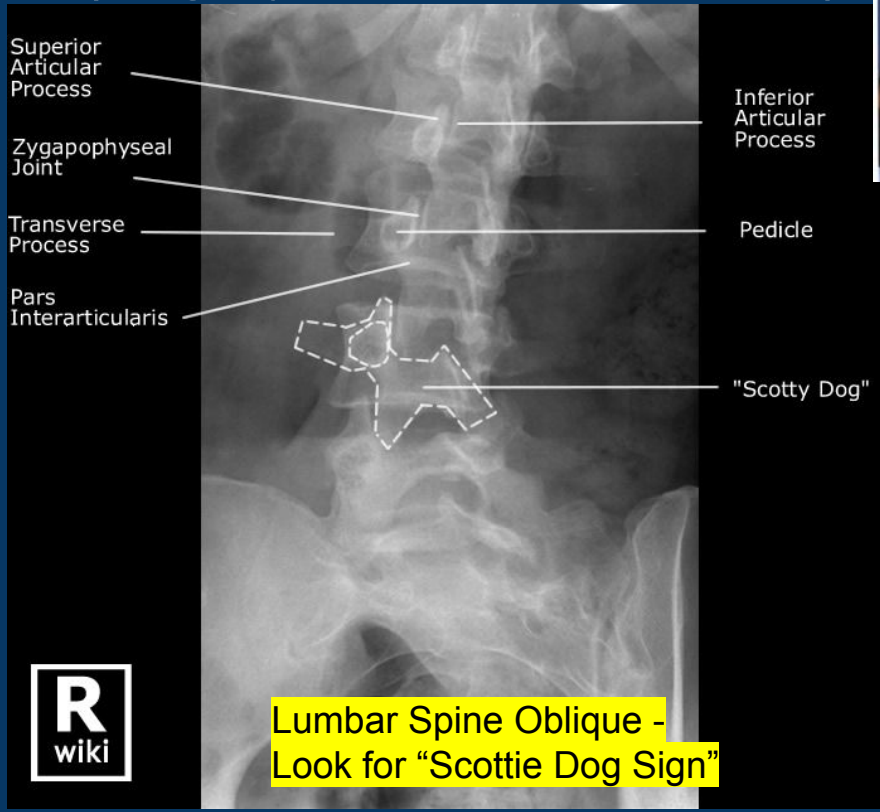
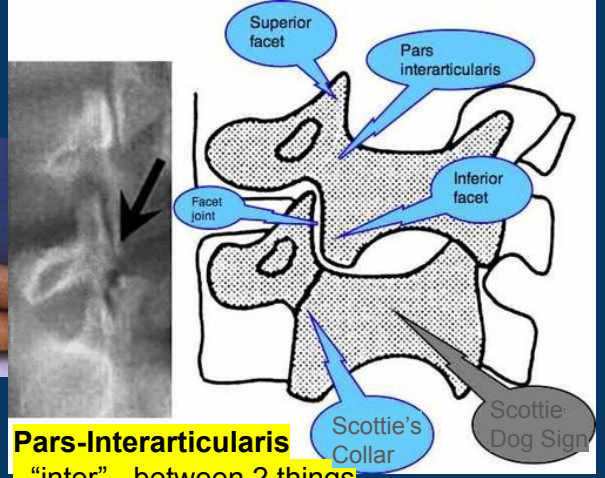
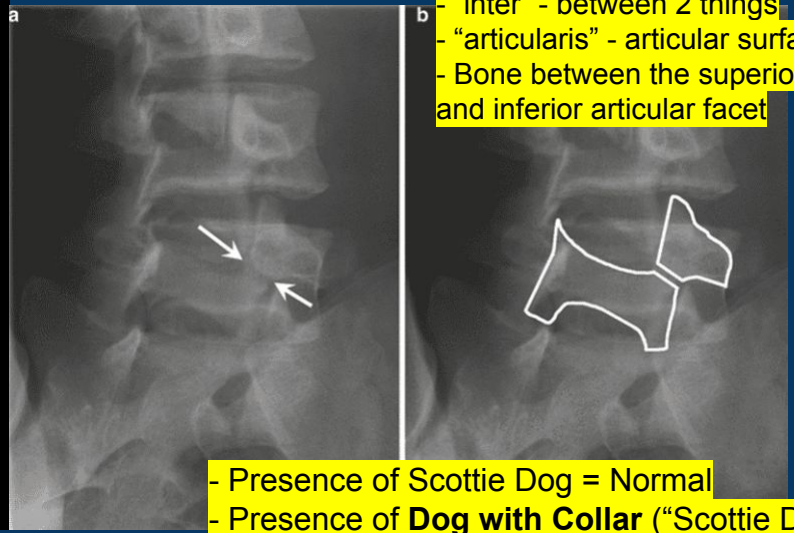
Lumbar Spine Special Views (largely replaced with CT)



Lumbar Spine Oblique -
Look for “Scottie Dog Sign”



Pars-Interarticularis
- “inter” - between 2 things
- “articularis” - articular surface
- Bone between the superior articular facet and inferior articular facet



- Presence of Scottie Dog = Normal
- Presence of **Dog with Collar** (“Scottie Dog Sign”)= Fracture of Pars-Interarticularis

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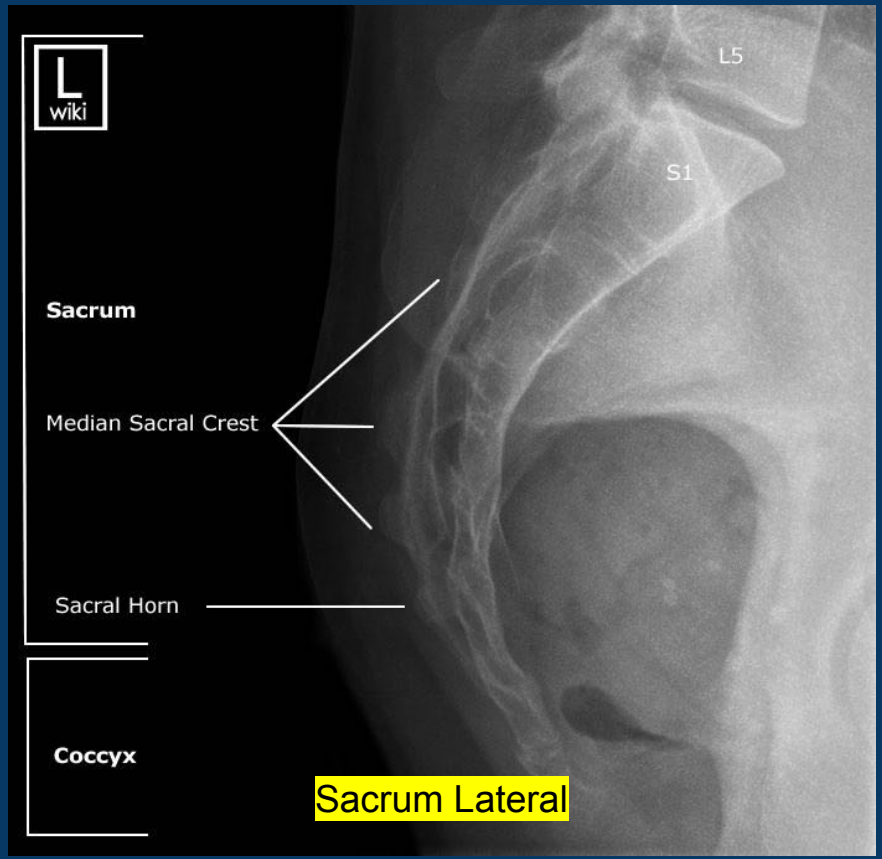
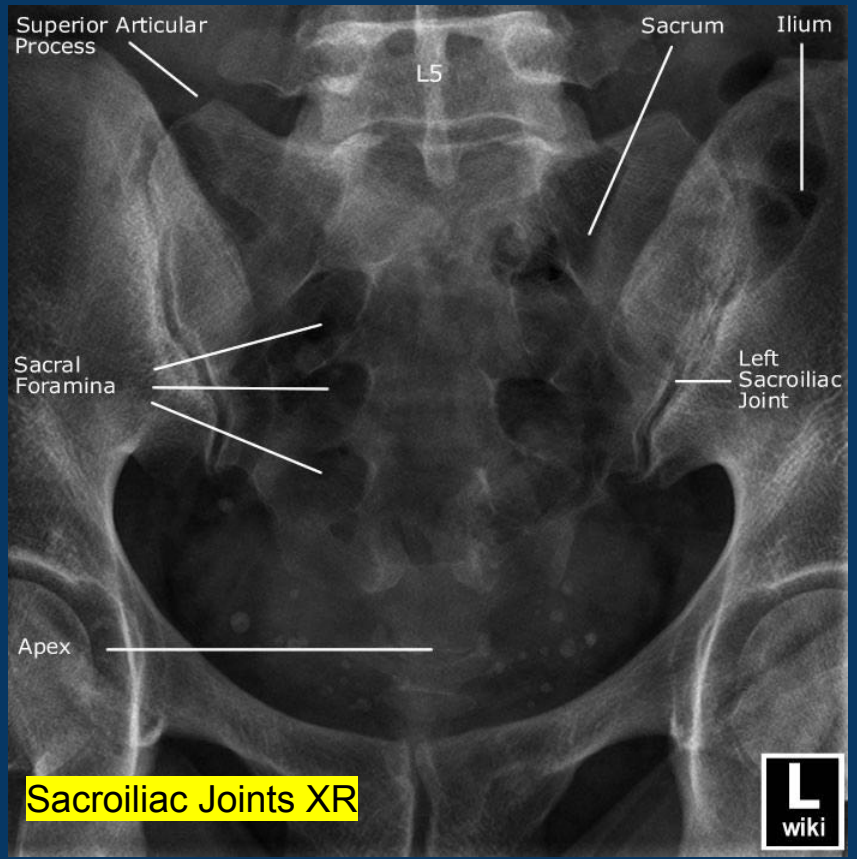
Sacrum/ Sacroiliac Joint Normal XR



Sacrum Lateral



Sacroiliac Joints XR

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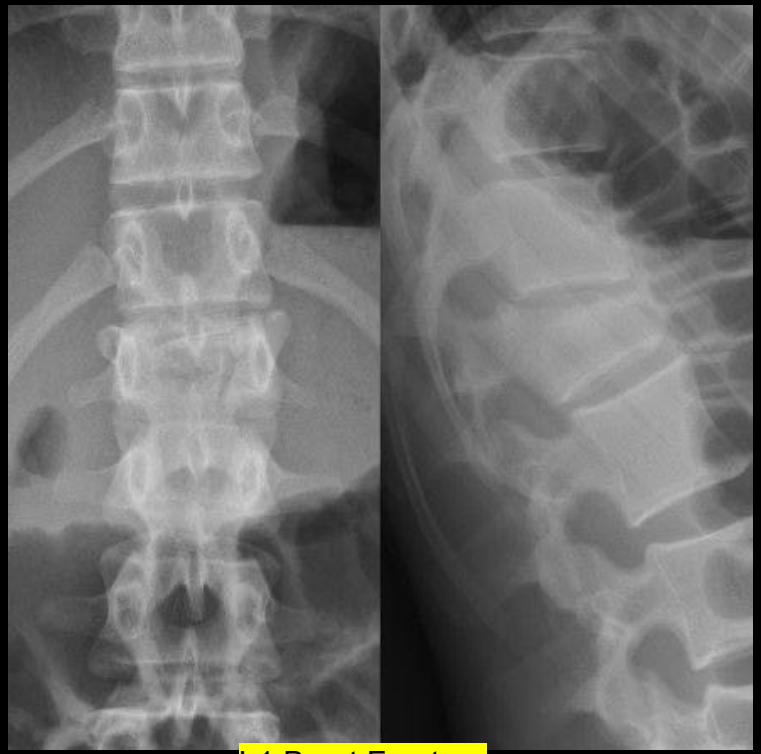
Abnormal Lumbar XRs



L1 Burst Fracture

L? Compression Fracture

L5/S1 DDD

Summary Table of XRs

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Region *(Lines)*	Orthogonal Sets	Special Views
Shoulder ***(Moloney's Arch)***	AP/ Axial	Y-Scapula, Velpeau Zanca (ACJ)
Humerus	AP/ Lateral	
Elbow ***(Anterior Humeral, Radiocapitellar Lines)***	AP/ Lateral	Greenspan (Radial head) Internal Oblique (Lateral Condyle #)
Forearm	AP/ Lateral	
Wrist ***(Gilula Lines, Radial Parameters)***	PA/ Lateral	Scaphoid Carpal Tunnel
Hand	PA/ Lateral/ Oblique	
Finger	PA/ Lateral/ Oblique	
Pelvis ***(Acetabular Lines)***	AP	Inlet/ Outlet Iliac/Obturator Oblique
Sacroiliac Joint	AP Sacrum lateral	

Region *(Lines)*	Orthogonal Sets	Special Views
Hip ***(Shenton's Line)***	AP/ Lateral	
Femur	AP/ Lateral	
Knee	AP/ Lateral (Weight bearing for OA)	Skyline (PFJ) Rosenberg (Medial Joint Space) Long Leg (Mech axis)
Tibia	AP/ Lateral	
Ankle	AP/ Lateral/ Mortise	
Foot	AP/ Lateral/ Oblique	Harris, Broden's (Calcaneum)
Toes	AP/ Lateral/ Oblique	
Cervical Spine ***(4 Lines for alignment)*** ***(Retropharyngeal Swelling 2-6-6-2)***	AP/ Lateral	Open mouth (C2) Swimmer's (C7) Flexion/ Extension
Lumbar Spine	AP/ Lateral	Flexion/ Extension

YMS

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Quiz Time!

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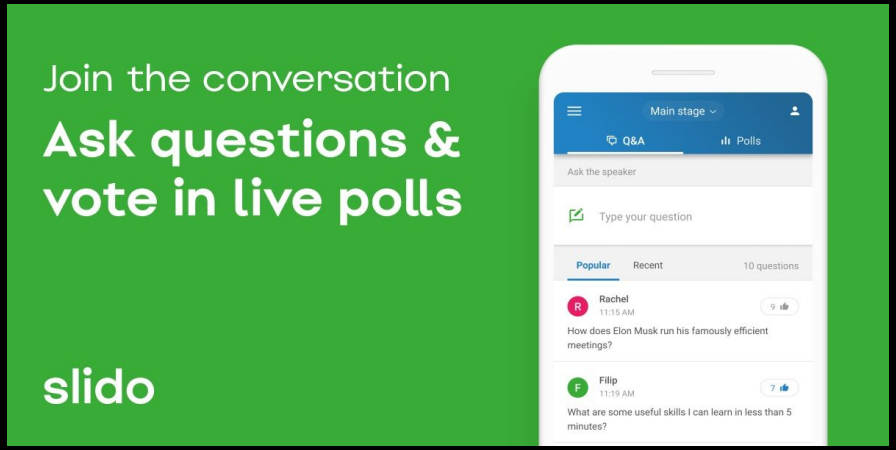

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Normal XR Quiz Q9

17 **What is the role of flexion/ extension views in the spine?**

- To look for soft tissue masses
- To look for Arthritis
- To look for dynamic instability
- To Look for Loose bodies

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Normal XR Quiz Q10

⏱ 19 **Which of these is NOT a line to recognise on a cervical spine XR?**

- Anterior vertebral line
- Posterior vertebral Line
- Intervertebral Line
- Spinolaminar Line
- Spinous Process Line

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Normal XR Quiz Q11

19 **In which XR may you visualise the "Scottie Dog sign"?**

- Cervical Spine Lateral View
- Lumbar spine Lateral View
- Lumbar Spine Oblique View
- Lumbar Spine AP View

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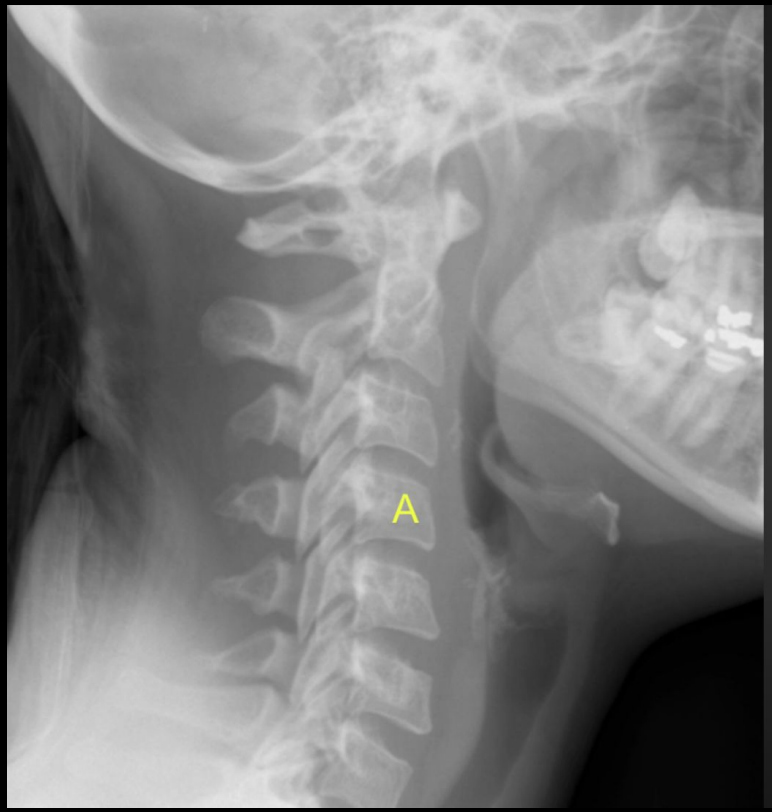
Normal XR Quiz Q12



14

Which bone is labelled A

- C2
- C3
- C4
- C5

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4. Identify skeletal **maturity** - immature vs mature

Two Views

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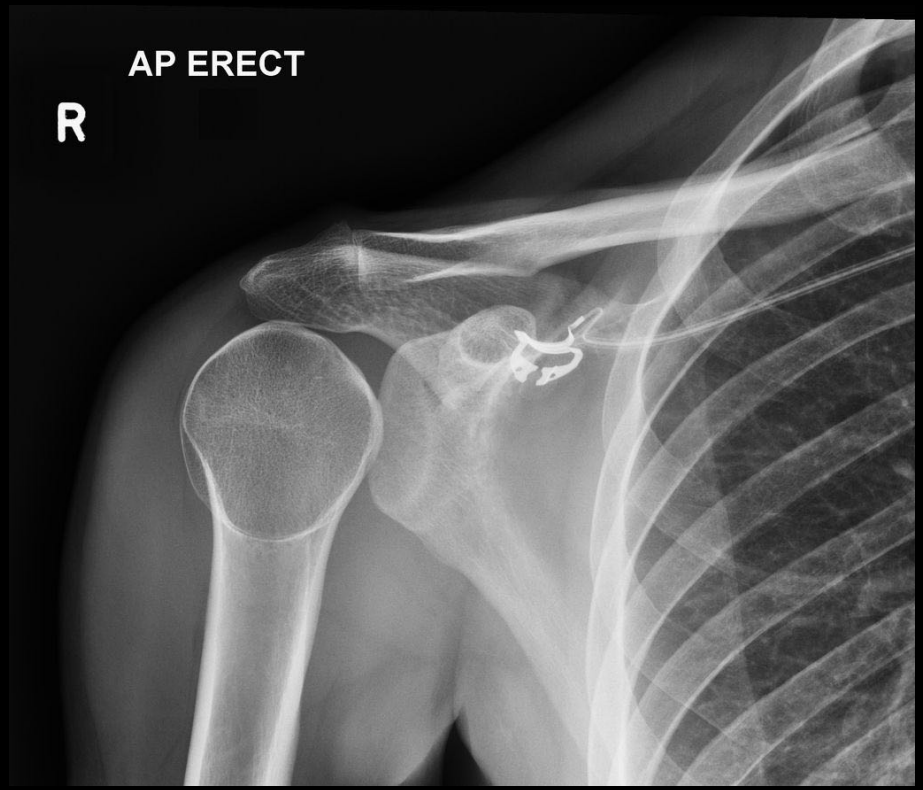
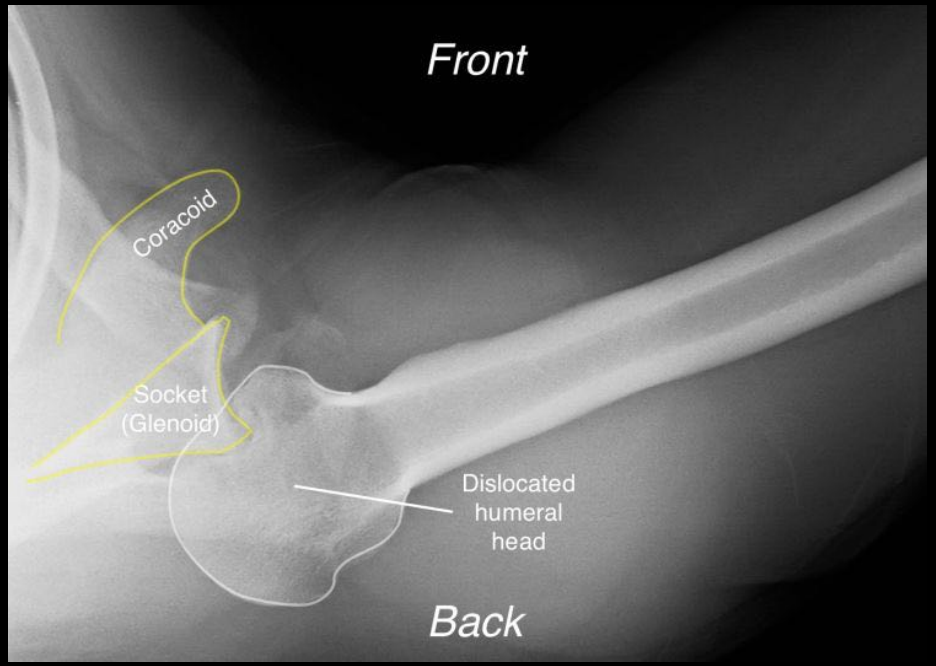
Two Views





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Two Joints

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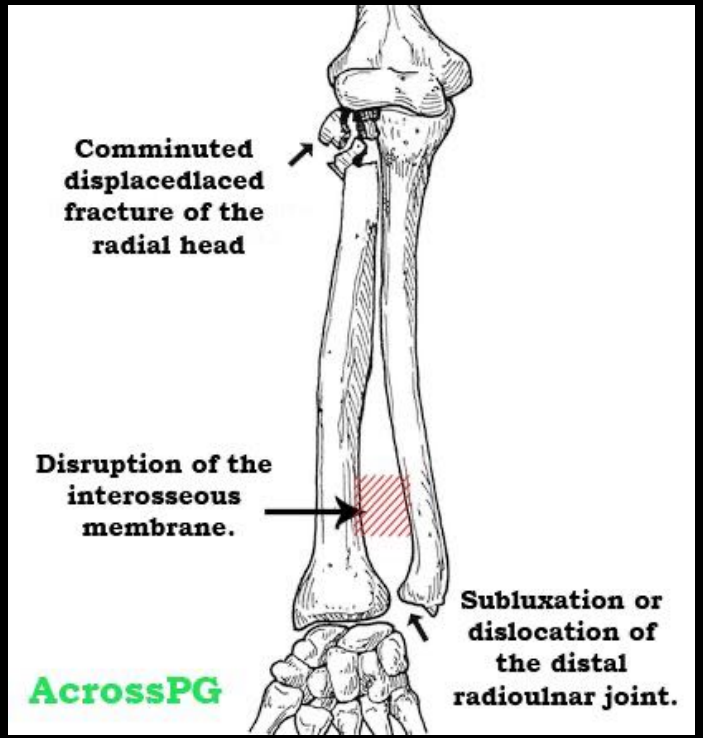
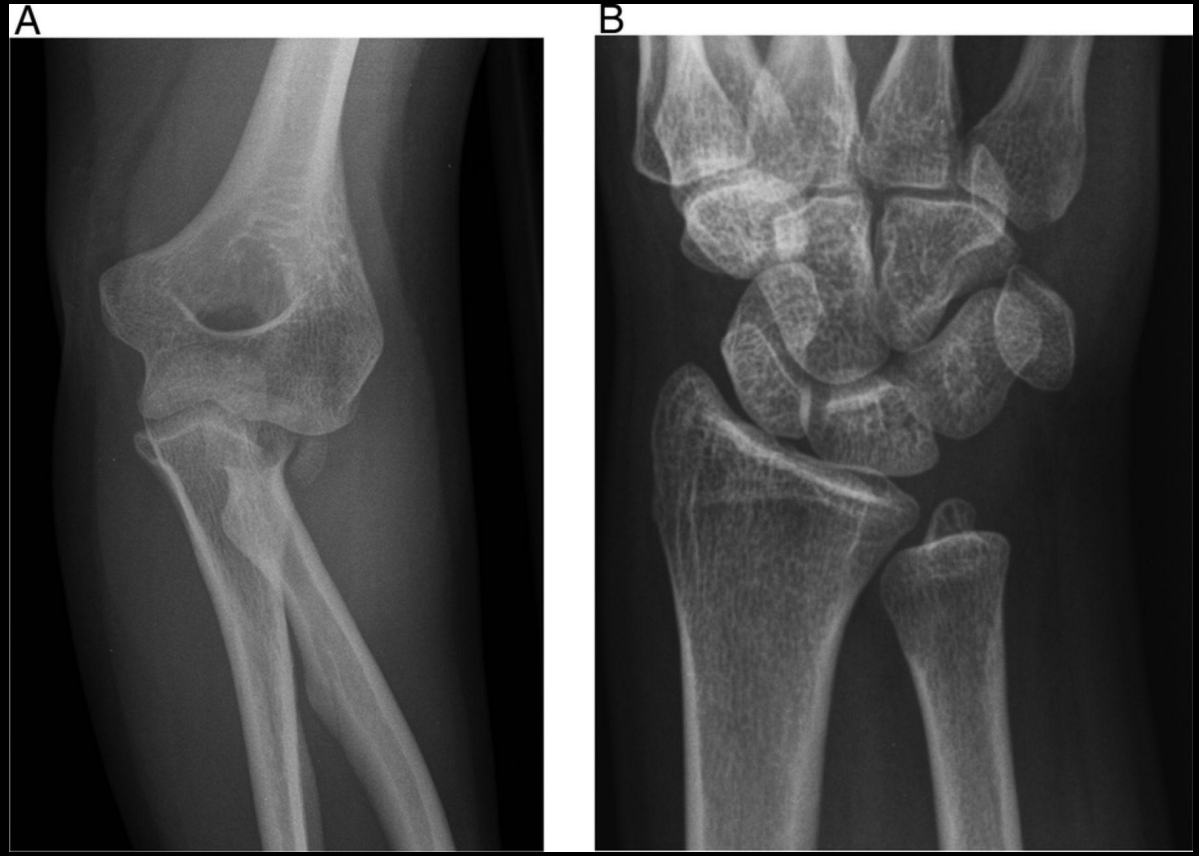
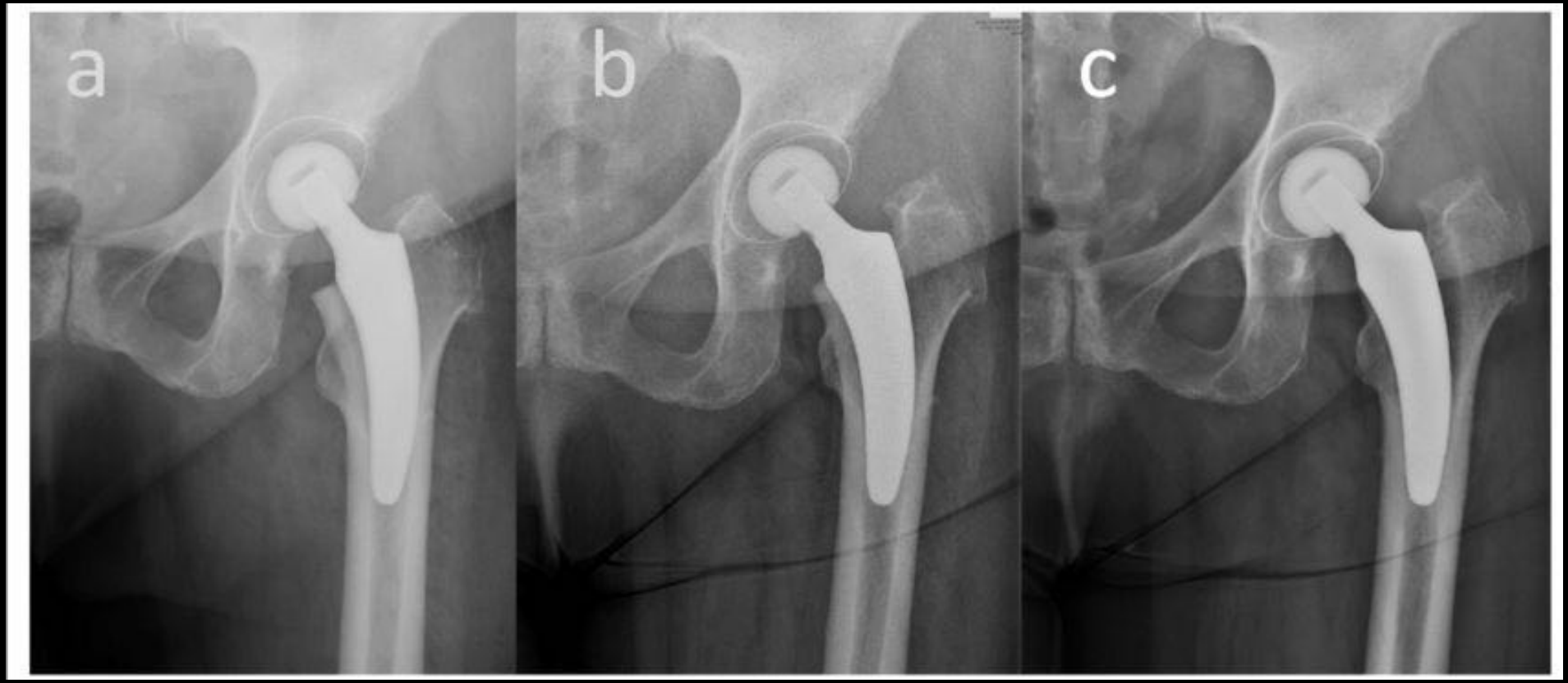
Two Joints





Two Occasions



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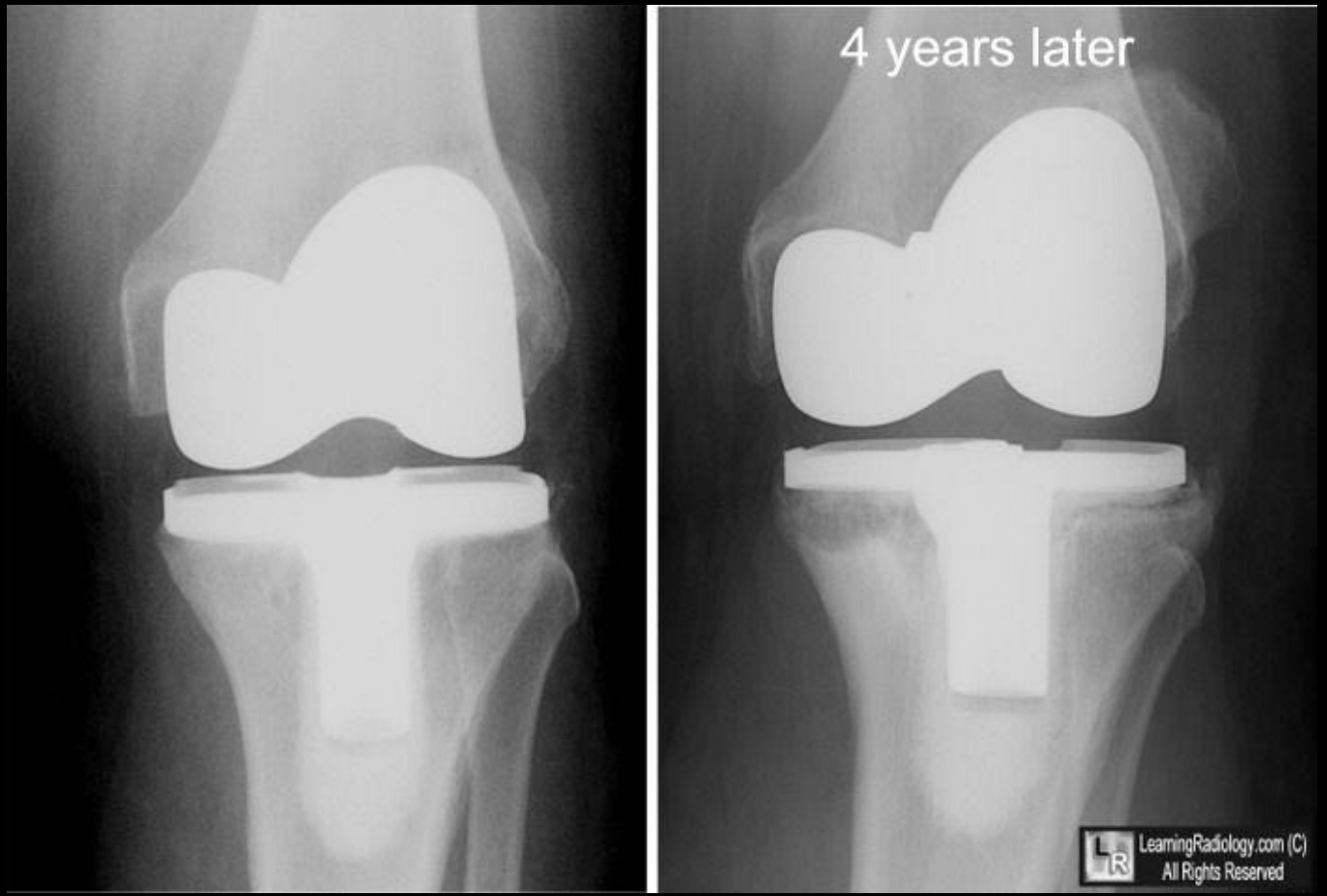
Two Occasions



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Skeletally Immature XR

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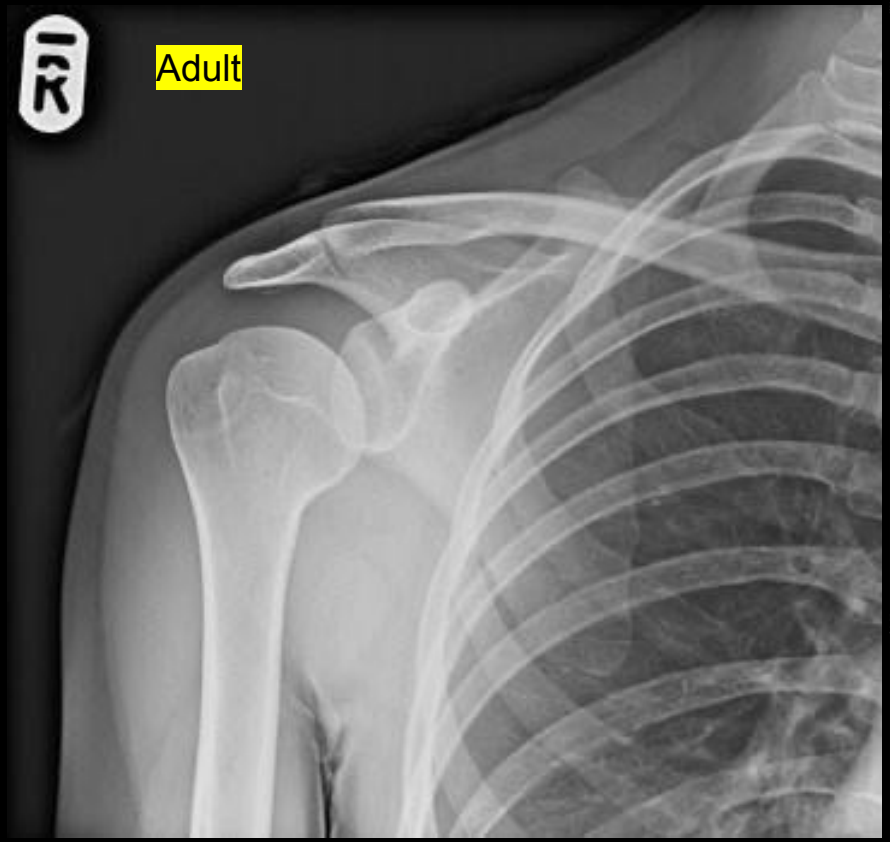
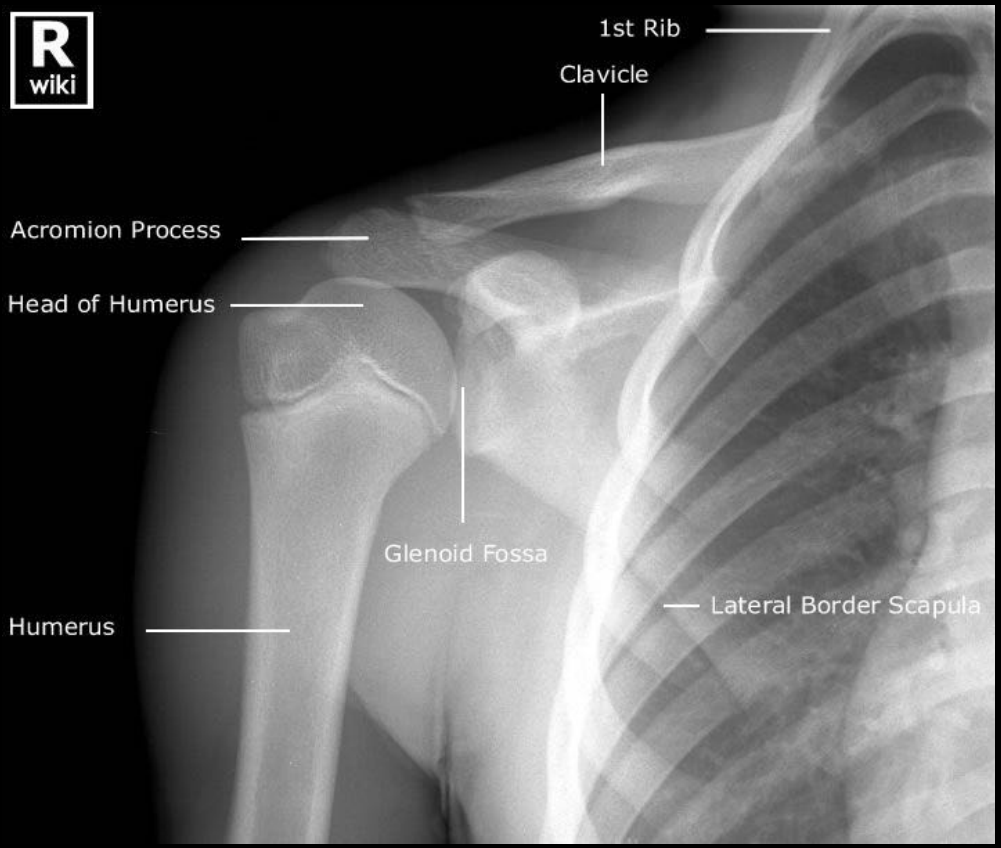
Skeletally Immature Upper Limb XR





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Skeletally Immature Upper Limb XR

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Skeletally Immature Upper Limb XR

Adult

Adult

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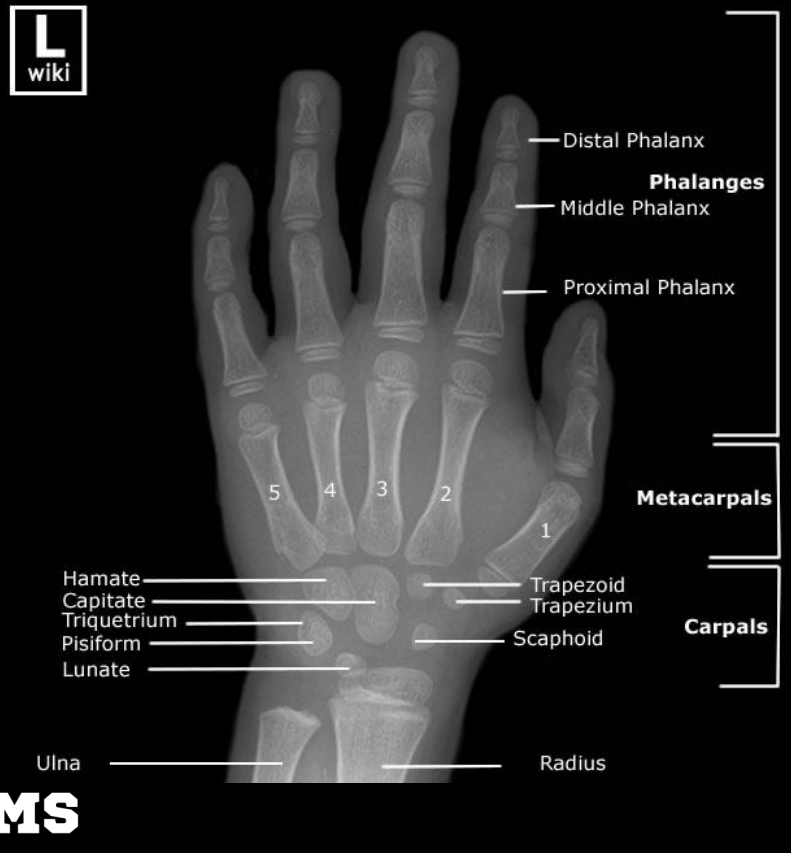
Skeletally Immature Upper Limb XR



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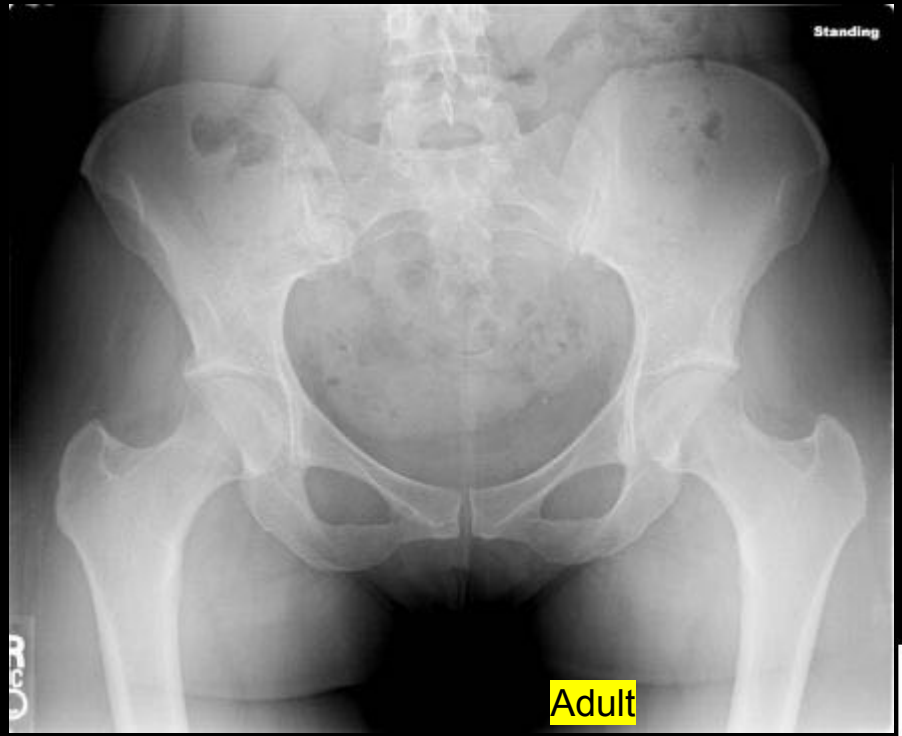
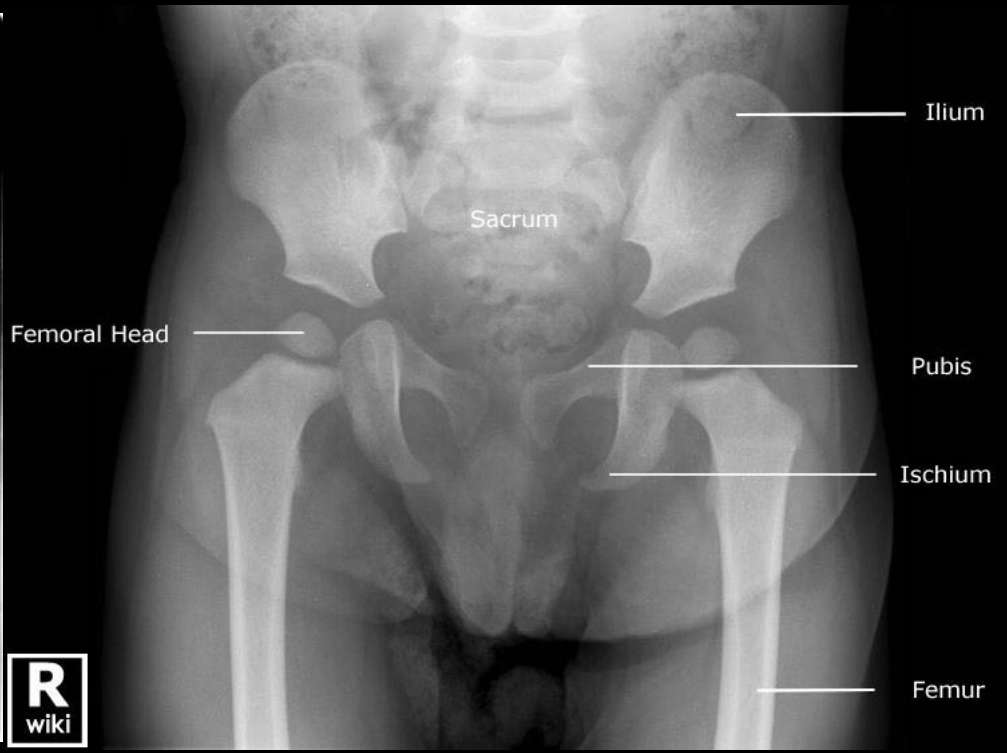
Skeletally Immature Lower Limb XR





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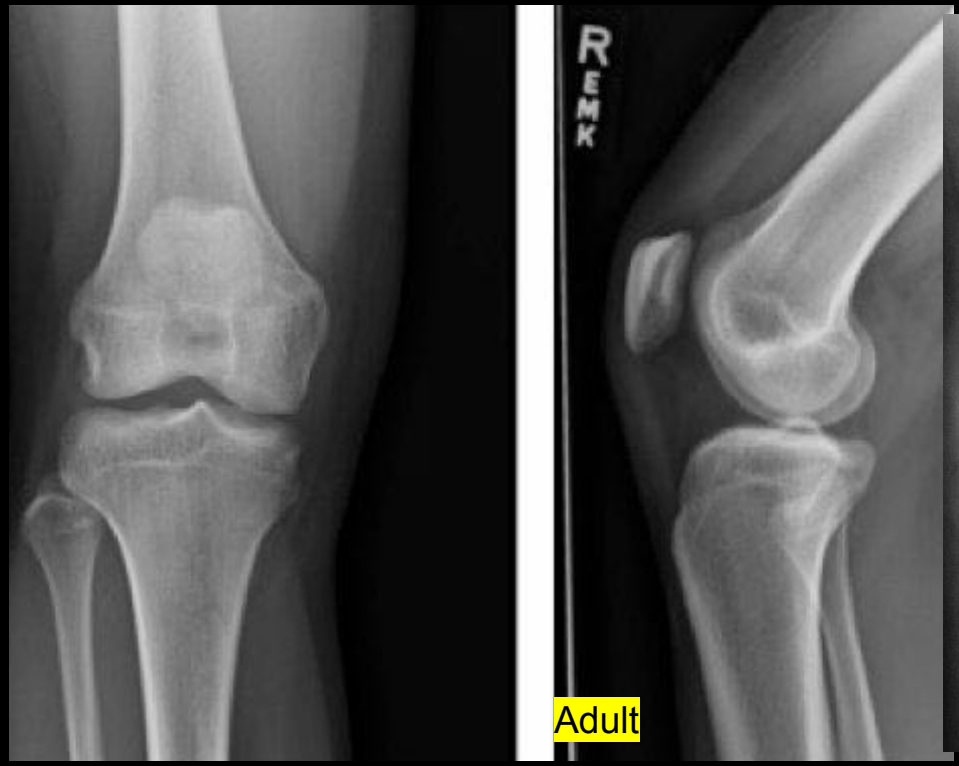
Skeletally Immature Lower Limb XR



How mature? Elbow Ossification Centers

Capitellum **1 yr.**

Radial Head **3 yrs.**

Internal Epicondyle **5 yrs.**
(medial)

Trochlea **7 yrs.**

Olecranon **9 yrs.**

External Epicondyle **11 yrs.**
(lateral)

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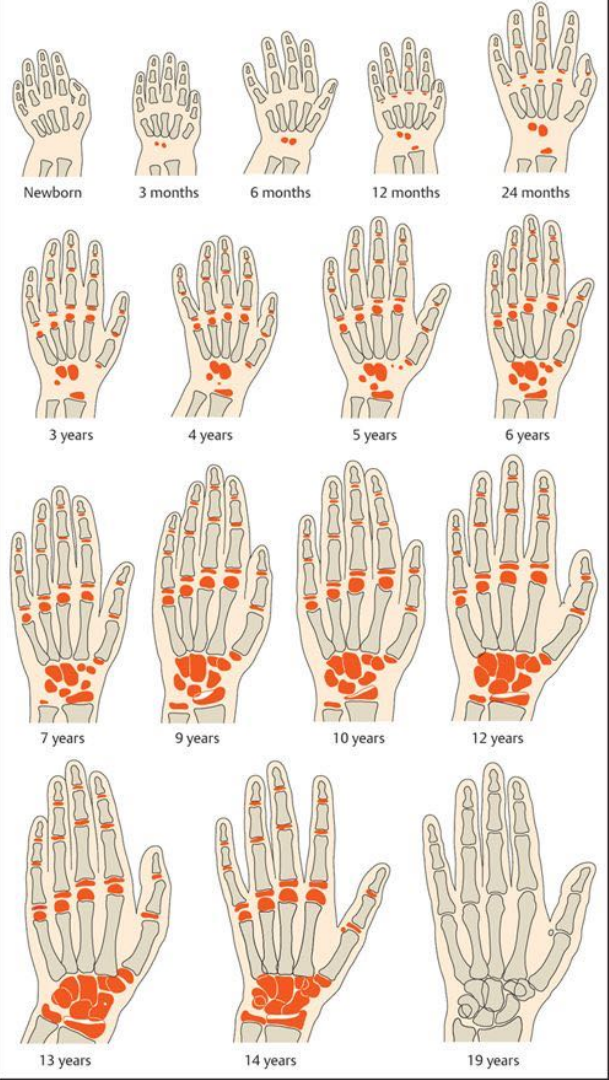
How mature?

RADIOGRAPHIC ATLAS OF SKELETAL DEVELOPMENT OF THE HAND AND WRIST

SECOND EDITION

WILLIAM WALTER GREULICH
Professor of Anatomy, Stanford University School of Medicine

S. IDELL PYLE
Research Associate, Departments of Anatomy, Western Reserve University and Stanford University Schools of Medicine



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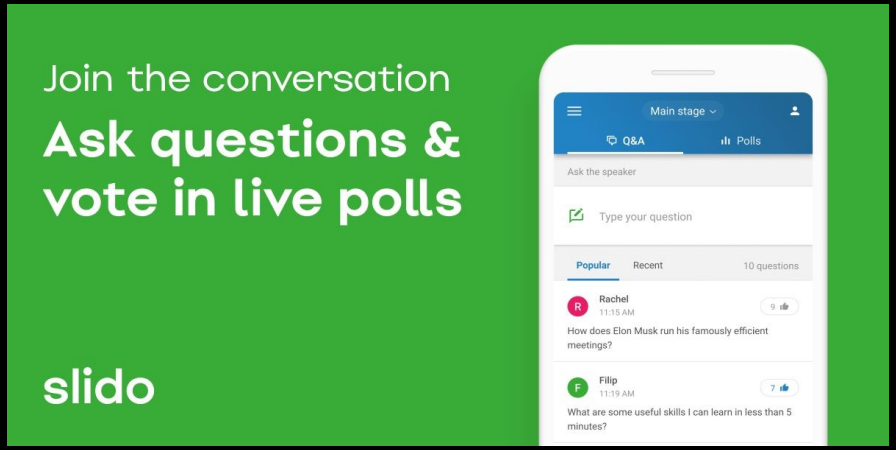

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Normal XR Quiz Q13

19

Given this XR, what would you immediately ask for?

- History of the patient
- Examination Findings
- Lateral view XR
- Location of Pain

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Normal XR Quiz Q14

16

What is this the maturity of this patient's bone?

- Mature
- Immature

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Normal XR Quiz Q15

18

What is this the maturity of this patient's bone?

- Mature
- Immature

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Normal XR Quiz Q16

37

What is this patient's skeletal age?

- 1
- 3
- 5
- 7
- 9
- 11

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Maximising our Time!

- Post Lecture Quiz for OMS Radio Part 1 = Normal XR
- https://docs.google.com/forms/d/1TzrrbgWaZZg-7XpTlRkdmW-enfs9IpeMizukY37Rj30/edit

M3 LW OMS Radio 1 Quiz

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Applied Radiology in Orthopaedics 2

Ortho Made Simple

Mok Ying Ren

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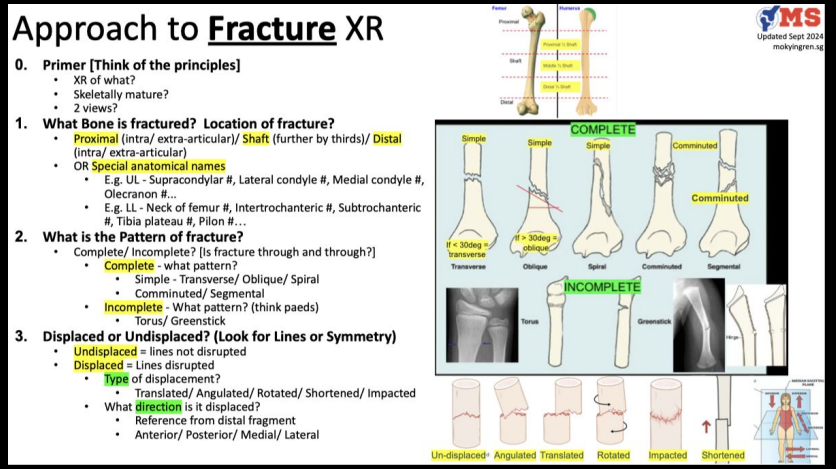
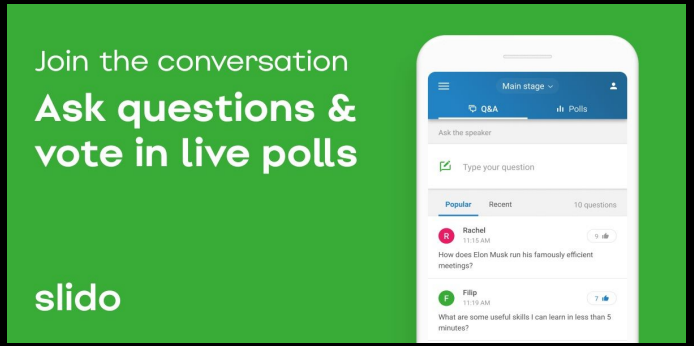
How to Maximise My Lecture Series

- You will be given 2 sets of notes
  - **OMS Master Summary** (Helicopter view of entire lecture)
  - **Lecture slides** for annotation
    - Applied Radiology
    - Approach Frameworks
    - Shoulder and Elbow Exam
- Suggested **3 Pronged Method**
  - Open **OMS Master Summary** - ensure visibility throughout lecture
  - Annotate on **lecture slides**
  - Separate Pen and Paper to write down questions → Ask on Slido immediately
    - Safe space to ask questions - if you are thinking about it, someone is too! Please please ask!
- Post lecture quizzes for each lecture in slides

Summary Slide For this lecture:





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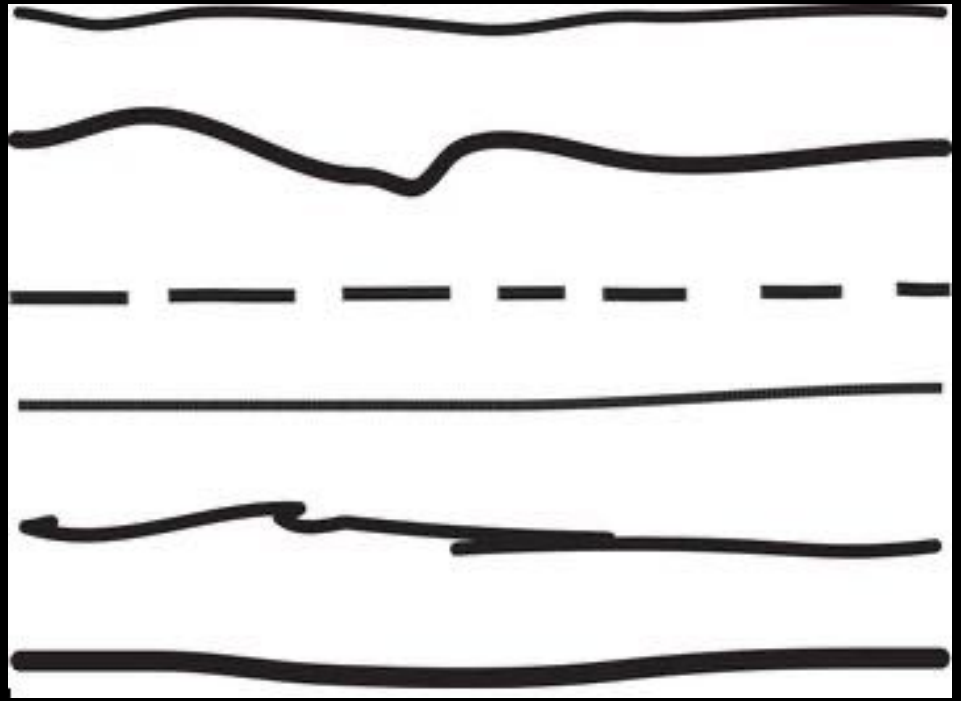
Reading XR

- Reading XRs is like how you tell a curved line from a straight line
  - You either compare with a physical ruler
  - Or you compare with an imaginary ruler etched in your mind
- Pattern recognition
- Implication: you need to be patient with yourself!



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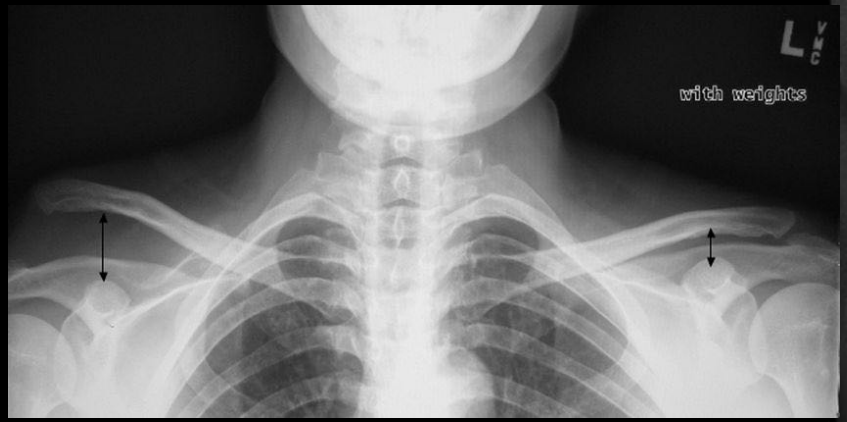
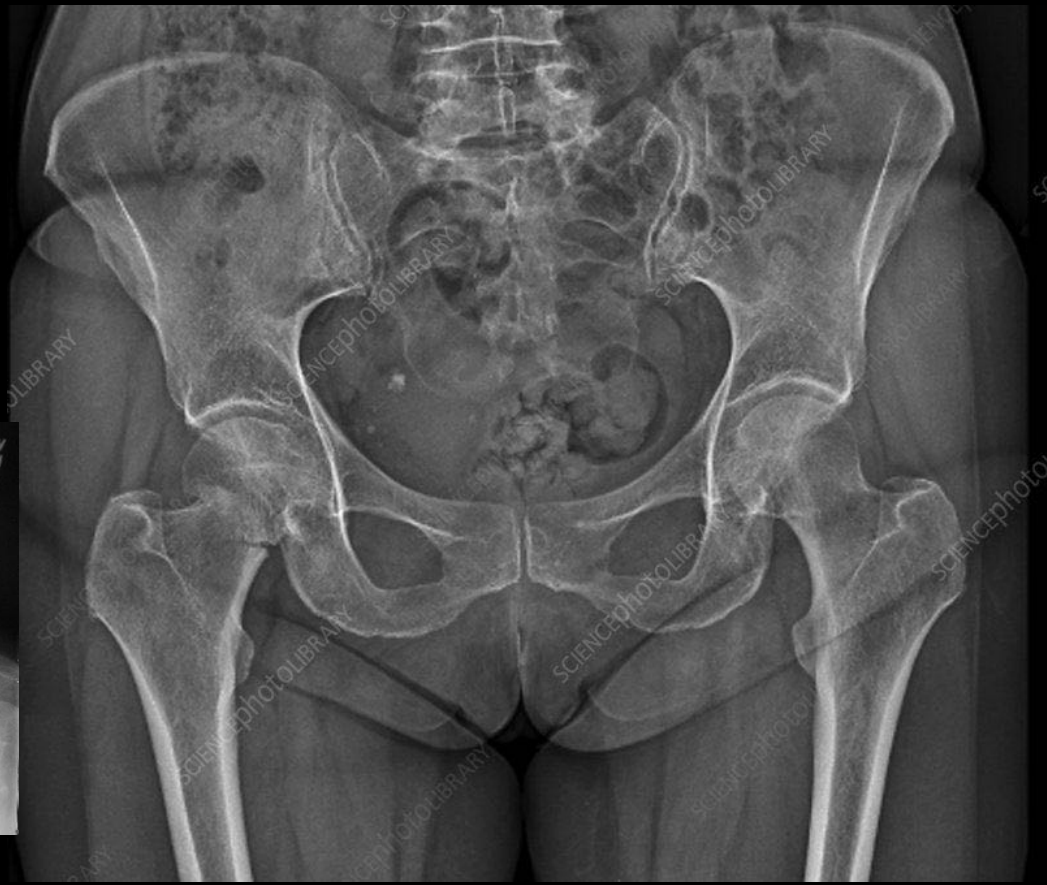
Comparison is Key

- Compare to a normal XR in the mind

Comparison is Key

- Compare to contralateral side





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You need new Vocabulary

- You know it is broken but you need words to describe - new vocabulary
- Like teaching a toddler colours, shapes and size
- Be patient with yourself

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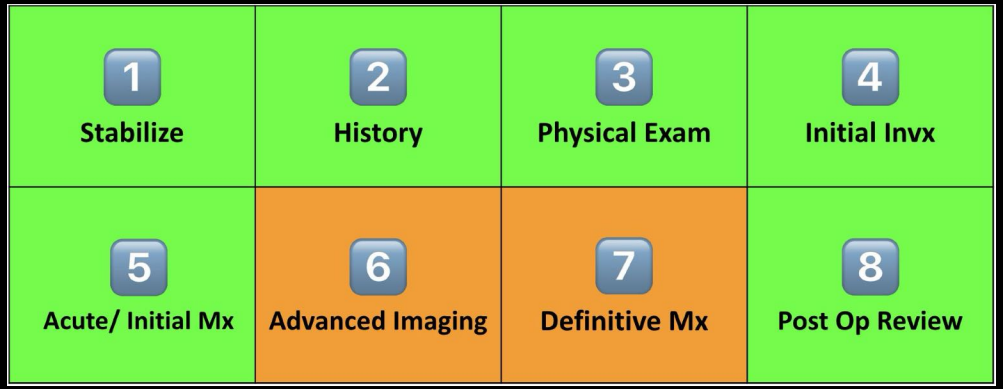
When do we order XR?

- As part of Initial investigation
  - **Imaging = XR**
  - Bloods



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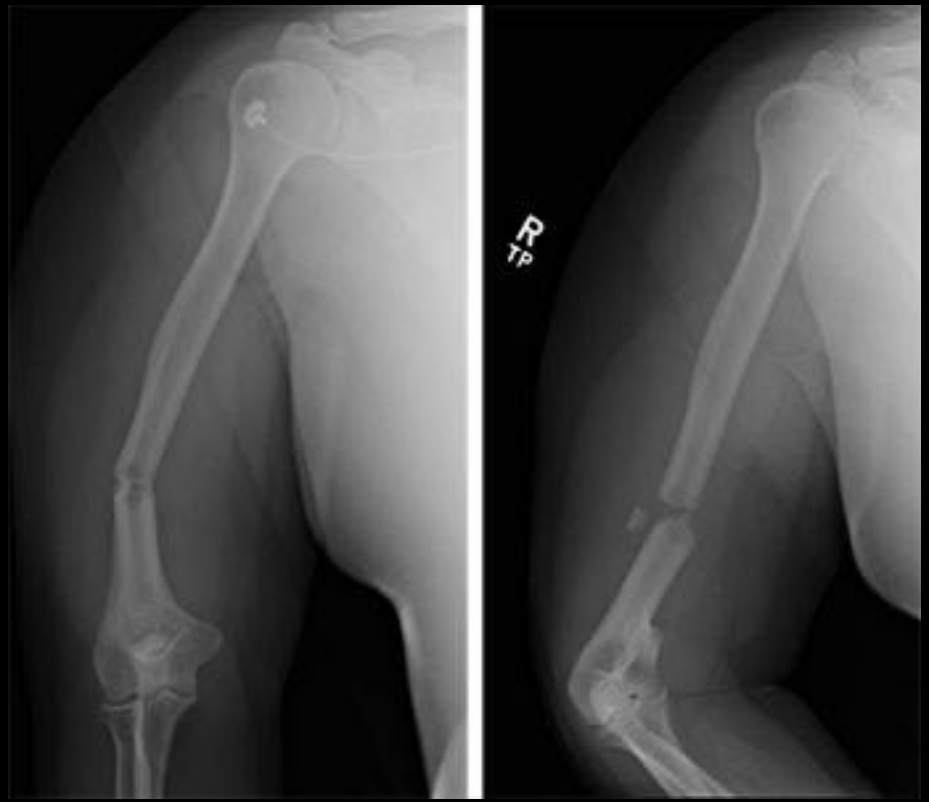
Why the need to describe XR?

- Phone call with senior (Why cannot just whatsapp the picture? 😂)
  - Putting a picture into words

- Exams - learning how to write your script fast in your mind
  - High chance of your ortho exam starting by showing you an XR
  - You need to be able to describe well to give a good impression



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Approaching the Fracture XR

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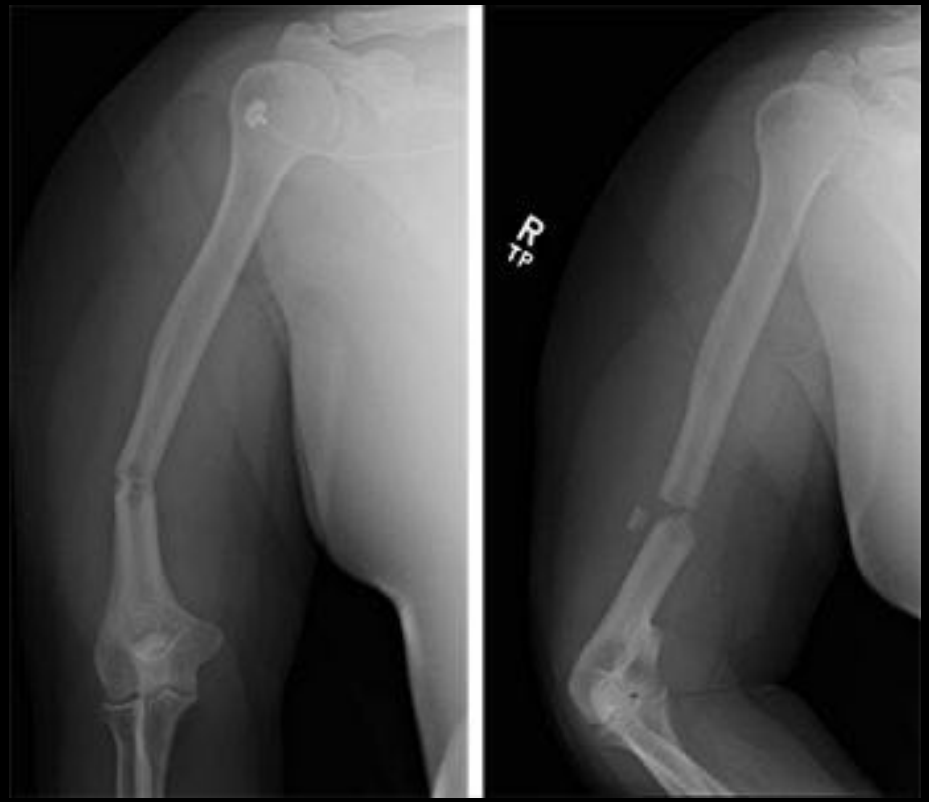
Approaching the **Fracture** XR

1. Primer [Think of the principles]
    a. XR of what?
    b. Skeletally mature?
    c. 2 views?
2. What Bone is fractured?
    a. Location of fracture
3. What is the pattern of fracture?
    a. Complete/ Incomplete?
        i. Complete - what Pattern?
        ii. Incomplete - What pattern?
4. Displaced or Unddisplaced?
    a. If displaced, what kind of displacement?
    b. What direction is it displaced?



YMS

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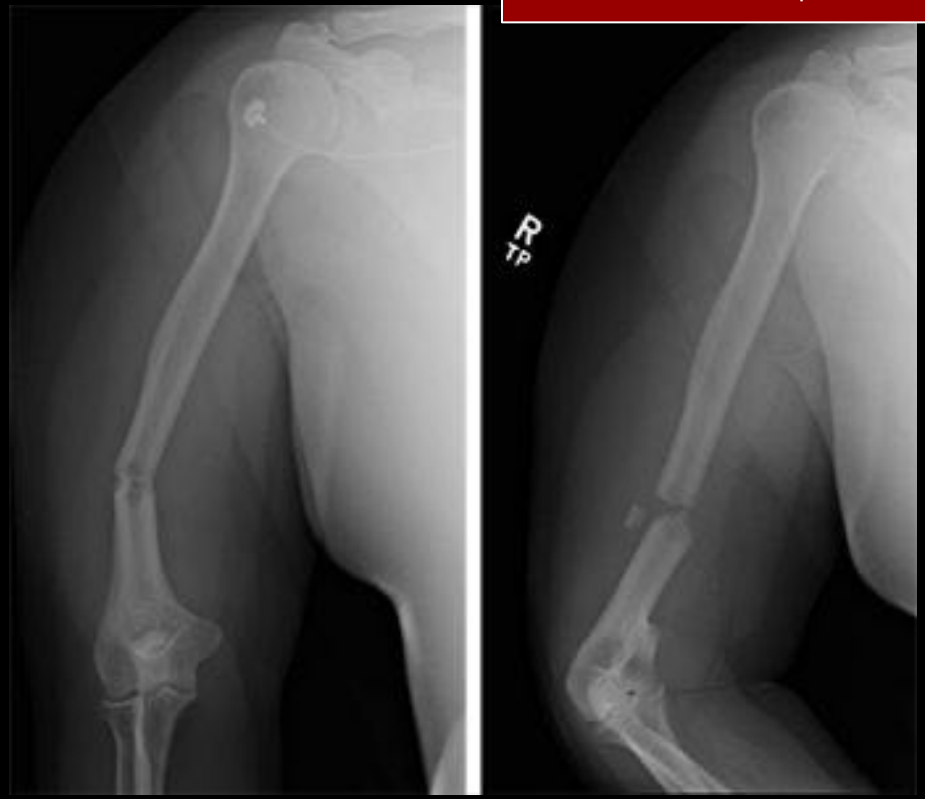
Approaching the **Fracture** XR

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone is fractured?
   a. **Location** of fracture
3. What is the **pattern** of fracture?
   a. Complete/ Incomplete?
      i. Complete - what Pattern?
      ii. Incomplete - What pattern?
4. Displaced or Unddisplaced?
   a. If displaced, what **Type** of displacement?
   b. What **direction** is it displaced?

Describing XR

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement



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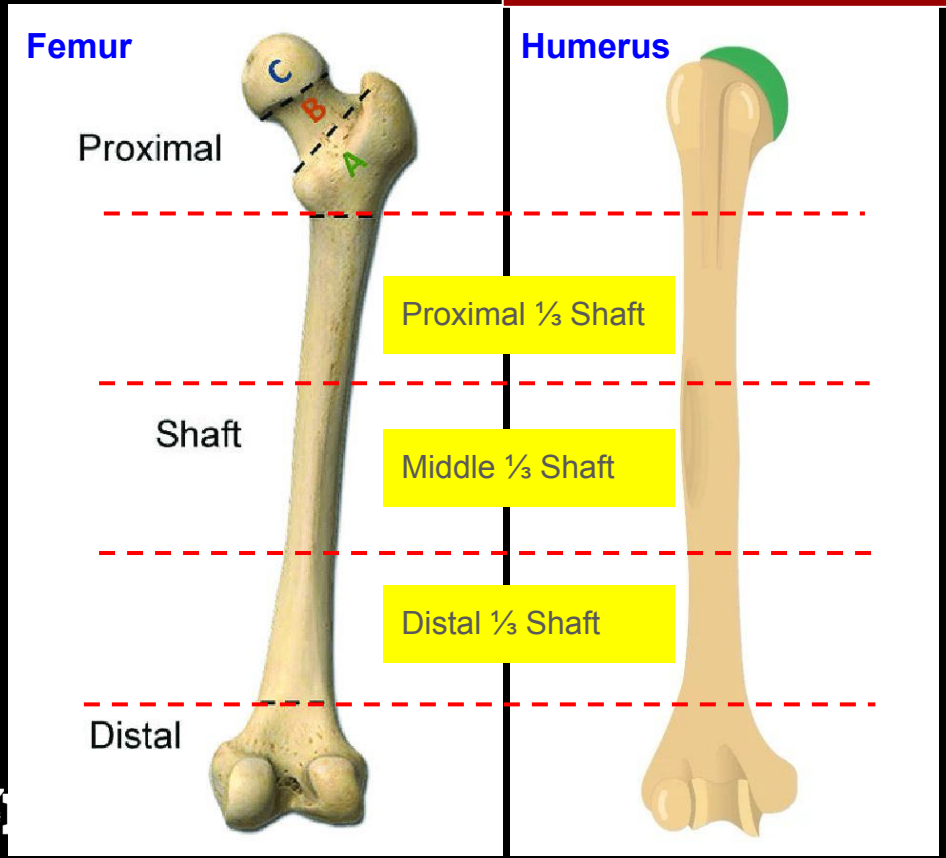
We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

Location

1. Proximal
   a. Intra-articular
   b. Extra-articular
2. Shaft
   a. Proximal ⅓
   b. Mid shaft/ Middle ⅓
   c. Distal ⅓
3. Distal
   a. Intra-articular
   b. Extra-articular

- Specific anatomical fractures e.g.
  - Scaphoid - proximal pole, waist, distal pole
  - Humerus - distal supracondylar, lateral condyle
  - Hip - Inter-trochanteric, neck, subtrochanteric
- Don't worry. Build up along the way.



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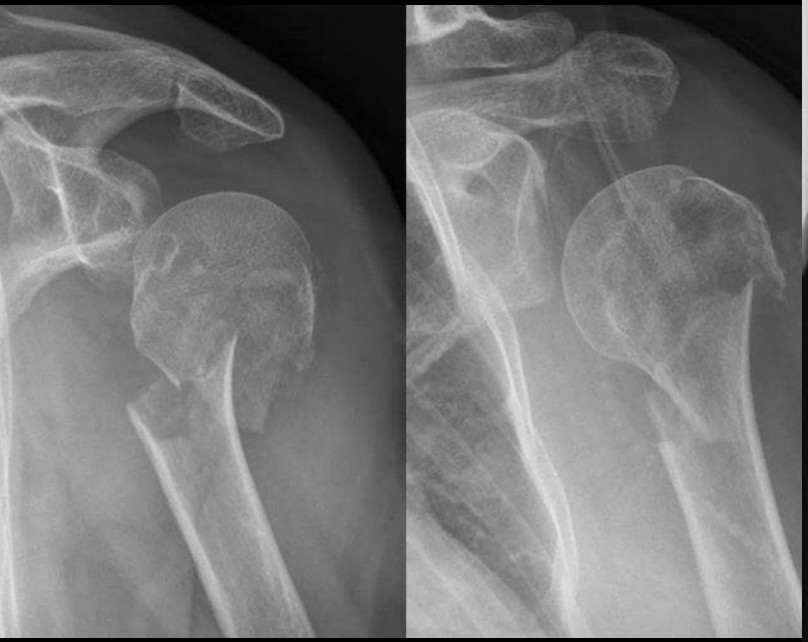
We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

Examples - Humerus



1. Proximal; Extra-articular

1. Mid-Shaft

1. Distal; Intra-articular

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We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

Examples - Tibia

1. Proximal; Intra-articular
aka *Tibia Plateau* Fracture

1. Mid-Shaft

1. Distal; Intra-articular
aka *Pilon* Fracture

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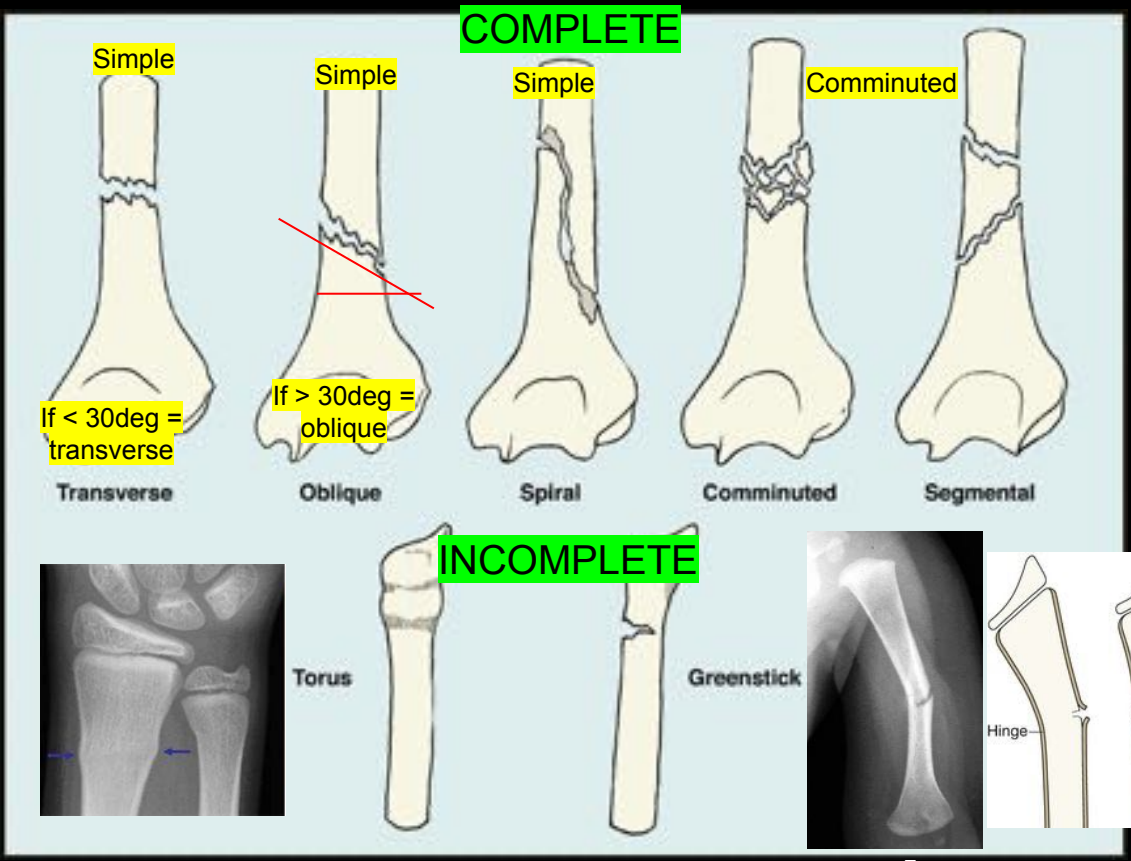
We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

Pattern of Fracture?



- Complete
  - Simple fracture patterns (1 fracture line)
    - Transverse (< 30 deg)
    - Oblique (> 30 deg)
    - Spiral
  - Comminuted
    - Segmental
- Incomplete - usually paediatrics due to thick periosteum
  - Torus (compression - crush)
  - Greenstick (tension - snapping a chopstick)

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XR Patterning

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Building on Examples - Humerus

We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

1. Proximal; Extra-articular
2. Complete; Oblique

1. Mid-Shaft
2. Complete; Spiral

1. Distal; Intra-articular
2. Complete; Comminuted

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We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

Building on Examples - Tibia

1. Proximal; Intra-articular
2. Complete; Comminuted

1. Mid-Shaft
2. Complete, Spiral

1. Distal; Intra-articular
2. Complete; Comminuted

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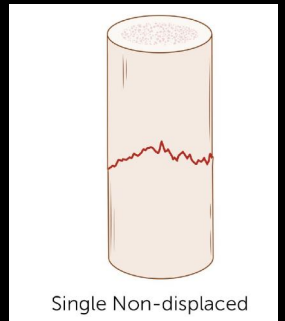
3. Type of Displacement

- **Undisplaced** = Fracture has not moved
- **Displaced** = fracture has moved.
  - ***Angulated*** - one cortex still in contact
  - ***Translated*** - “original” cortices no more in contact
  - ***Rotated***
  - ***Shortened -*** overlapping has occurred
  - ***Impacted*** - (shortened without translation/ overlap)

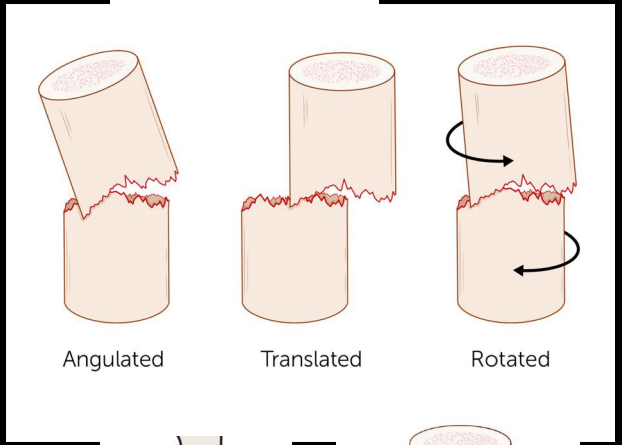
- Can be a combination!
- How do you know fracture has displaced?
  - Some line is disrupted - name the line if it has a name!
- Direction is described ***based on distal fragment***

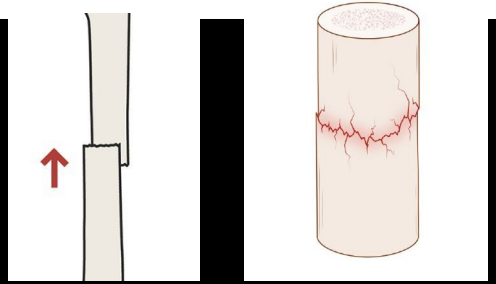
We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement



Single Non-displaced





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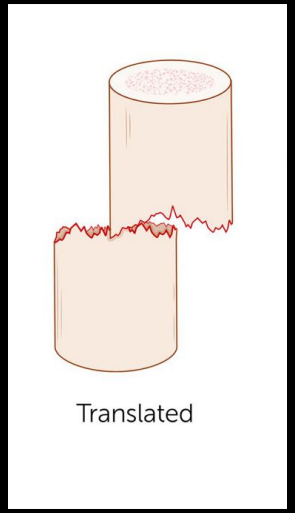
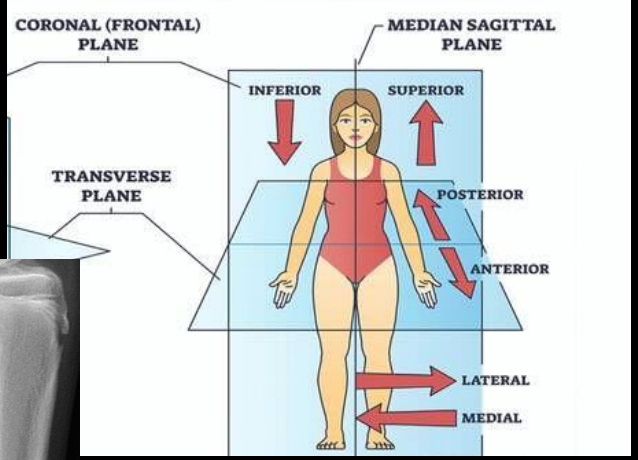
4. Direction of Translation

- Anterior
- Posterior
- Medial
- Lateral
- Proximally (Shortened)





You need a “lighthouse”

- Shoulder - Coracoid
- Wrist - Ulnar styloid
- Elbow - Radial head
- Knee, Ankle - Fibula
- Femur - Femoral neck

YMS

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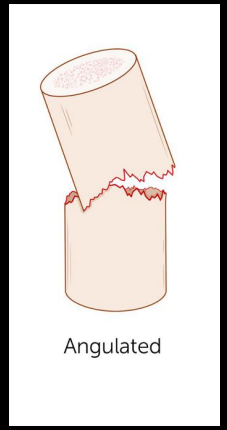
Direction Variations 🤦

- Forearm/ Hand
  - Laterally = Radially
  - Medially = Ulnarly
  - Anteriorly = Palmarly
  - Posteriorly = Dorsally
- Ankle/ Foot
  - Laterally
  - Medially
  - Anteriorly = Dorsally
  - Posteriorly = Plantarly

4. Direction of Angulation

- Posteriorly angulated
- Anteriorly angulated
- Medially angulated
- Laterally angulated

- Also described based on where the apex is?
  - Medial angulation = apex lateral
  - Lateral angulation = apex medial
  - Anterior angulation = apex posterior
  - Posterior angulation = apex anterior



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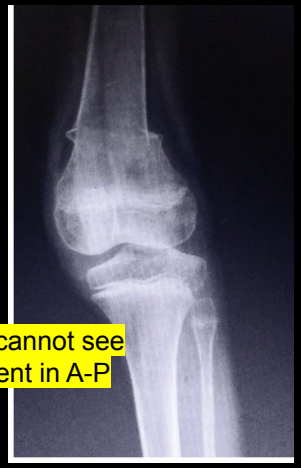
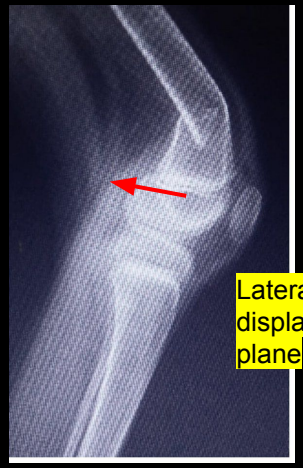
Cannot evaluate Displacement in same plane as XR!

- Cannot evaluate displacement in the Anterior-Posterior (A-P) plane in an AP XR
  - But can evaluate displacement in Medial-Lateral (M-L) plane
- Cannot evaluate displacement in the M-L plane in a Lateral XR
  - But can evaluate displacement in the A-P plane

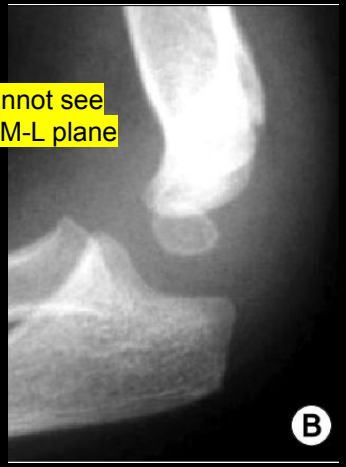


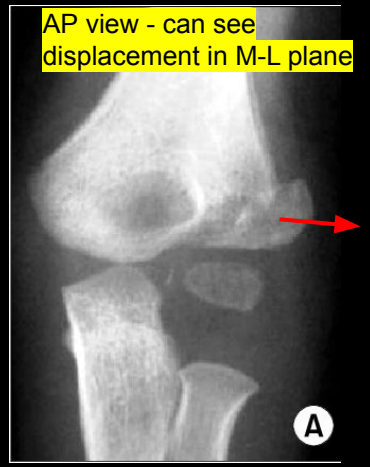
AP view - cannot see displacement in A-P plane



Lateral view - can see displacement in A-P plane

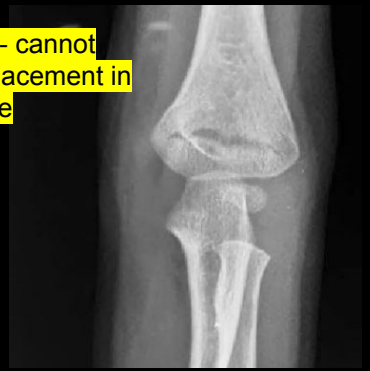
Lateral view - cannot see displacement in M-L plane

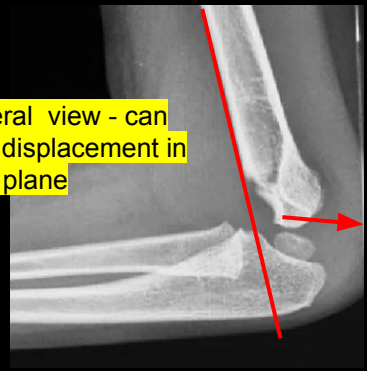




AP view - can see displacement in M-L plane

AP view - cannot see displacement in A-P plane





Lateral view - can see displacement in A-P plane

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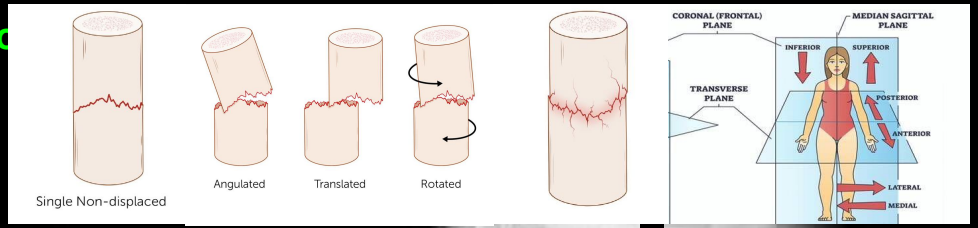
Building on XR Patterning



Incomplete
Oblique Greenstick
Medially angulated

Complete
Simple
Transverse
Undisplaced

Complete
Simple Oblique
Laterally
Translated

Complete
Simple Spiral
Laterally
angulated

Complete
Comminuted
Mild Posterior
angulation

Complete
Segmental
Laterally Translated

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We need vocab for

1. **Location** of fracture
2. **Pattern** of fracture
3. **Type** of displacement
4. **Direction** of displacement

Building on Examples - Humerus

1. Proximal; Extra-articular
2. Complete; Oblique
3. Translated medially

1. Mid-Shaft
2. Complete; Spiral
3. Angulated medially

1. Distal; Intra-articular
2. Complete; Comminuted
3. Shortened

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Building on Examples - Tibia

1. Proximal; Intra-articular
2. Complete; Comminuted
3. Displaced

1. Mid-Shaft
2. Complete, Spiral
3. Unddisplaced

1. Distal; Intra-articular
2. Complete; Comminuted
3. Displaced

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Case #0

1. Primer [Think of the principles]
    a. XR of what?
    b. Skeletally mature?
    c. 2 views?
2. What Bone is fractured?
    a. Location of fracture
3. What is the pattern of fracture?
    a. Complete/ Incomplete?
        i. Complete - what Pattern?
        ii. Incomplete - What pattern?
4. Displaced or Unddisplaced?
    a. If displaced, what kind of displacement?
    b. What direction is it displaced?

1. XR of Humerus, skeletally mature, 2 views
2. Distal 1/3 shaft
3. Complete, comminuted, transverse
4. Medial angulation

YMS

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Let’s Play

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Case #1

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone is fractured?
   a. Location of fracture
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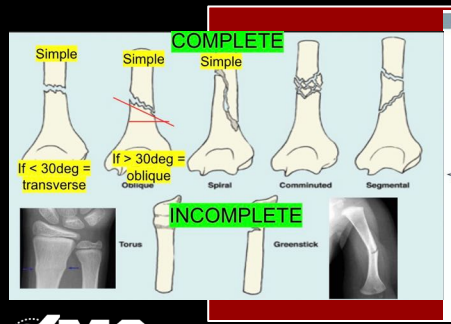
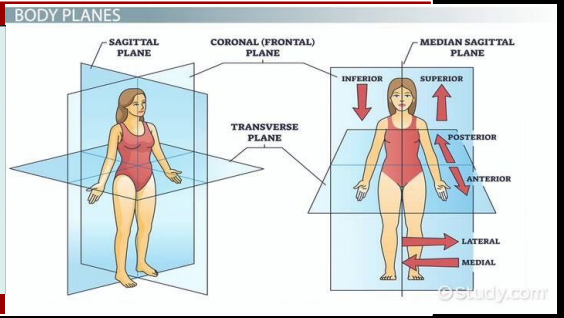
   a. If displaced, what kind of **displacement**?
   b. What direction is it **displaced**?





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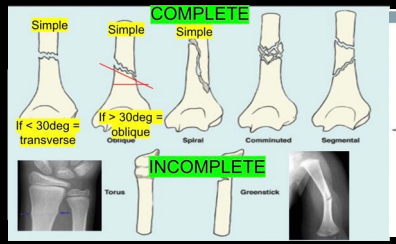
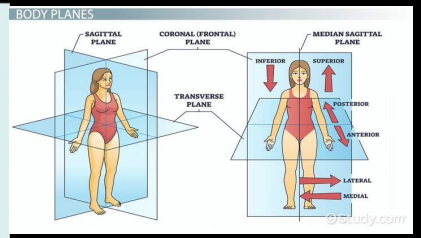
Case #2 - SLIDO

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone is fractured?
   a. Location of fracture
3. What is the pattern of fracture?
   a. Complete/ Incomplete?
      i. Complete - what Pattern?
      ii. Incomplete - What pattern?
4. Displaced or Undisplaced?
   a. If displaced, what kind of **displacement**?
   b. What direction is it **displaced**?





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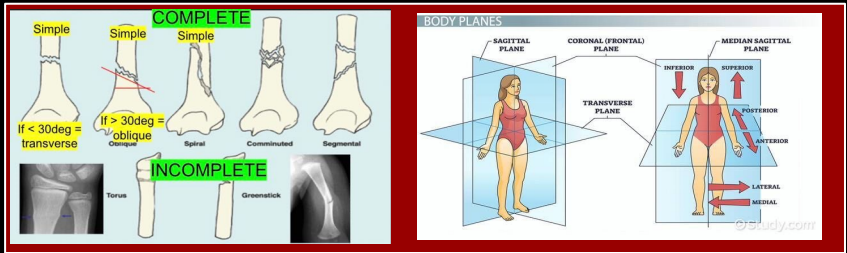
Case #3

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone is fractured?
   a. Location of fracture
3. What is the pattern of fracture?
   a. Complete/ Incomplete?
      i. Complete - what Pattern?
      ii. Incomplete - What pattern?
4. Displaced or Undisplaced?
   a. If displaced, what kind of **displacement**?
   b. What direction is it **displaced**?



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Approaching the Dislocation XR

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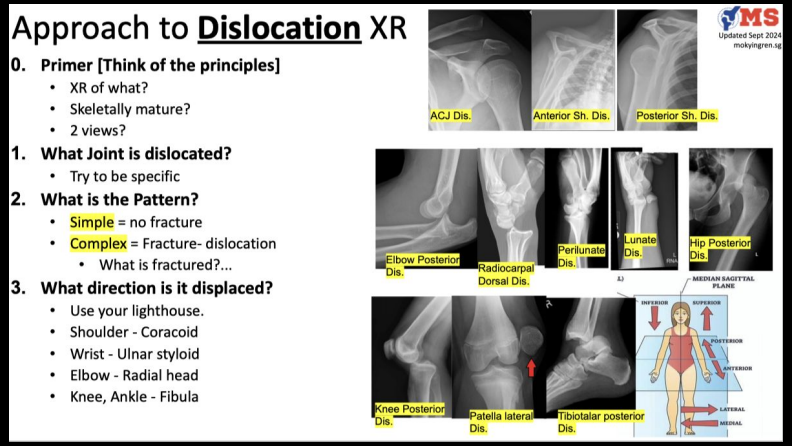
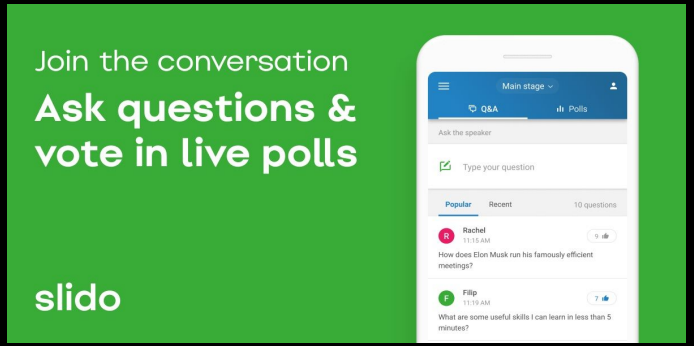
How to Maximise My Lecture Series

- You will be given 2 sets of notes
  - **OMS Master Summary** (Helicopter view of entire lecture)
  - **Lecture slides** for annotation
    - Applied Radiology
    - Approach Frameworks
    - Shoulder and Elbow Exam
- Suggested **3 Pronged Method**
  - Open **OMS Master Summary** - ensure visibility throughout lecture
  - Annotate on **lecture slides**
  - Separate Pen and Paper to write down questions → Ask on Slido immediately
    - Safe space to ask questions - if you are thinking about it, someone is too! Please please ask!
- Post lecture quizzes for each lecture in slides

Summary Slide For this lecture:





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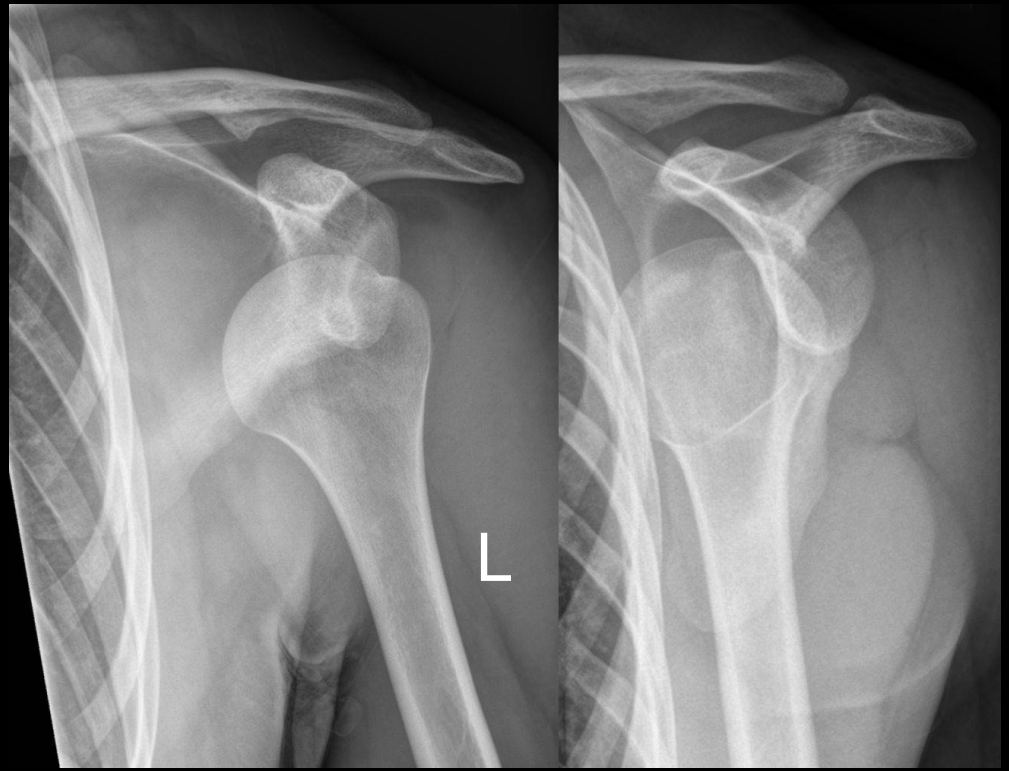
Approaching the **Dislocation** XR

1. Primer [Think of the principles]
    a. XR of what?
    b. Skeletally mature?
    c. 2 views?
2. What Joint is dislocated?
    a. Try to be specific
3. What is the pattern?
    a. Simple = no fracture
    b. Complex = Fracture- dislocation
        i. What is fractured?...
4. What direction is it displaced? Use your lighthouse.
    a. Shoulder - Coracoid
    b. Wrist - Ulnar styloid
    c. Elbow - Radial head
    d. Knee, Ankle - Fibula

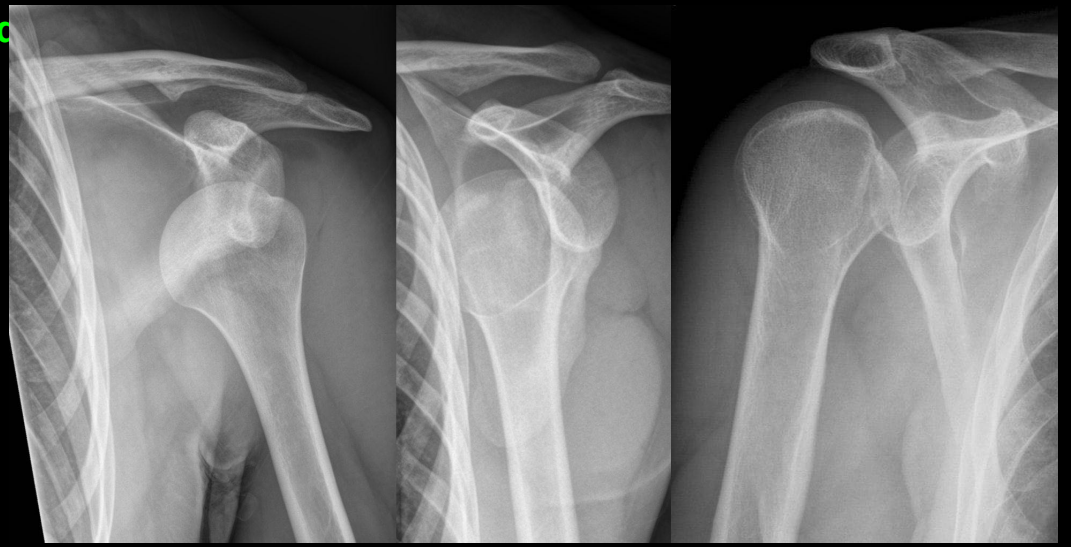


YMS

Slic

Locate your Light House

1. Shoulder - Coracoid
2. Wrist - Ulnar styloid, Metacarpals
3. Elbow - Radial head
4. Knee, Ankle - Fibula



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Case #0

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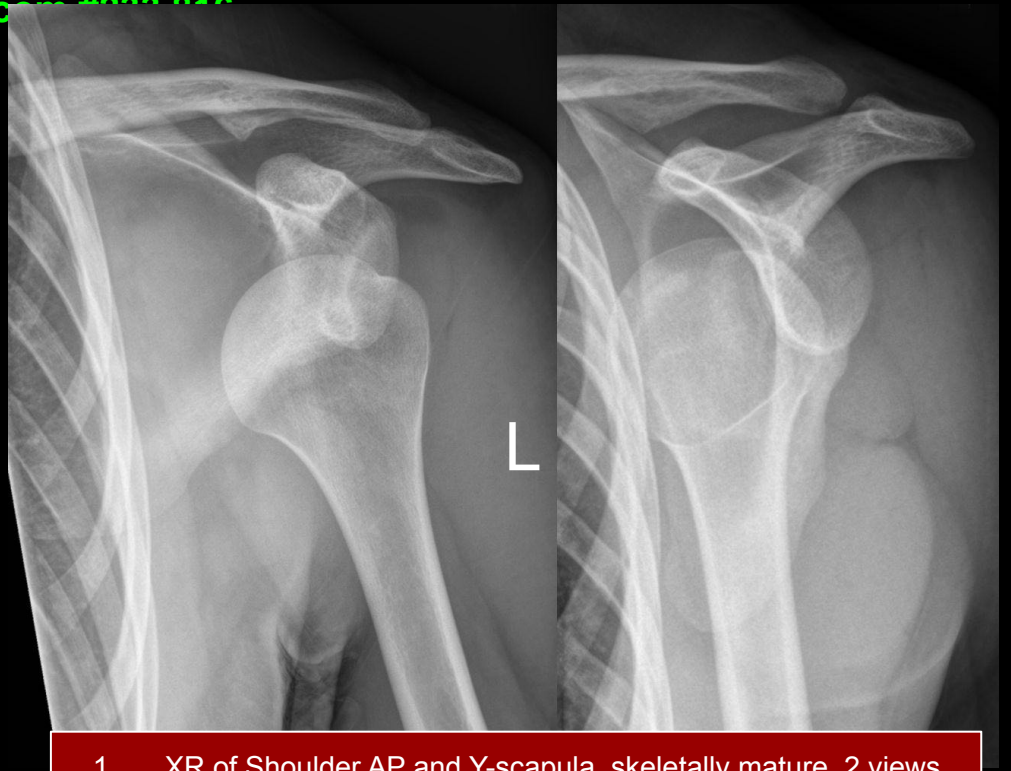
   a. Shoulder - Coracoid
   b. Wrist - Ulnar styloid
   c. Elbow - Radial head
   d. Knee, Ankle - Fibula
   e. Femur - Femoral neck



1. XR of Shoulder AP and Y-scapula, skeletally mature, 2 views
2. Glenohumeral joint
3. Simple
4. Displaced anteriorly

YMS

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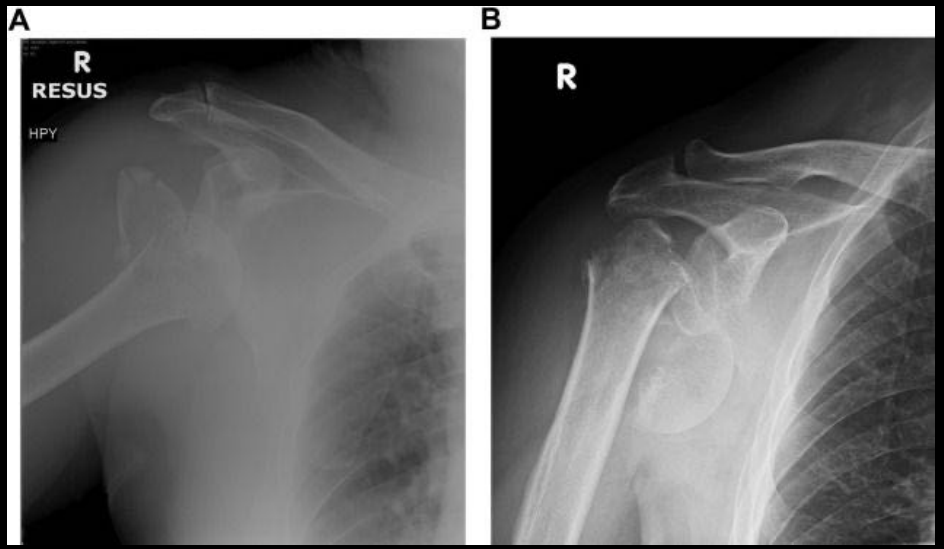
Shoulder Fracture Dislocations



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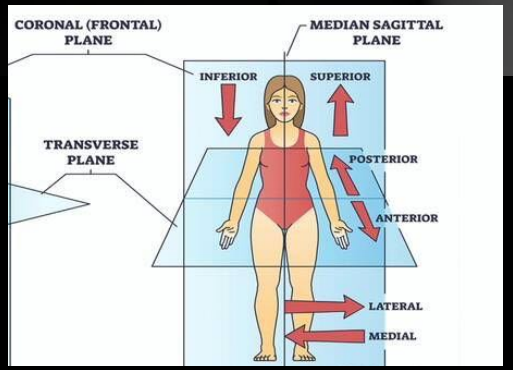
Let’s Play

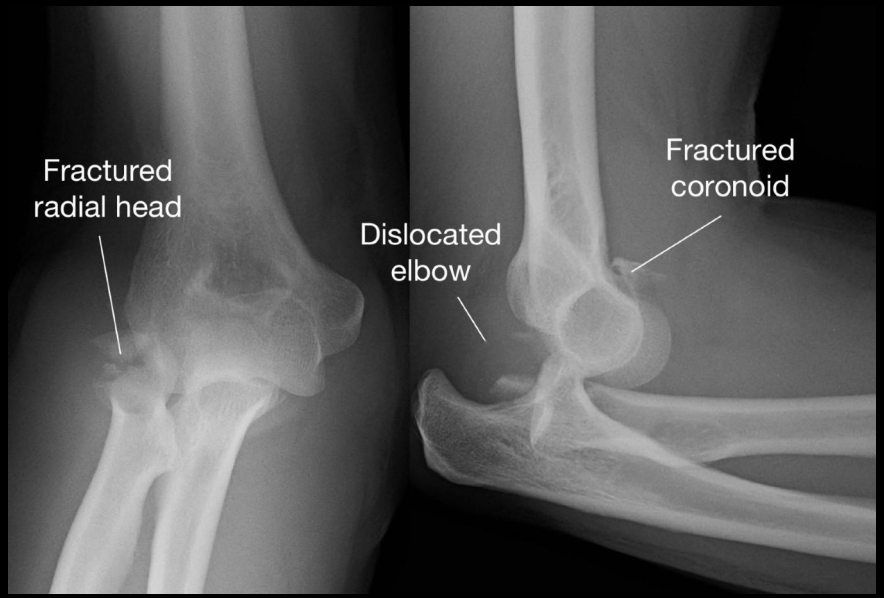
Slic

Case #1

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Joint is dislocated?
   a. Try to be specific
3. What is the pattern?
   a. Simple = no fracture
   b. Complex = Fracture- dislocation
      i. What is fractured?...
4. What direction is it displaced? Use your lighthouse.
   a. Shoulder - Coracoid
   b. Wrist - Ulnar styloid
   c. Elbow - Radial head
   d. Knee, Ankle - Fibula
   e. Femur - Femoral neck



Elbow Fracture Dislocations



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Case #2 - SLIDO

1. Primer [Think of the principles]
    a. XR of what?
    b. Skeletally mature?
    c. 2 views?
2. What Joint is dislocated?
    a. Try to be specific
3. What is the pattern?
    a. Simple = no fracture
    b. Complex = Fracture- dislocation
        i. What is fractured? …
4. What direction is it displaced? Use your lighthouse.
    a. Shoulder - Coracoid
    b. Wrist - Ulnar styloid
    c. Elbow - Radial head
    d. Knee, Ankle - Fibula
    e. Femur - Femoral neck

1. ?
2. ?
3. ?
4. ?

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Ankle Fracture Dislocations

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Case #3 SLIDO

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Joint is dislocated?
   a. Try to be specific
3. What is the pattern?
   a. Simple = no fracture
   b. Complex = Fracture- dislocation
      i. What is fractured? …
4. What direction is it displaced? Use your lighthouse.
   a. Shoulder - Coracoid
   b. Wrist - Ulnar styloid
   c. Elbow - Radial head
   d. Knee, Ankle - Fibula
   e. Femur - Femoral neck

1. ?
2. ?
3. ?
4. ?

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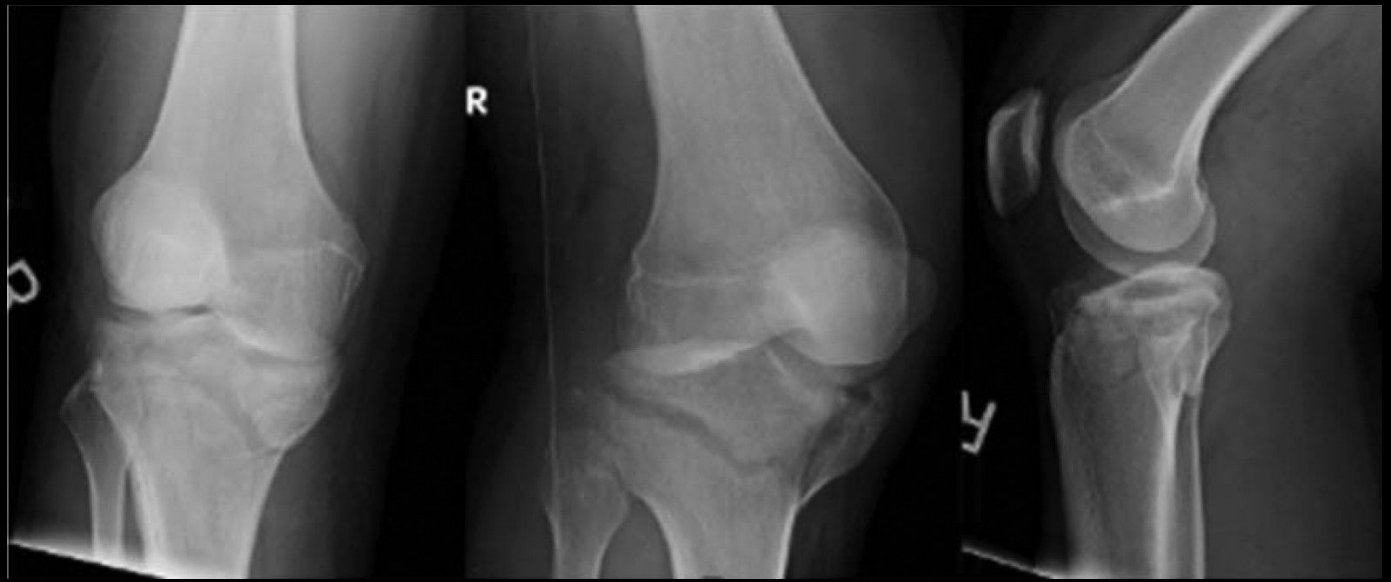
Knee Fracture Dislocations



Dislocation vs Subluxation

- Subluxation = **partial** loss of continuity of the joint surfaces

- Dislocation = **complete** loss of continuity of the joint surfaces

- Can be “grey”

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Approaching the Arthritis XR

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    - Applied Radiology
    - Approach Frameworks
    - Shoulder and Elbow Exam
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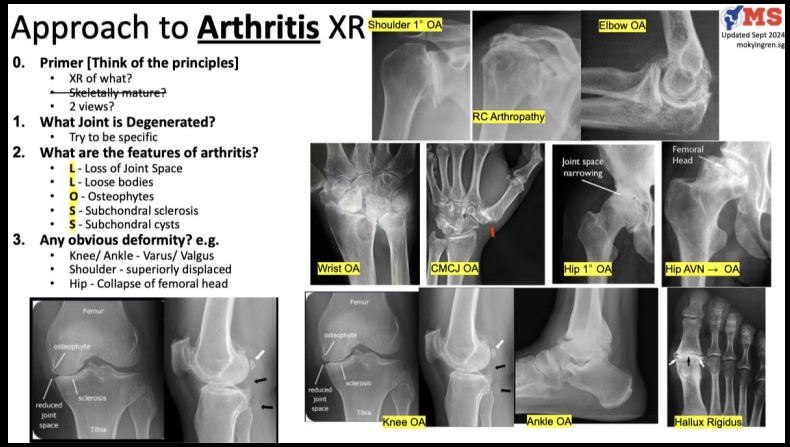

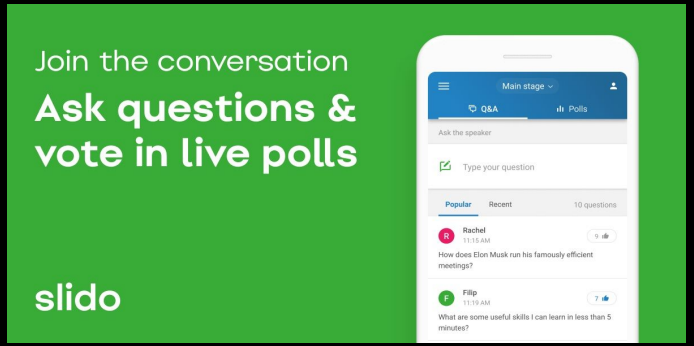

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Approaching the **Arthritis** XR

1. Primer [Think of the principles]
   a. XR of what?
   b. ~~Skeletally mature?~~
   c. 2 views?
2. What Joint is Degenerated?
   a. Try to be specific
3. What are the features of arthritis?
   a. L - Loss of Joint Space
   b. L - Loose bodies
   c. O - Osteophytes
   d. S - Subchondral sclerosis
   e. S - Subchondral cysts
4. Any obvious deformity?
   a. Knee/ Ankle - Varus/ Valgus
   b. Shoulder - superiorly displaced
   c. Hip - Collapse of femoral head

YMS

Must know: 5 features of Osteoarthritis on XR

- Loss of joint space
- Loose bodies
- Osteophytes
- Subchondral sclerosis
- Subchondral cyst

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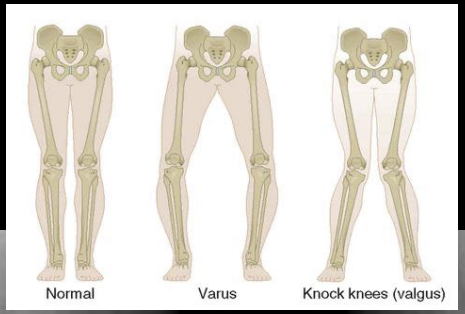
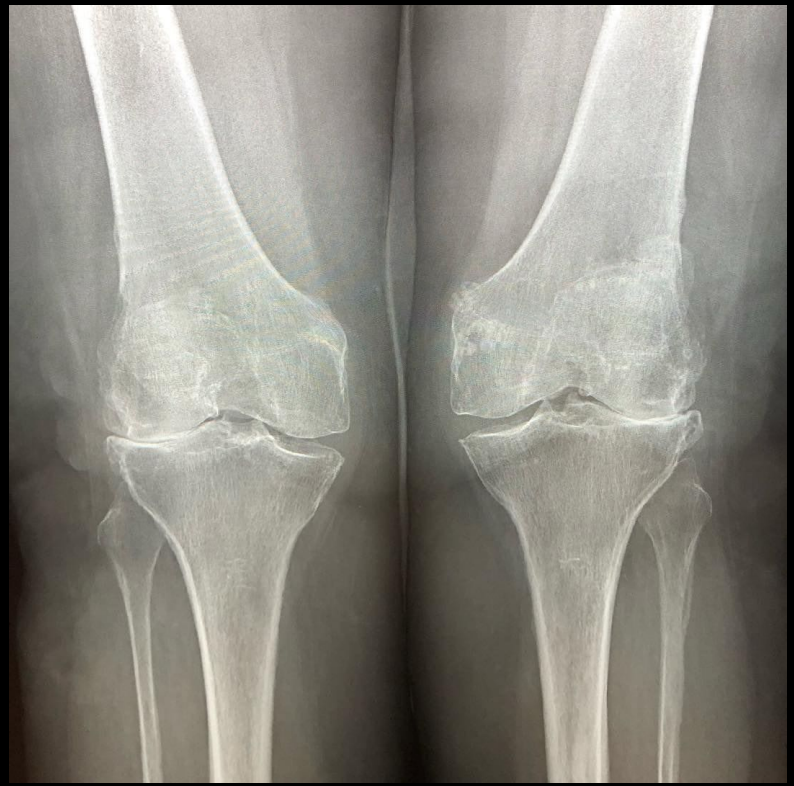
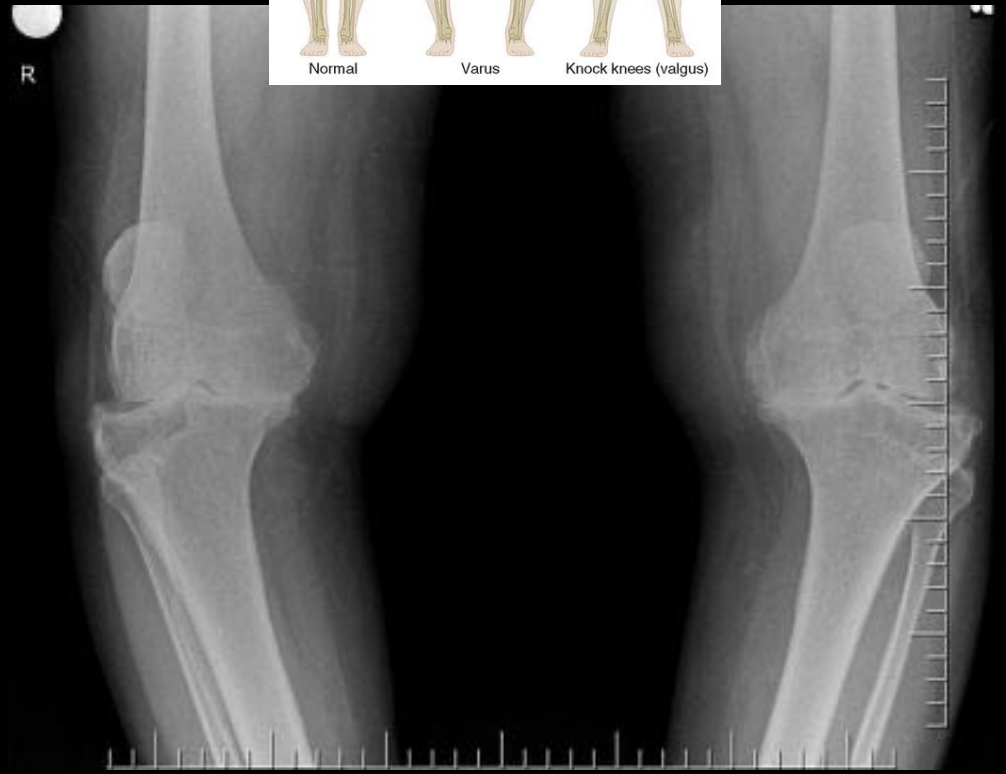
E.g. Deformities in Knee Arthritis







Case #0

1. Primer [Think of the principles]
   a. XR of what?
   b. ~~Skeletally mature?~~
   c. 2 views?
2. What Joint is Degenerated?
   a. Try to be specific
3. What are the features of arthritis?
   a. L - Loss of Joint Space
   b. L - Loose bodies
   c. O - Osteophytes
   d. S - Subchondral sclerosis
   e. S - Subchondral cysts
4. Any obvious deformity?
   a. Knee/ Ankle - Varus/ Valgus
   b. Shoulder - superiorly displaced
   c. Hip - Collapse of femoral head

1. XR of right knee, AP lateral, skeletally mature
2. OA of tibiofemoral joint, medial compartment
3. LLOSS present
4. Varus deformity

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Let’s Play

Case #1

1. Primer [Think of the principles]
    a. XR of what?
    b. ~~Skeletally mature?~~
    c. 2 views?
2. What Joint is Degenerated?
    a. Try to be specific
3. What are the features of arthritis?
    a. L - Loss of Joint Space
    b. L - Loose bodies
    c. O - Osteophytes
    d. S - Subchondral sclerosis
    e. S - Subchondral cysts
4. Any obvious deformity?
    a. Knee/ Ankle - Varus/ Valgus
    b. Shoulder - superiorly displaced
    c. Hip - Collapse of femoral head

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Case #2

1. Primer [Think of the principles]
   a. XR of what?
   b. ~~Skeletally mature?~~
   c. 2 views?
2. What Joint is Degenerated?
   a. Try to be specific
3. What are the features of arthritis?
   a. L - Loss of Joint Space
   b. L - Loose bodies
   c. O - Osteophytes
   d. S - Subchondral sclerosis
   e. S - Subchondral cysts
4. Any obvious deformity?
   a. Knee/ Ankle - Varus/ Valgus
   b. Shoulder - superiorly displaced
   c. Hip - Collapse of femoral head

1. ?
2. ?
3. ?
4. ?

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1. ?
2. ?
3. ?
4. ?

Case #3 SLIDO

1. Primer [Think of the principles]
   a. XR of what?
   b. ~~Skeletally mature?~~
   c. 2 views?
2. What Joint is Degenerated?
   a. Try to be specific
3. What are the features of arthritis?
   a. L - Loss of Joint Space
   b. L - Loose bodies
   c. O - Osteophytes
   d. S - Subchondral sclerosis
   e. S - Subchondral cysts
4. Any obvious deformity?
   a. Knee/ Ankle - Varus/ Valgus
   b. Shoulder - superiorly displaced
   c. Hip - Collapse of femoral head

LLOSS in Every Arthritic Joint!

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LLOSS in Every Arthritic Joint!

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Maximising our Time!

- Post Lecture Quiz for OMS Radio Part 2 = Abnormal XR
- https://docs.google.com/forms/d/e/1FAIpQLSfiziWLWjdxSLFF5Uudy5reyg0eGbK7-0zfyirnvTP-ip6yuQ/viewform?usp=sf_link

M3 LW OMS Radio 2 Quiz

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Applied Radiology in Orthopaedics 3

Ortho Made Simple

Mok Ying Ren

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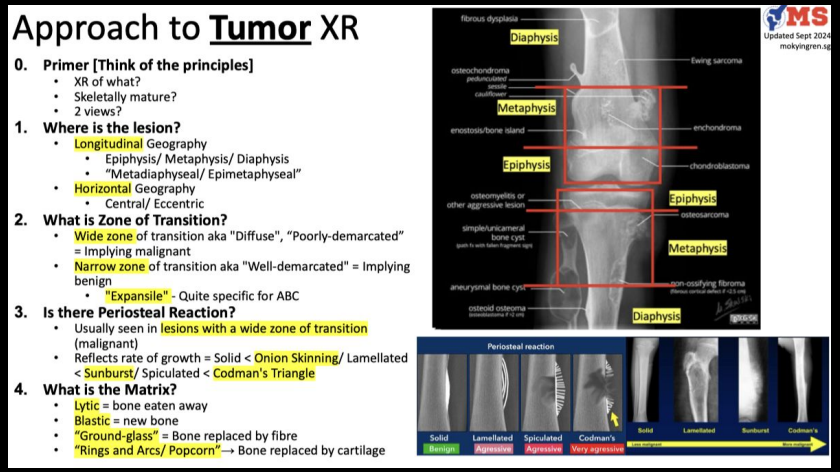

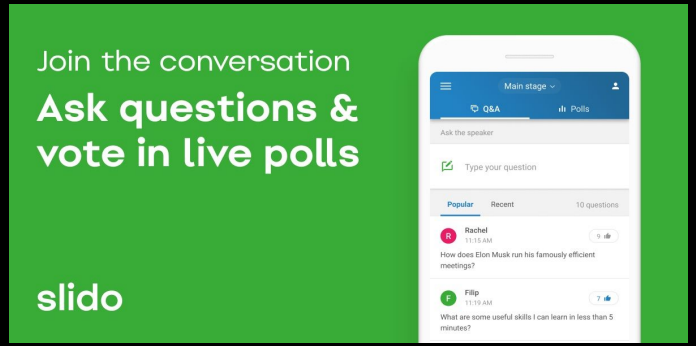

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Goals in our 3- Part Lecture Series

- Part 1 - Normal XR
  - Review of normal XRs
  - Understand the key principles in ordering XRs
- Part 2 - Abnormal XR
  - Approach to reading common XR - Vocab training
  - Application to Trauma - Fractures
  - Application to Trauma - Dislocations
  - Application to Arthritis
- Part 3 - Abnormal XR + Advanced Imaging
  - Application to Tumor
  - Application to Misc. - Osteomyelitis, Charcot
  - **Advanced Imaging - CT and MRI scans**
    - Basic Principles
    - Ordering of Advanced Imaging
    - Approach to Reading Advanced Imaging

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Approaching the Tumor XR

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“Enneking” 4 Questions

1. Where is the lesion?
2. What is zone of transition?
3. Is there Periosteal reaction?
4. What is the matrix?

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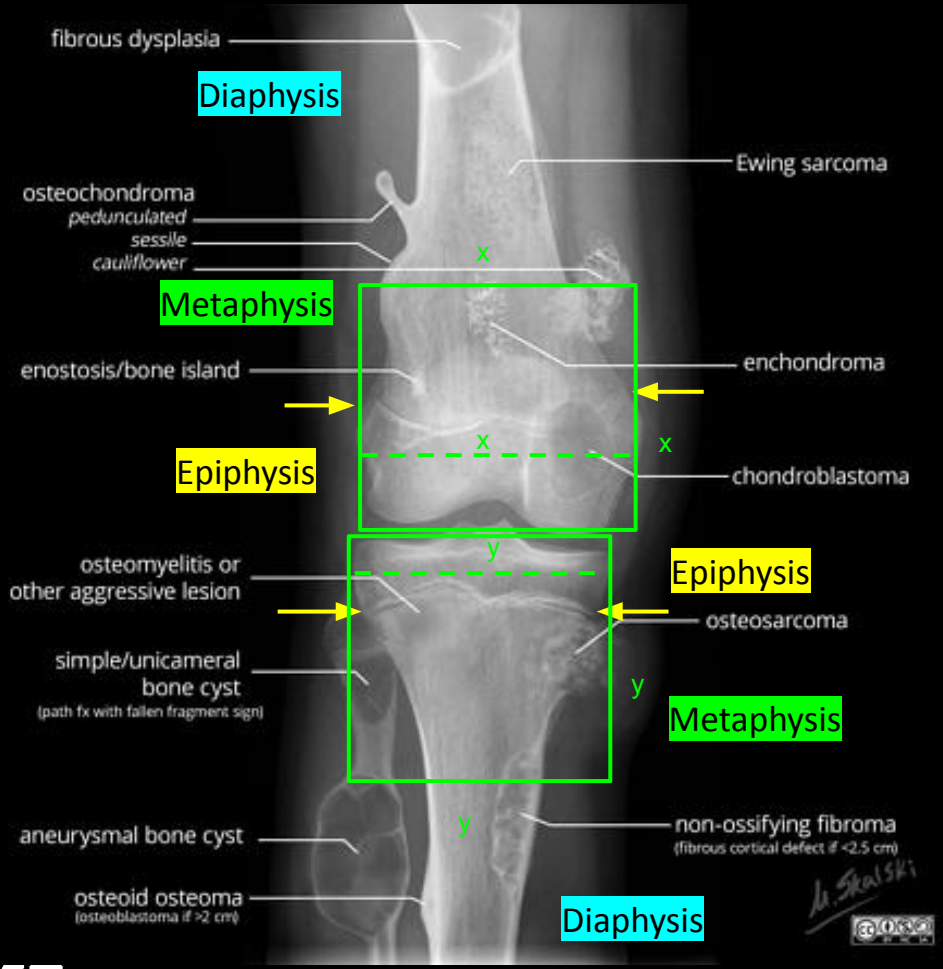
1. Where is the Lesion?

- **Epiphysis**
  - From Joint to Physis
  - *No epiphysis in adults*
- **Metaphysis (Müller Box)**
  - "... defined by a **square** whose sides are the same length as the **widest part of the epiphysis**" (Müller et al. 1990)
  - From Physis to extent of muller's box
- **Diaphysis**
  - From edge of Müller box to rest of shaft
- In the middle? "Meta-diaphyseal/ Epi-metaphyseal"



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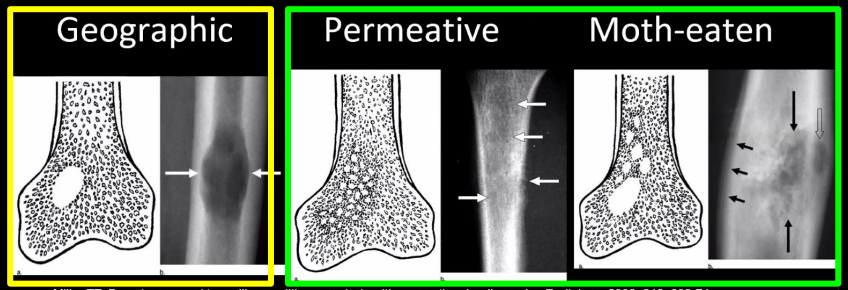
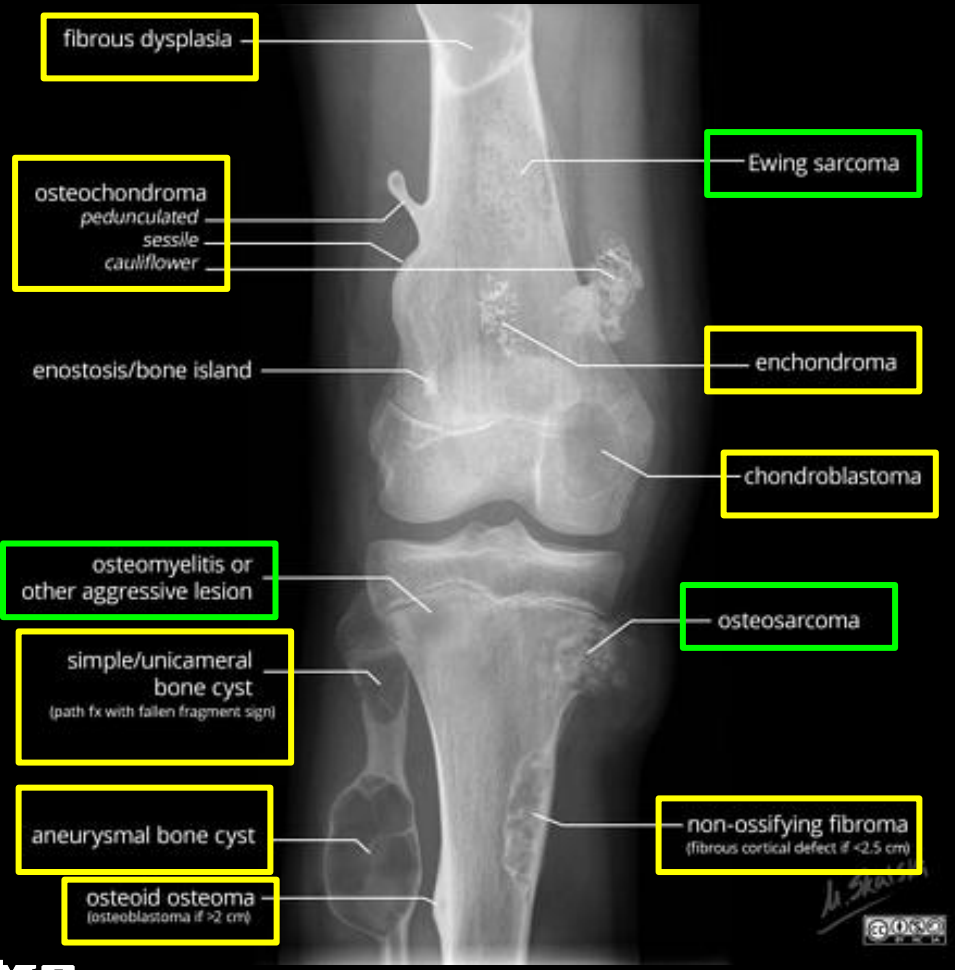
2. What is the zone of transition?

"Can you trace the lesion with your finger?"

- **Narrow** zone of transition
  - Synonyms: "Well-demarcated", "Geographical"
  - "Expansile"
    - Specific term for Aneurysmal Bone Cyst (ABC)
  - Implies **Benign** Lesion
- **Wide** zone of transition
  - Synonyms: "Diffuse", "Poorly-demarcated", "Permeative", "Moth-eaten", "Broad Zone of Transition"
  - Implies **Malignant** Lesion



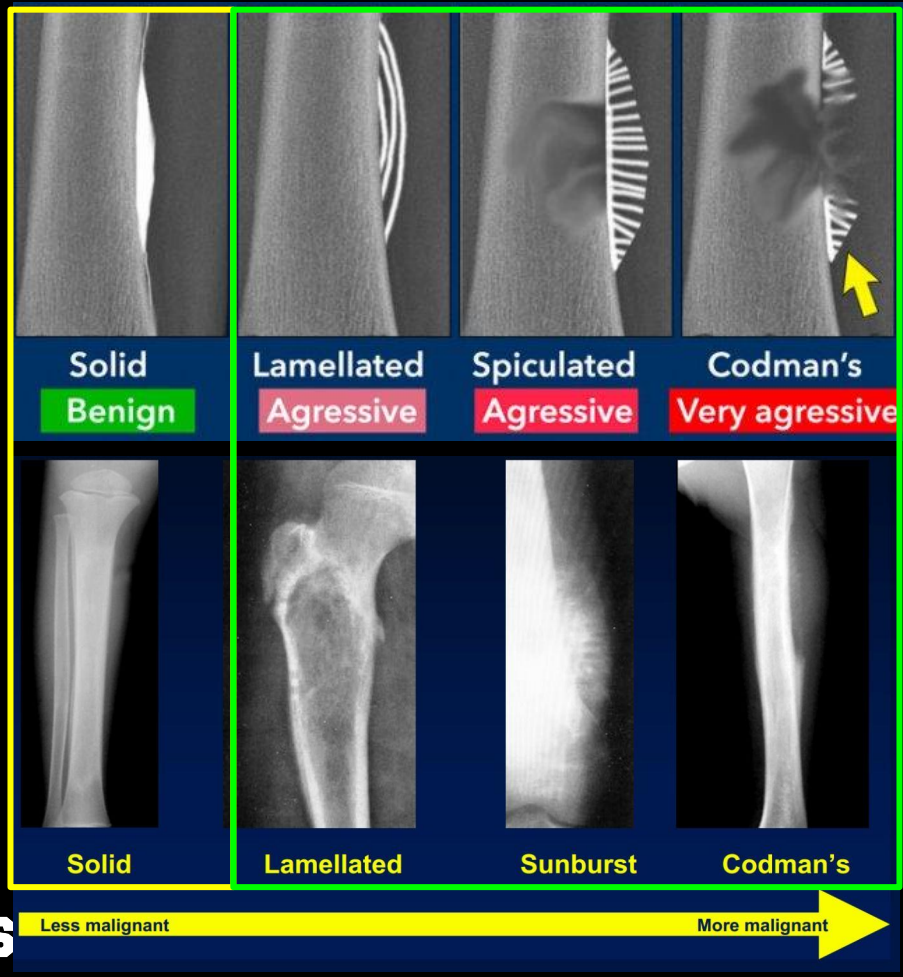
Miller TT, Bone tumors and tumorlike conditions: analysis with conventional radiography. Radiology. 2008; 246: 662-74



3. Any Periosteal Reaction?

- Not all tumors have periosteal reaction
  - **Benign tumors** with **narrow zone** of transition have minimal to no periosteal reaction as they are slow growing
  - **Malignant tumors** with a **wide zone** of transition will likely have periosteal reaction → Be ready to describe!

- Important descriptors corresponding to increasing rates of tumor growth:
  - Onion Skinning/ Lamellated
  - Sunburst/ Spiculated/ “Hair-on-end”
  - Codman's Triangle



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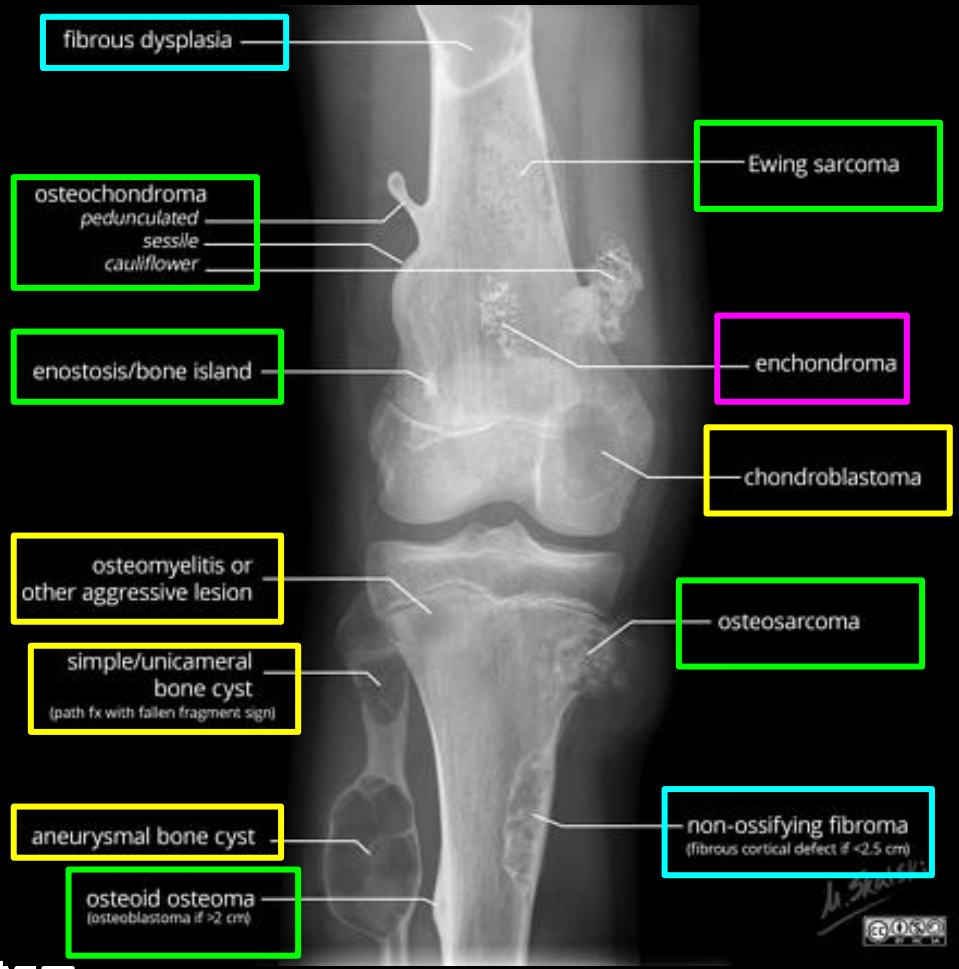
4. What is the matrix?

"What is the lesion filled with?"

- Appears more Radiolucent → **Lytic**
- Appears more Radiopaque) → **Blastic**/ Sclerotic
- Fibrous → **Ground-glass**
- Cartilage → **Rings and Arcs**/ **Popcorn**

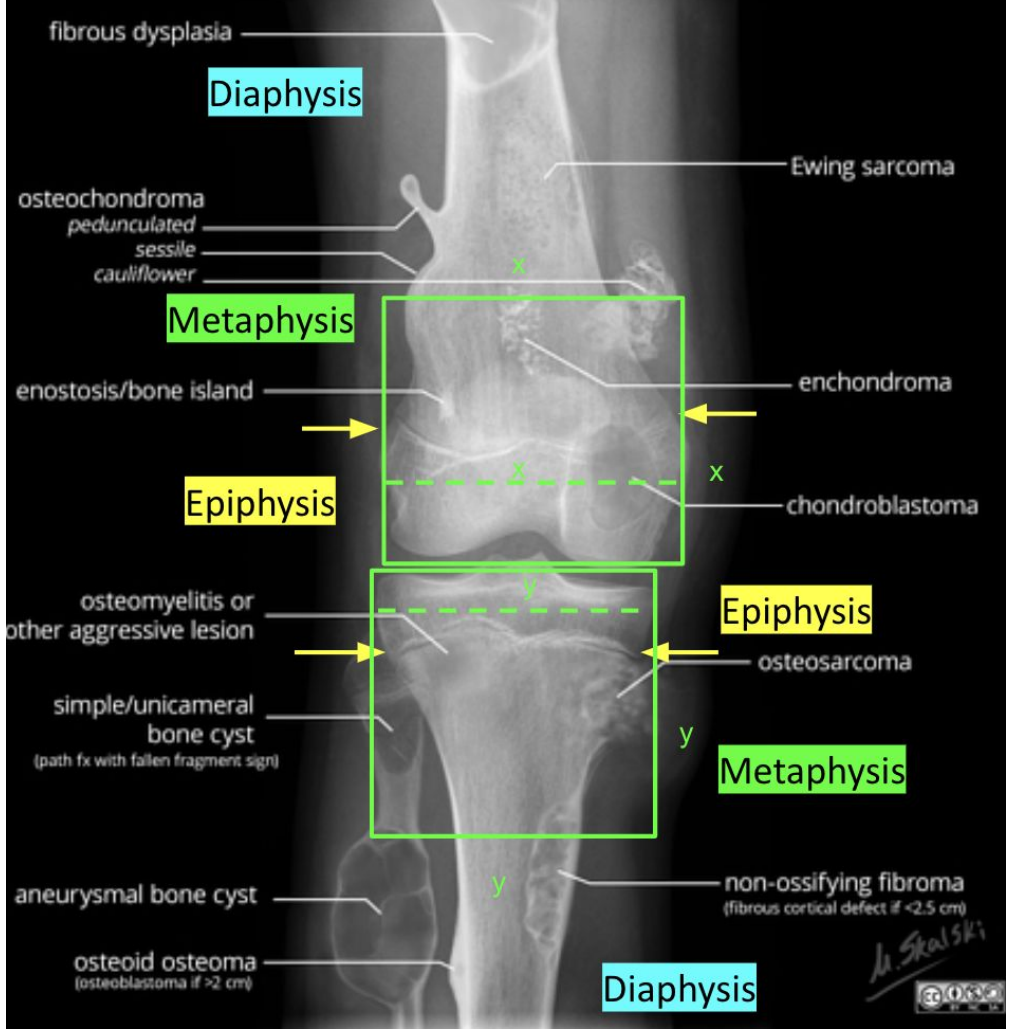
** Strategy - These are just descriptive terms e.g. color and can be ***subjective***. So try to avoid mentioning except for obvious ones like "lytic" or "blastic"

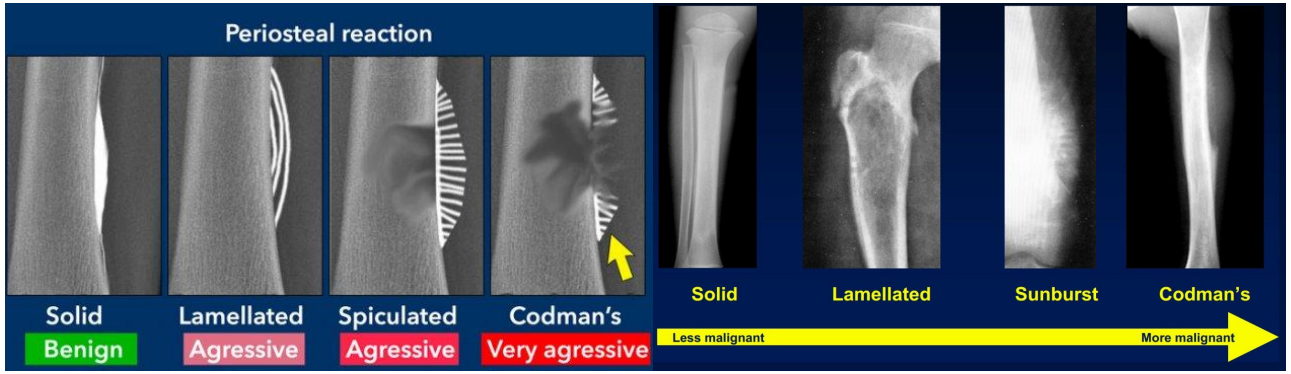


Approach to **Tumor** XR

Updated Sept 2024
mokyingren.sg

0. **Primer [Think of the principles]**
   - XR of what?
   - Skeletally mature?
   - 2 views?
1. **Where is the lesion?**
   - Epiphysis (only in immature skeleton)
   - Metaphysis (Müller Box)
   - Diaphysis
   - In the Middle? “Meta-diaphyseal/ Epi-metaphyseal”
2. **What is the Zone of Transition?**
   - **Wide zone** of transition aka "Diffuse", “Poorly-demarcated”, “Moth-eaten”, “Permeative” ***= Implies malignant***
   - **Narrow zone** of transition aka "Well-demarcated", “Geographical” ***= Implies benign***
     - **"Expansile"** - Specific for ABC
3. **Is there Periosteal Reaction?**
   - Usually seen in lesions with a **wide** zone of transition (malignant)
   - Reflects rate of growth = Solid < **Onion Skinning**/ Lamellated < **Sunburst**/ Spiculated < **Codman's Triangle**
4. **What is the Matrix?**
   - **Lytic** = bone eaten away
   - **Blastic** = new bone laid down
   - “Ground-glass” = Bone replaced by fibre
   - “Rings and Arcs/ Popcorn”→ Bone replaced by cartilage





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Let’s Play

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Describe the Lesion #1

Where is the Lesion?

What is the Zone of Transition?

Any Periosteal Reaction?

What is the Matrix?

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Describe the Lesion #2

Where is the Lesion?

What is the Zone of Transition?

Any Periosteal Reaction?

What is the Matrix?

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Quiz

- Choose the appropriate answer:
  - Mature/ Immature
  - E/ M/ D/ EM/ MD
  - Narrow/ Wide
  - Yes/ No
  - Benign/ Malignant
- Dx: _____

- Choose the appropriate answer:
  - Mature/ Immature
  - E/ M/ D/ EM/ MD
  - Narrow/ Wide
  - Yes/ No
  - Benign/ Malignant
- Dx: _____

- Choose the appropriate answer:
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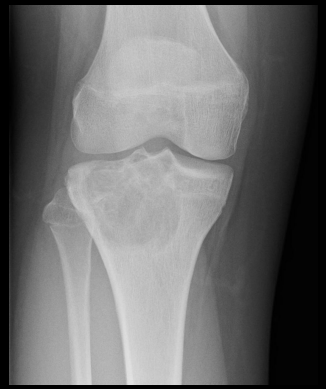
- Dx: _____



- Choose the appropriate answer:
  - Mature/ Immature
  - E/ M/ D/ EM/ MD
  - Narrow/ Wide
  - Yes/ No
  - Benign/ Malignant
- Dx: _____

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Misc. XR

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Misc. - Osteomyelitis XR

- Setting of infection:
  - Systemic - fever, chills, rigors
  - Local - erythema, pain, ulcer

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone is affected?
   a. Be specific
3. Extent of destruction?
   a. Lytic changes extending to…
4. Other bone involvement?

1. XR of foot; request lateral/ oblique; skeletally mature
2. Abnormality over 4MT head
3. Lytic changes that does not extend down to shaft
4. No other obvious bony involvement

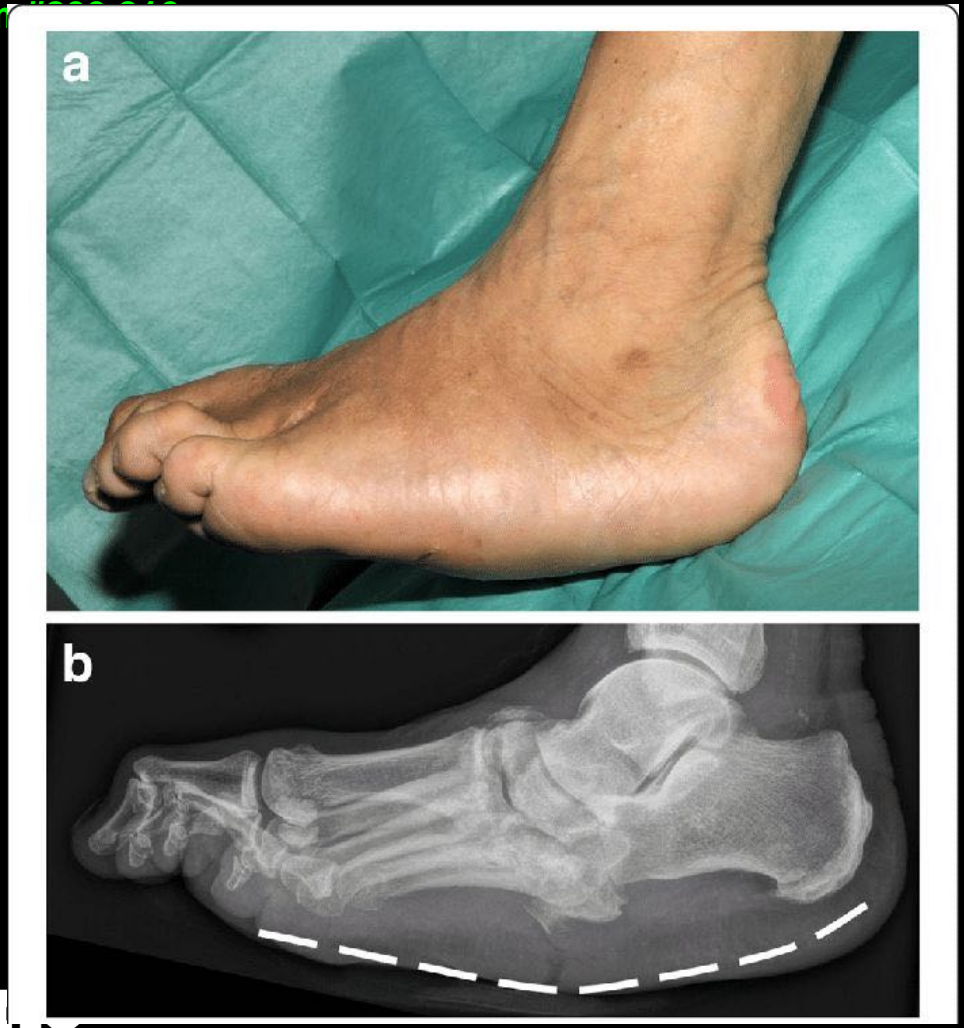
Osteomyelitis XR - Another Example

Misc. - Charcot's

- In the setting of an poorly controlled DM
  - Systemic - poorly controlled DM
  - Local - Neuropathy, Dermopathy, deformity

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone/ Joint is affected?
   a. Be specific
3. Extent of destruction?
4. Other bone/ joint involvement?

1. XR of foot lateral, request AP; skeletally mature
2. Abnormalities over midfoot at talonavicular, calcaneocuboid joints
3. Areas of destruction/ fragmentation
4. Does not affect ankle or forefoot



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Misc. - Gout XR

- Setting of inflammation:
  - Acute joint pain e.g. big toe (podagra)
  - Fever

1. Primer [Think of the principles]
   a. XR of what?
   b. Skeletally mature?
   c. 2 views?
2. What Bone is affected?
   a. Be specific
3. Extent of destruction?
   a. Lytic changes extending to…
4. Other bone involvement?

1. XR of foot; request lateral/ oblique; skeletally mature
2. Abnormality 1st MT Head and PP Base
3. Lytic changes; **"Rat Bitten Appearance, punched out lesions"** that does not extend down to shaft
4. No other obvious bony involvement

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  - Approach to reading common XR - Vocab training
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  - Application to Trauma - Dislocations
  - Application to Arthritis
- Part 3
  - Application to Tumor
  - Application to Misc. - Osteomyelitis, Charcot
  - **Advanced Imaging - CT and MRI scans**
    - Basic Principles
    - Ordering of Advanced Imaging
    - Approach to Reading Advanced Imaging

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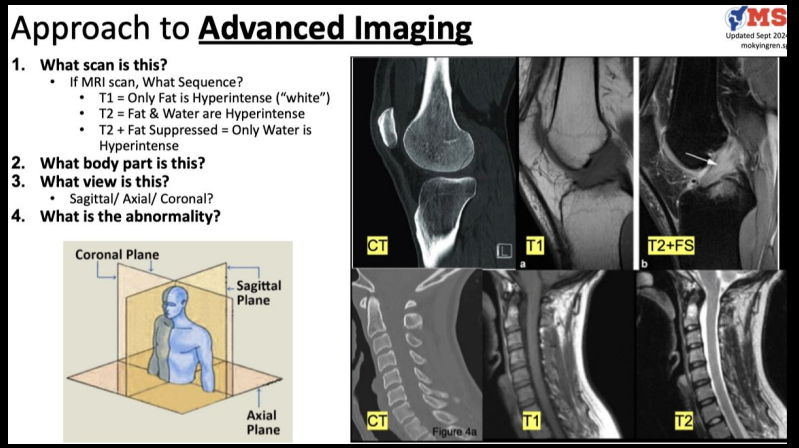

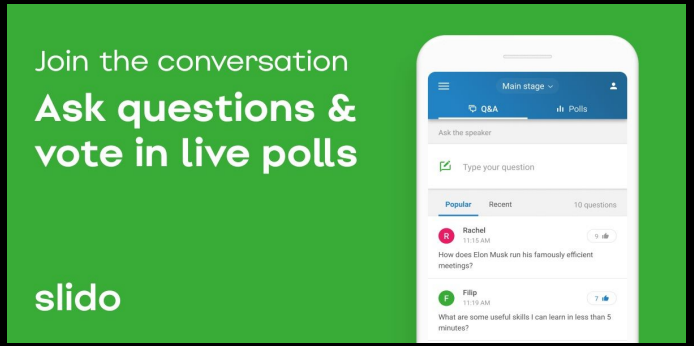

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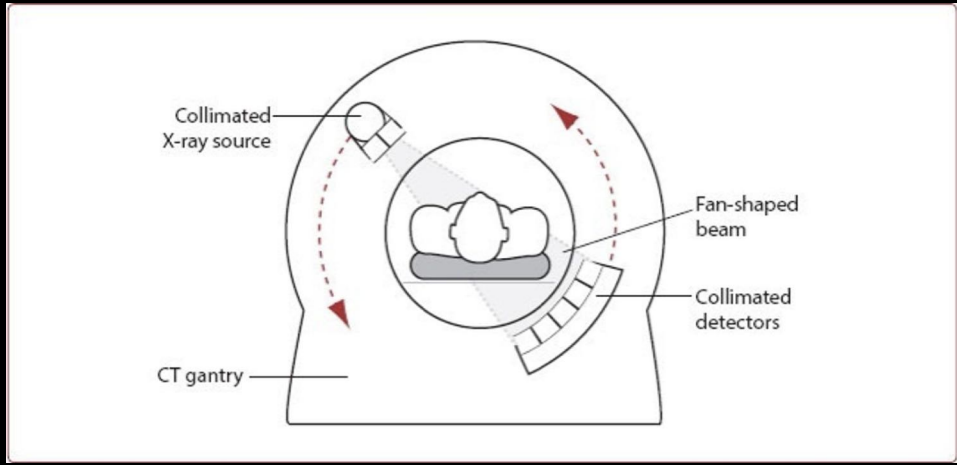
What is a CT Scan?

- Created using a series of x-rays
- Scanner emits XR that passes through tissues
  - High density tissue (e.g. bone) → XR absorbed (high attenuation) → less XR reach the scanner → Appear hyperintense (just like normal XR)
  - Low density tissue (e.g. muscle) → XR passes through (low attenuation) → more XR reach the scanner → Hypointense (dark)



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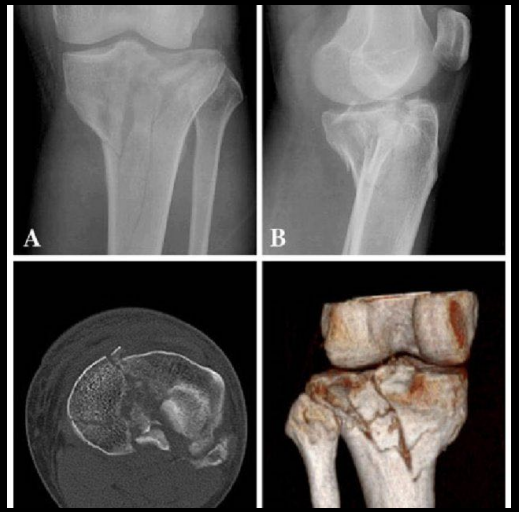
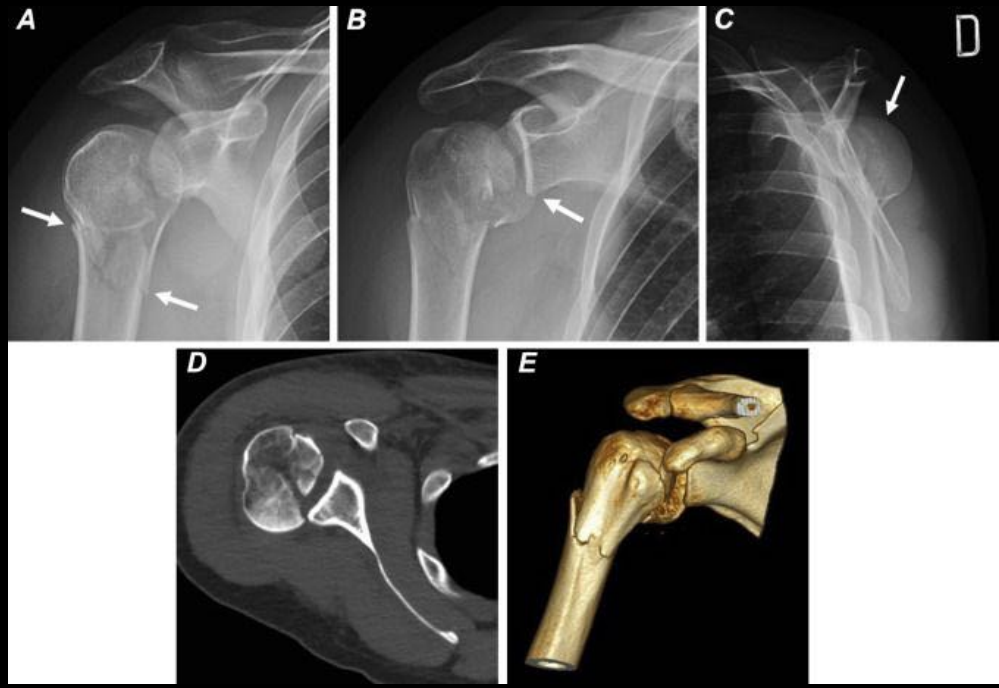
CT is a 3 Dimensional XR

- “CT is just a 3 dimensional XR”
  - Whatever you can see on XR, you can see on CT better.
  - Whatever you cannot see on XR, you cannot see on CT
- Can be used to create 3D images





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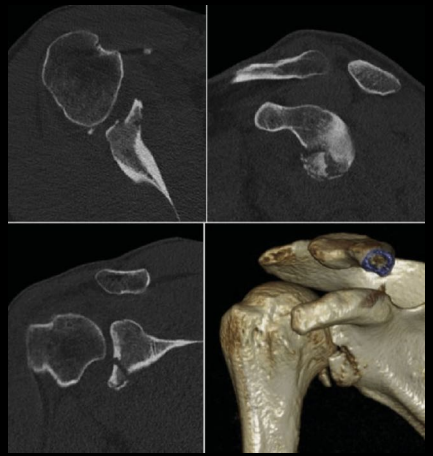
3D Reconstruction

- Only CT scan can provide the **3D reconstruction** (at this point) and subsequent **3D printing**
- Advantage - to visualize structures better for surgical planning



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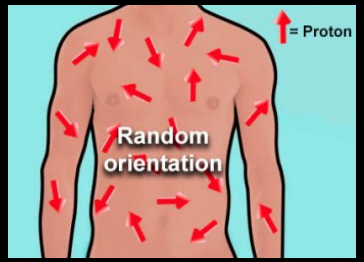
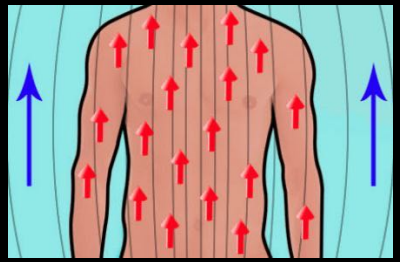
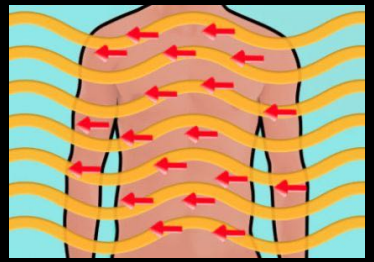
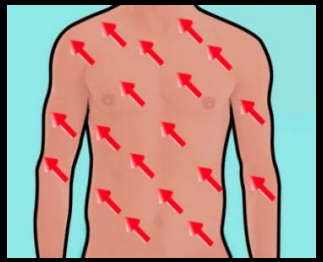
What is a MRI Scan?

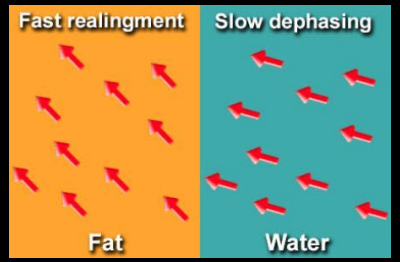
1. Scanner produces a **magnetic field**
2. When patient enters, all the **hydrogen ions (protons)** within their body become aligned with the field
3. Scanner further produces **radiofrequency** pulses that interact with protons → This produces a **signal**
4. Scanner detects signals and transforms into images











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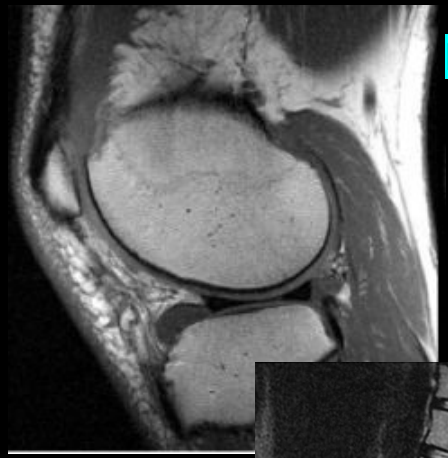
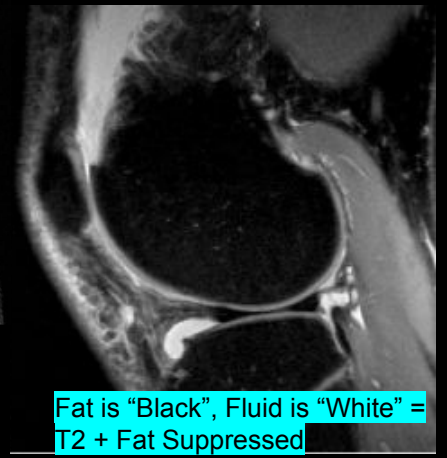
Sequences of MRI Scan

- T1 weighted (T1W)
  - T**1**W = Only **1** thing - Fat is white (***hyperintense***)
  - Where can we find normal fat?
    - Subcutaneous Fat
    - Fatty bone marrow
  - ***"T1 for Anatomy"*** - all the bone is white for you to see anatomy
- T2 weighted (T2W)
  - T**2**W = **2** things - Both Fat and Water is white
  - Where can we find normal fluid?
    - Joint fluid
    - CSF Fluid
- T2 weighted (T2W) with Fat Suppression
  - T2W + *Fat Suppression* = only Water is white; Fat is black
  - "T2 for pathology" - because all pathology comes with swelling and edema!



Fat is "white" = T1

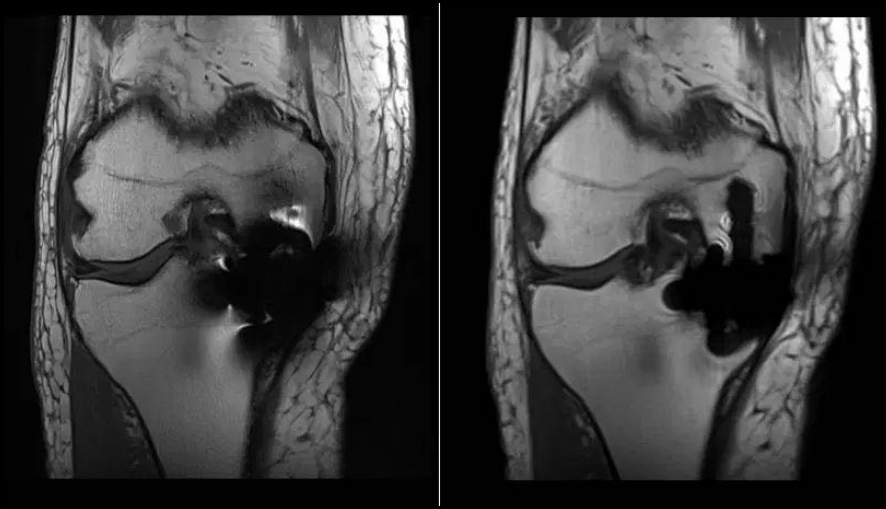
Fat and Water both "white" = T2



Fat is "Black", Fluid is "White" = T2 + Fat Suppressed

Special Sequences

- Metal Artifact Reduction Sequence (MARS)
  - Useful when imaging for pathology around implants



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MRI Safety

- Metal implants - need to confirm that they are MRI compatible
  - Cochlear implants
  - Pace Makers
  - Most orthopaedic implants are compatible
- Claustrophobic patients may need sedation or **open MRI**
- If contrast, need to check **renal** function

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MRI With Contrast

- MRI with contrast ≠ MRI Arthrogram
  - MRI with contrast injects contrast into the blood
  - MRI Arthrogram injects contrast into the joint
- 2 indications for MRI with contrast in Orthopaedics
  - Tumor
  - Infection

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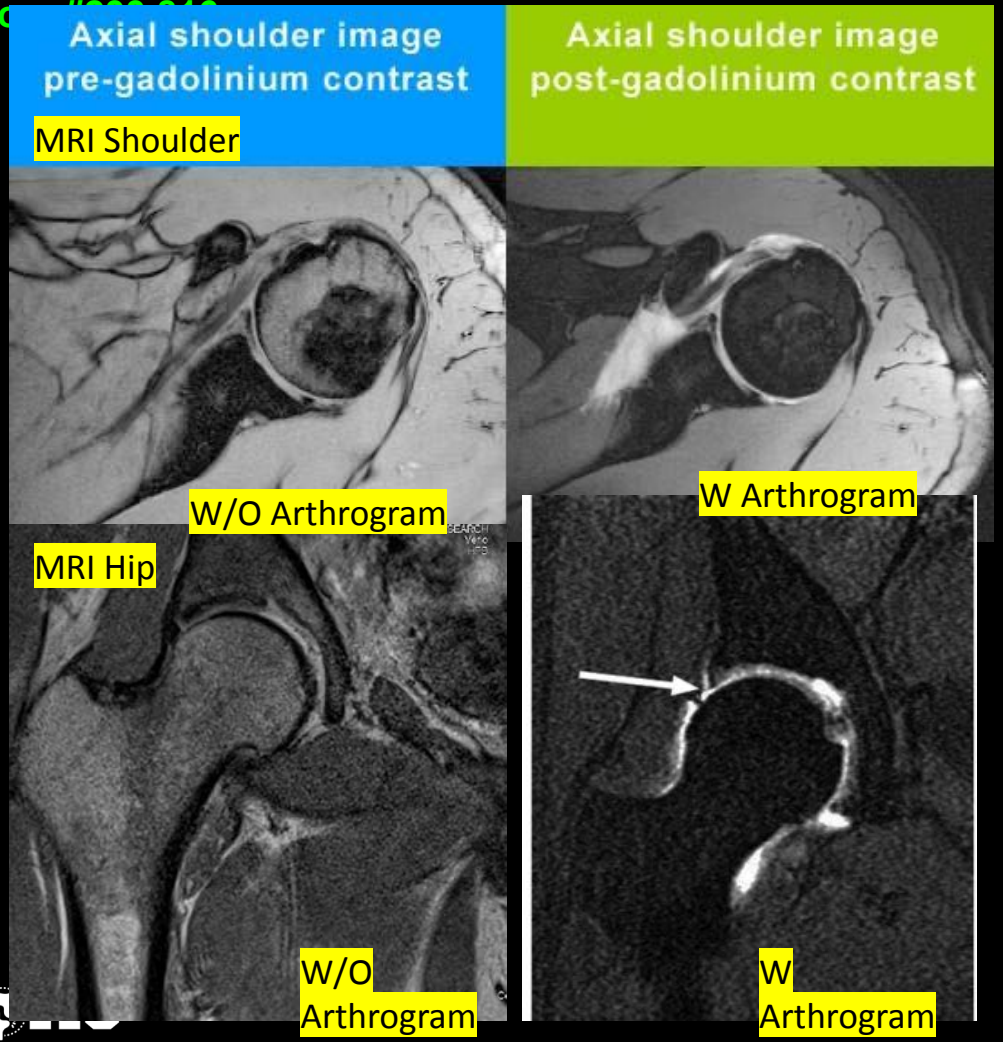
MRI Arthrogram

- MRI Arthrogram = injection of contrast into the joint
- “Although MRA have a higher sensitivity and specificity, it cannot replace MRI after the comprehensive consideration of accuracy and practicality.”

Cochrane Library

Cochrane Database of Systematic Reviews

Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered (Review)



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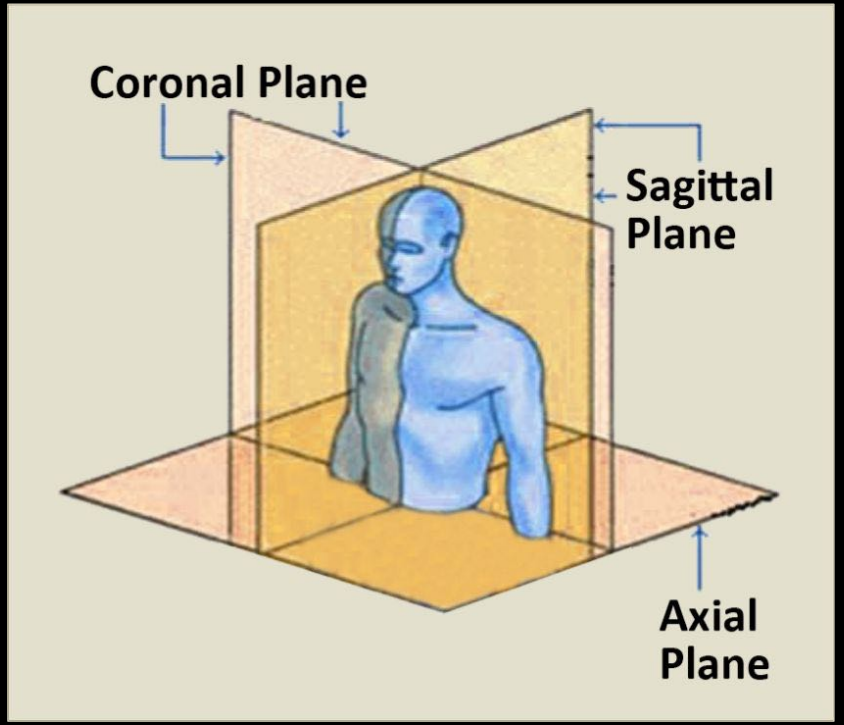
3 Dimensions of the CT and MRI Scan - SAC

- Sagittal
- Axial
- Coronal

- Often you need to see 2 views side by side to visualize the damaged structure better



What we Have Gone Through

- **CT** is just a better XR with 3 dimensions
  - Able to provide a 3D reconstruction
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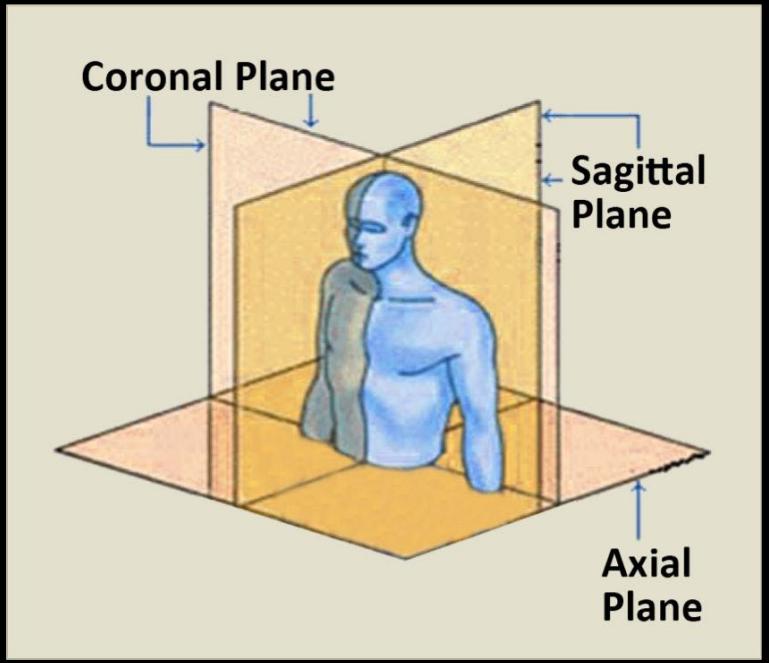
  - Beware of cochlear implants, pacemakers, other metal implants
  - Has 3 main sequences
    - **T1** = Only Fat is White
    - **T2** = Both Fat and Water is White
    - **T2** Fat Suppressed = Only Water is White
- CT and MRI both has 3 views - **Sagittal**, **Axial**, **Coronal**



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Ordering Advanced Imaging

1 Stabilize	2 History	3 Physical Exam	4 Initial Invx
5 Acute/ Initial Mx	6 Advanced Imaging	7 Definitive Mx	8 Post Op Review

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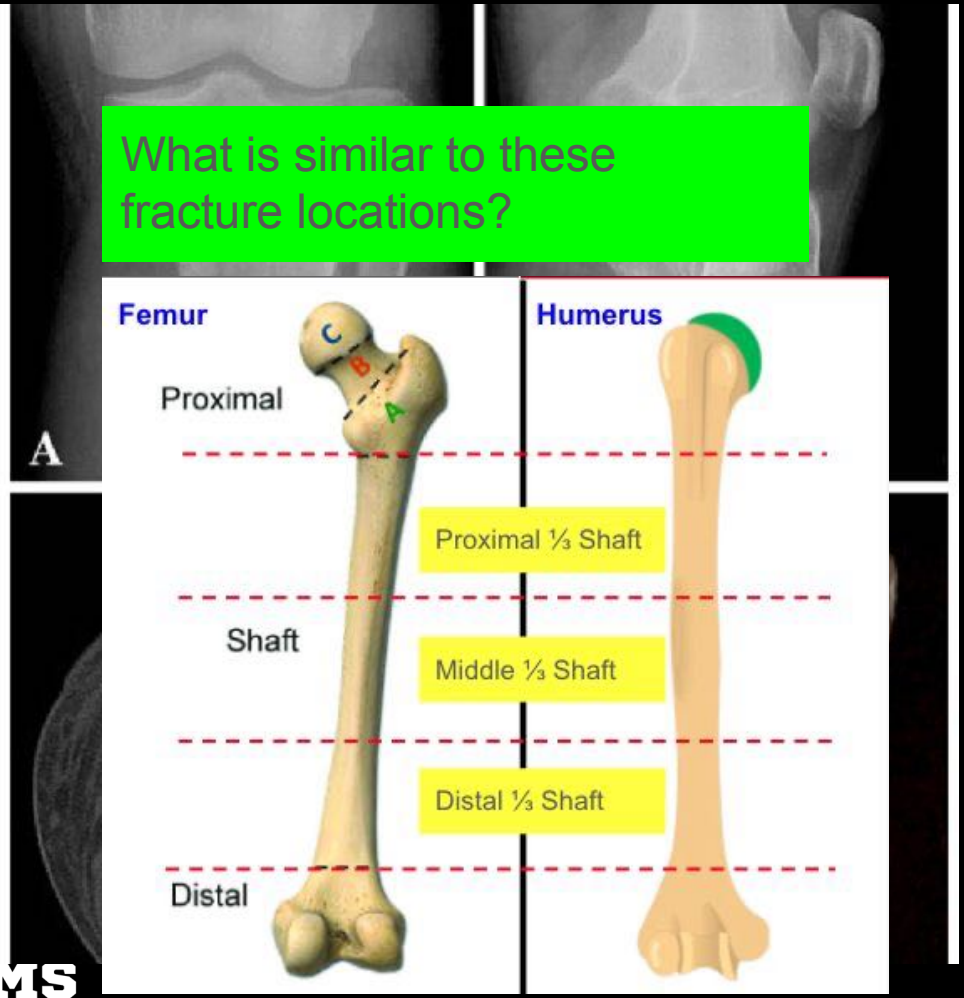
CT Scan - When?

"XR can see a fracture, but not sure severity"

- Intra-articular fractures that require more precise pre-op planning
- Common Examples
  - Young patient ➔ RTA ➔ XR Comminuted Proximal Tibia # (Tibia Plateau) ➔ CT scan to evaluate fracture patterning + planning
  - Elderly fall ➔ XR Comminuted fracture of proximal humerus ➔ CT scan to evaluate fracture patterning + planning
  - Young male RTA → XR Comminuted Distal Tibia # (Plilon) ➔ CT scan to evaluate fracture patterning + planning



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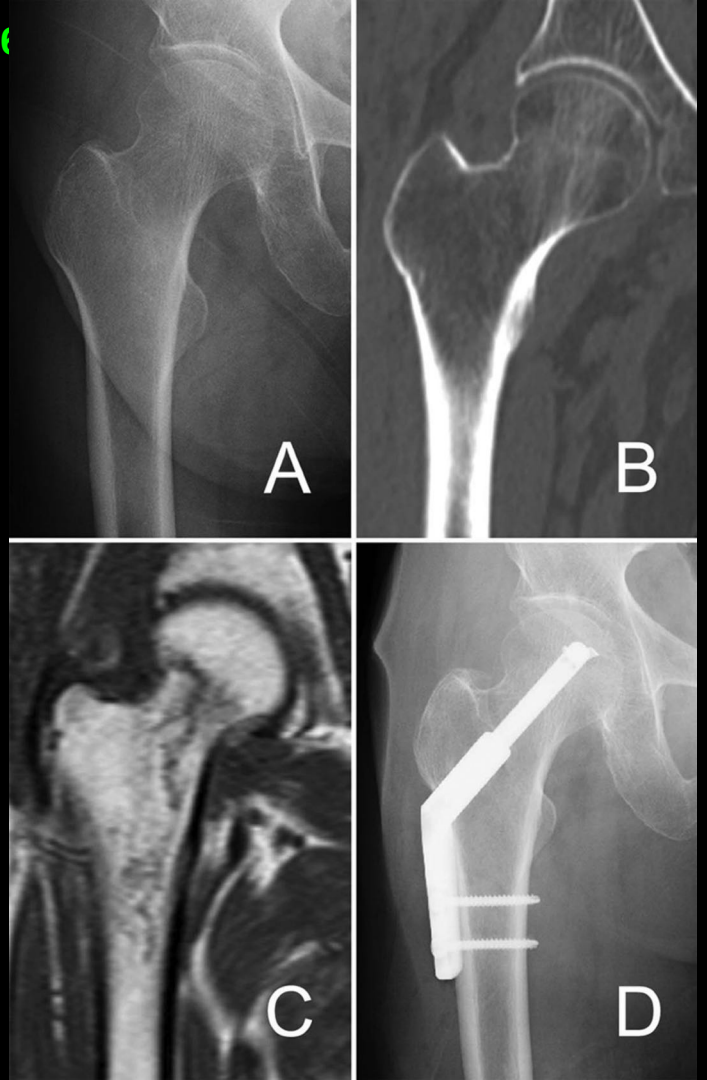
MRI Scan - When?

"XR cannot see fracture, want TRO soft tissue injury or occult fracture"

- Picks up injury by the presence of edema (increased water content)
- Common examples
  - Soccer ➔ "Pop" ➔ XR normal (expected) ➔ MRI to look at ACL, meniscus
  - Middle aged ➔ Fell on Shoulder ➔ XR normal ➔ MRI to look for Rotator Cuff tear
  - Elderly ➔ Fell on buttock ➔ XR of hips normal ➔ MRI to look for occult fracture



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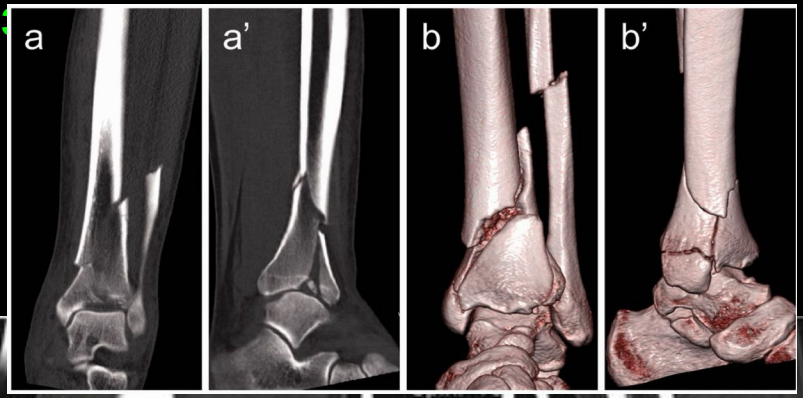
Which scan will you choose?

Distal Tibia # - Which scan will you choose?

- CT Scan
- MRI Scan

Distal Tibia # - CT Scan



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Which scan will you choose?

Proximal Humerus # - Which scan will you choose?

- CT Scan
- MRI Scan

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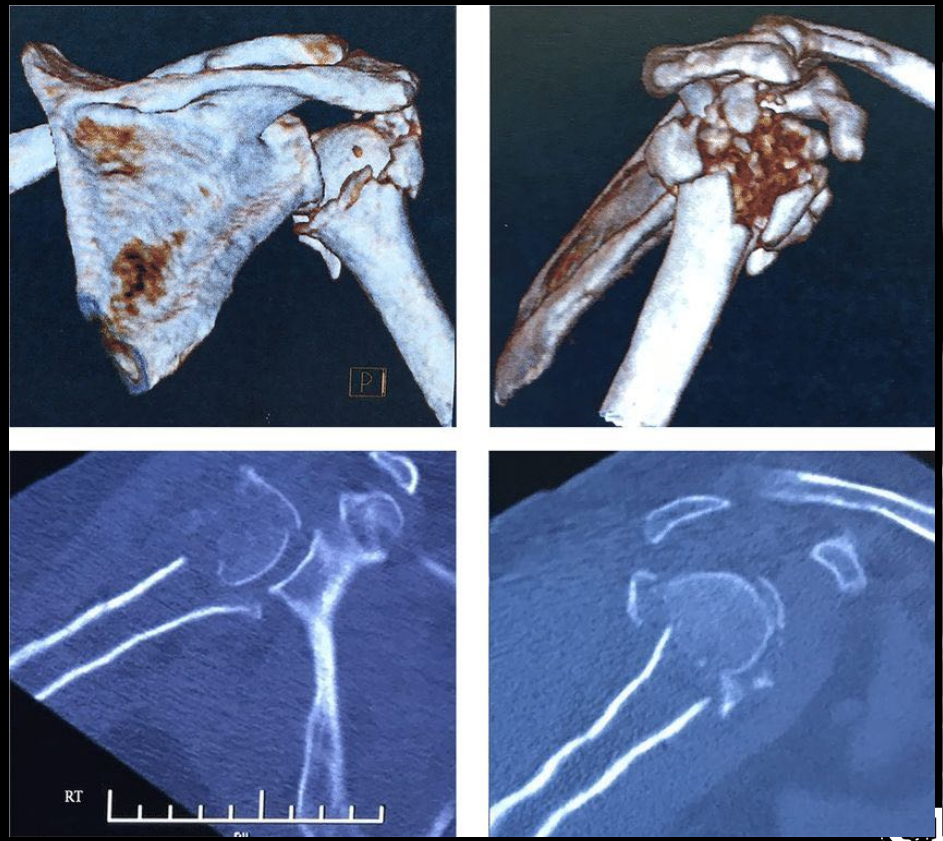
Proximal Humerus # - CT Scan



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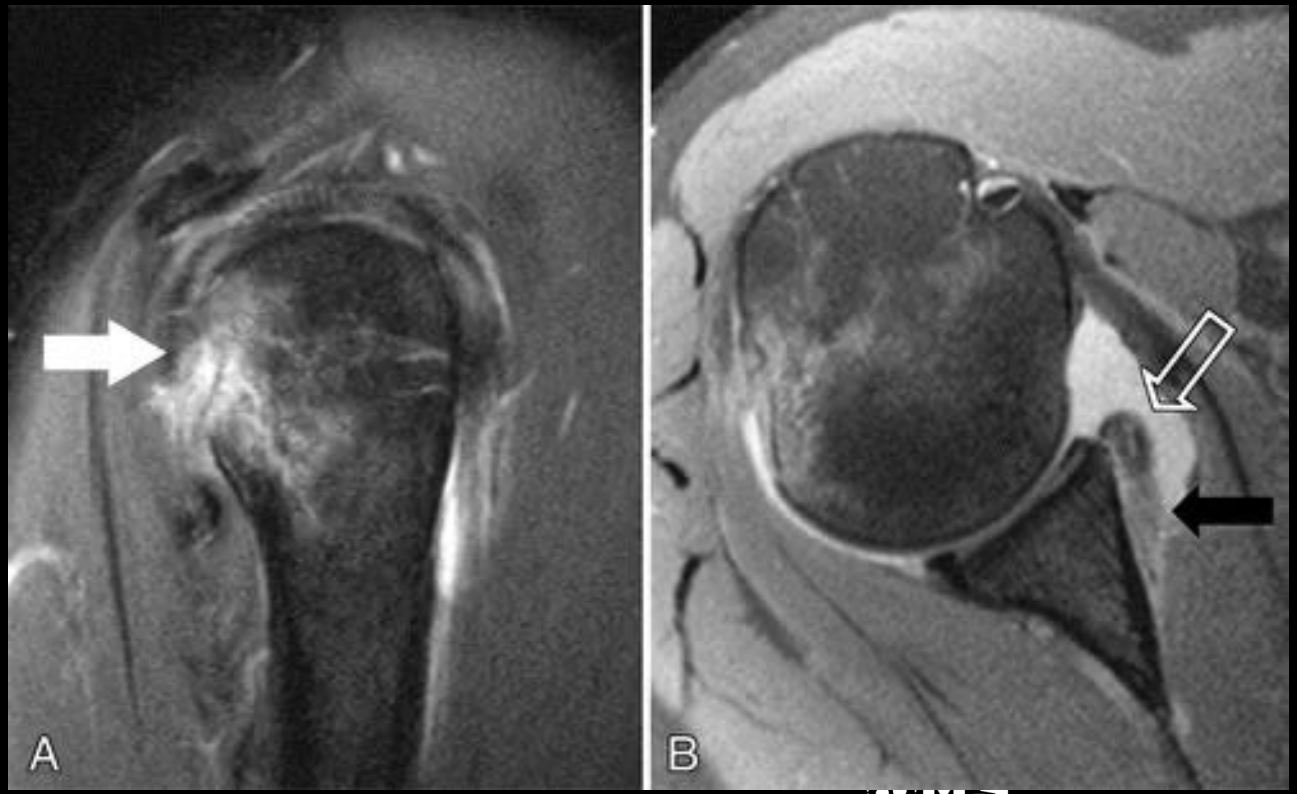
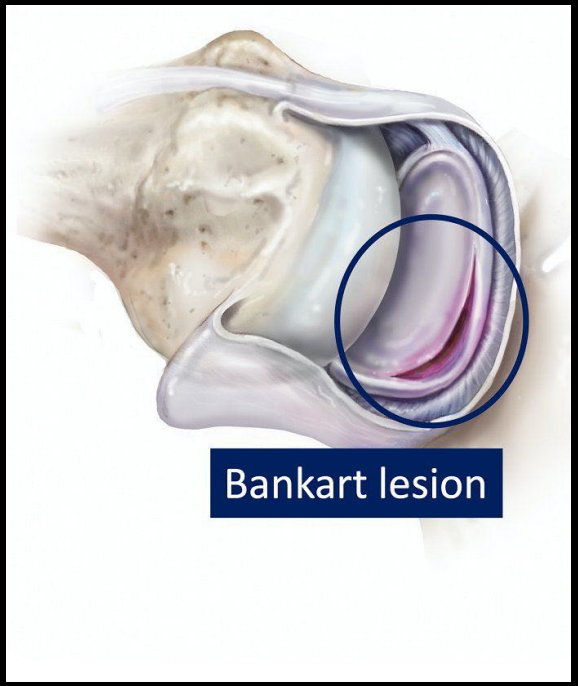
Which scan will you choose?

Shoulder Dislocation - Which scan will you choose?

- CT scan
- MRI scan

Shoulder Dislocation - MRI Scan





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Which scan will you choose?

Distal Femur # - Which scan will you choose?

- CT Scan
- MRI Scan

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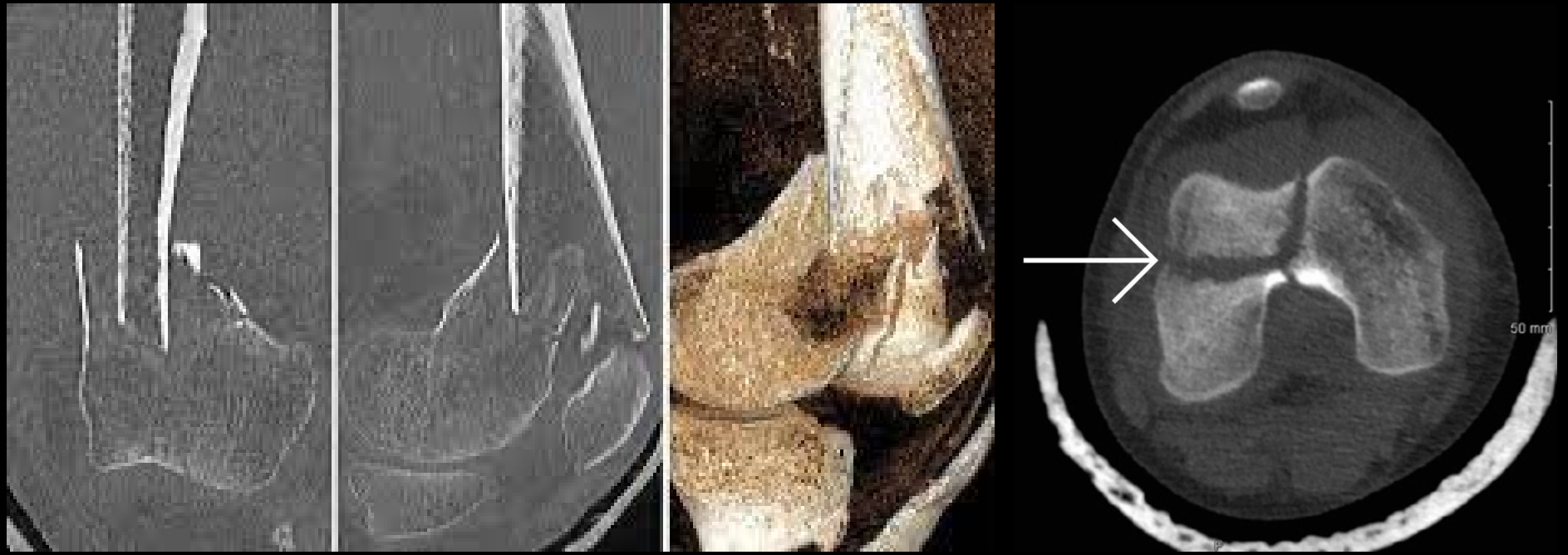
Distal Femur # - CT Scan



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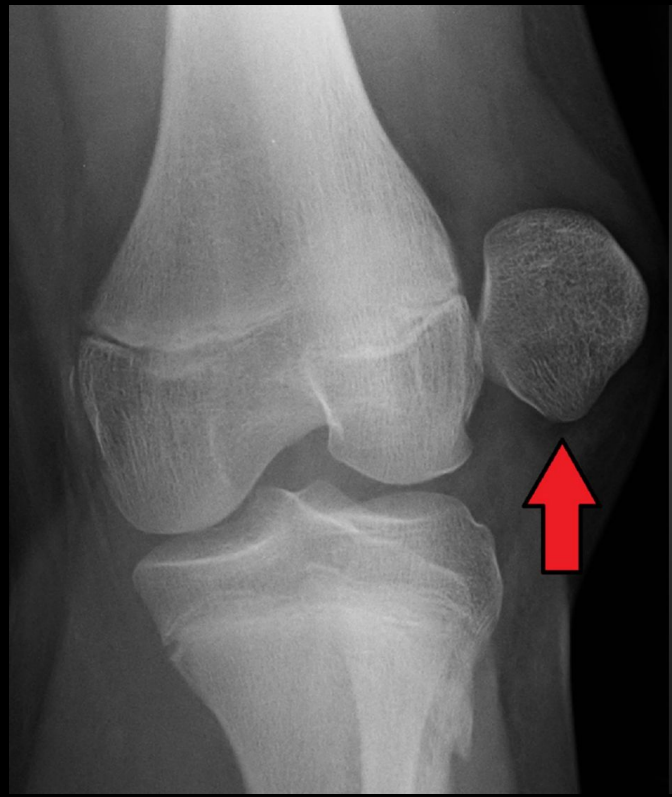
Which scan will you choose?



Patella Dislocation - Which scan will you choose?

- CT Scan
- MRI Scan

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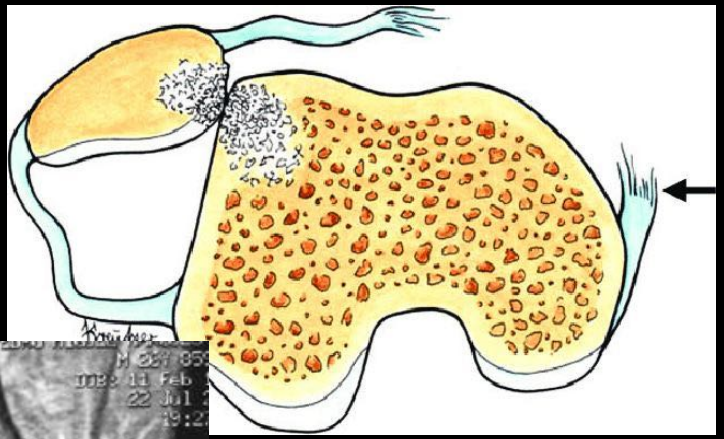
Patella Dislocation - MRI Scan



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Goals in our 3- Part Lecture Series

- Part 1 - Normal XR
  - Review of normal XRs
  - Understand the key principles in ordering XRs
- Part 2 - Abnormal XR
  - Approach to reading common XR - Vocab training
  - Application to Trauma - Fractures
  - Application to Trauma - Dislocations
  - Application to Arthritis
- Part 3 - Abnormal XR + Advanced Imaging
  - Application to Tumor
  - Application to Misc. - Osteomyelitis, Charcot
  - **Advanced Imaging - CT and MRI scans**
    - Basic Principles
    - Ordering of Advanced Imaging
    - Approach to Reading Advanced Imaging

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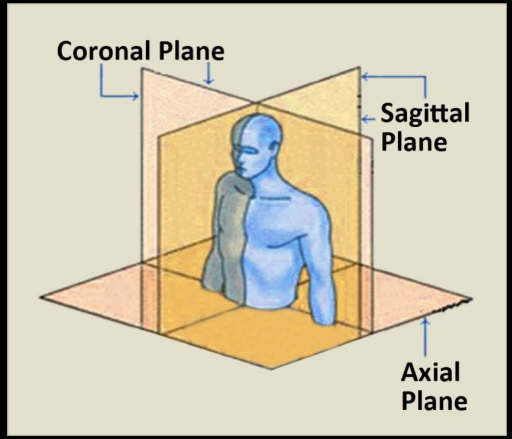
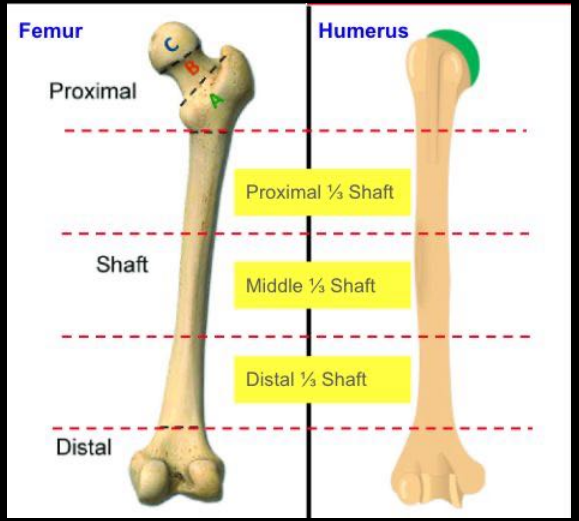
What we Have Gone Through

- **CT** is just a better XR with 3 dimensions
  - Able to provide a 3D reconstruction
- **MRI** utilizes a magnetic field and radiofrequency
  - Beware of cochlear implants, pacemakers, other metal implants
  - Has 3 main sequences
    - **T1** = Only Fat is White
    - **T2** = Both Fat and Water is White
    - **T2** Fat Suppressed = Only Water is White
- CT and MRI both has 3 views - **Sagittal**, **Axial**, **Coronal**
- When to order which?
  - [Trauma] XR can see fracture near joint (think proximal or distal) → **CT scan** for better evaluation
  - [Trauma] XR no fracture → **MRI scan** to look for soft tissue injury/ occult fracture
  - [Some Elective Surgeries] **CT scan** for pre op planning e.g. Shoulder replacement
  - [Tumor and Infection] MRI with **contrast**





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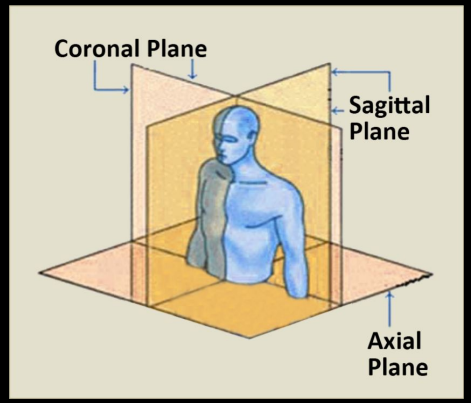
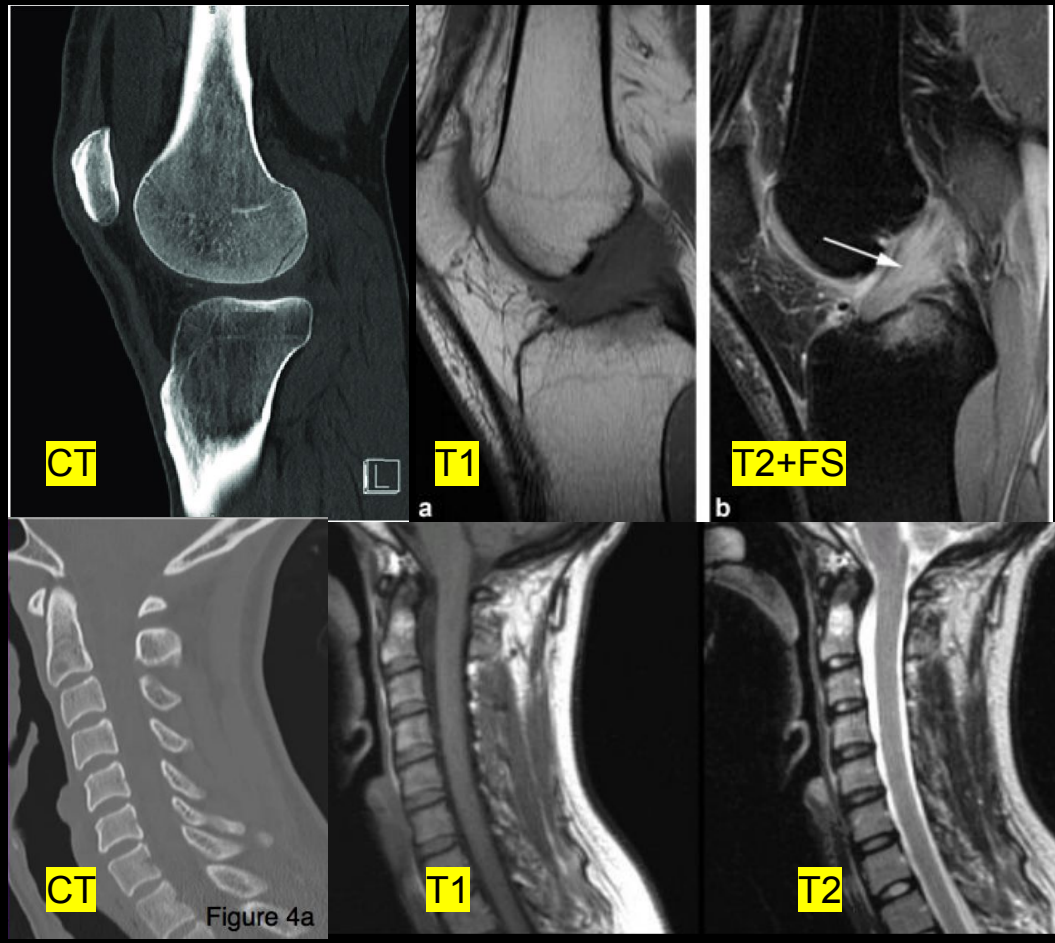
Approaching the Advanced Imaging - MRI/ CT

1. What scan is this?
   a. If MRI scan, what sequence?
      - T1 - only Fat is “white”
      - T2 - Both Fat + Water “White”
      - T2+ Fat suppressed = only Water is “white”
2. What body part is this?
3. What view is this?
   a. Sagittal, Axial or Coronal?
4. What is the abnormality?





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32

CT or MRI #1? View? (Answer each question, choose 2 options) - 45 sec

- [ ] * CT Scan
- [ ] * MRI Scan, T1 Sequence
- [ ] * MRI Scan, T2 Sequence
- [ ] * MRI Scan, T2 + Fat Suppression Sequence
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

YMS

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CT or MRI #1? What View? What Sequence for MRI?

CT Scan

MRI Scan

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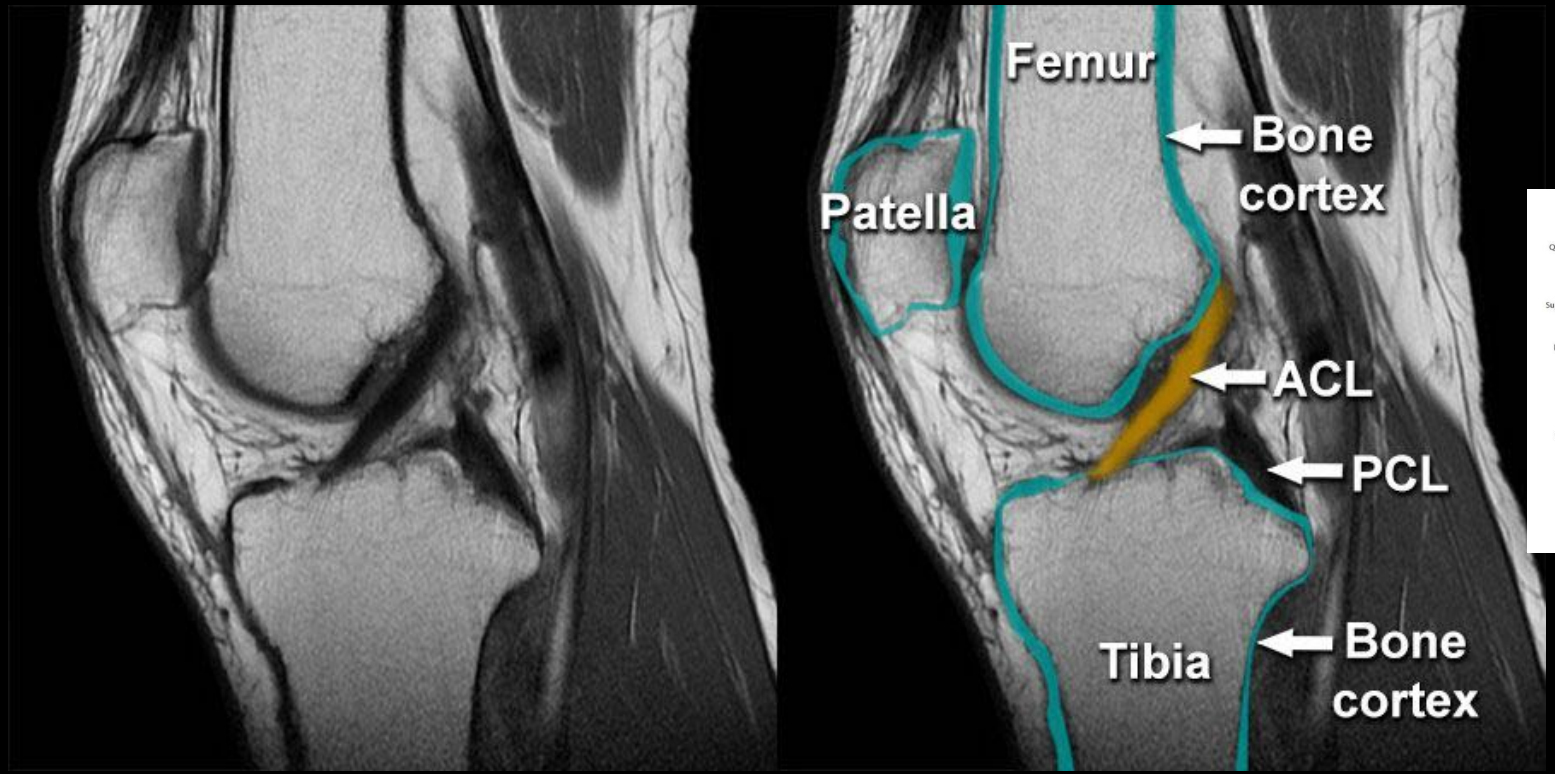
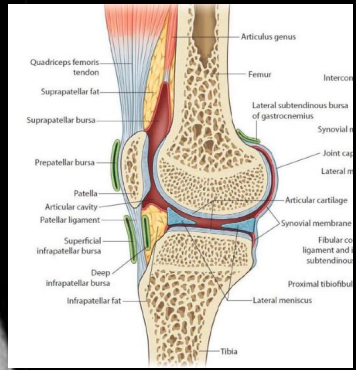
Knee - **Sagittal** View Key Structures



CT Scan



Sliced Anatomy

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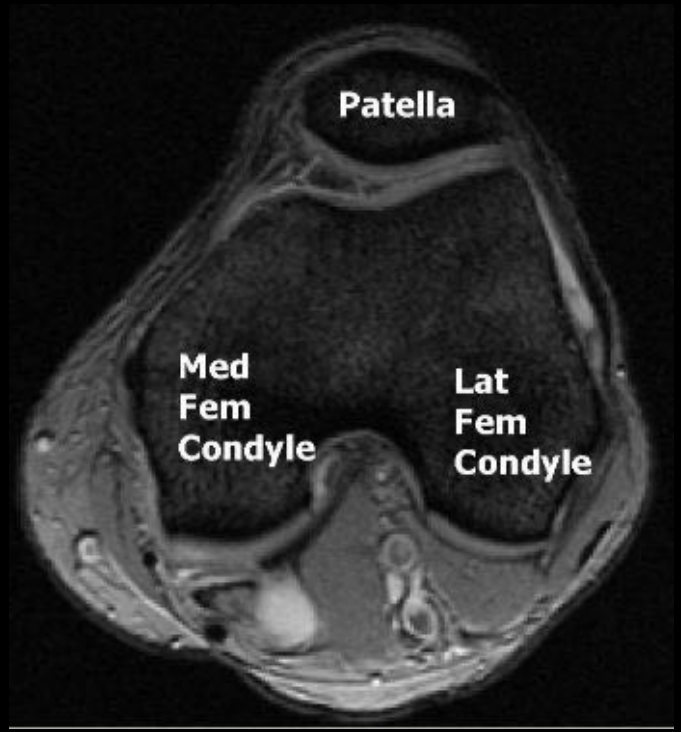
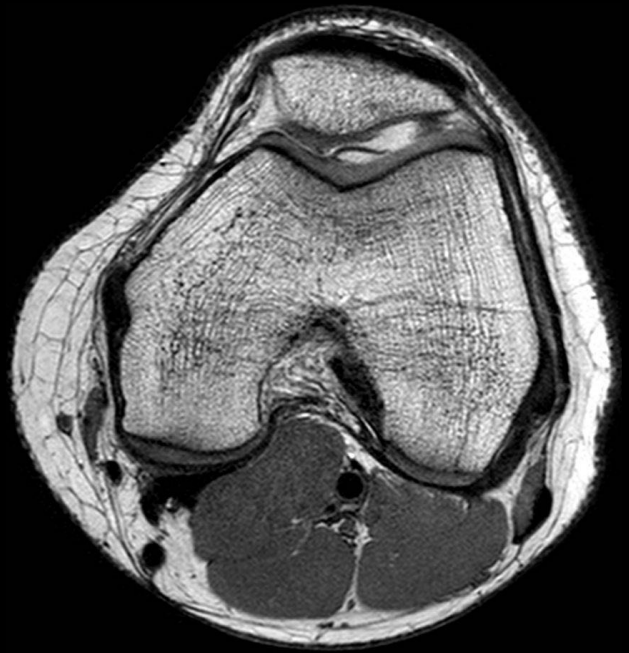
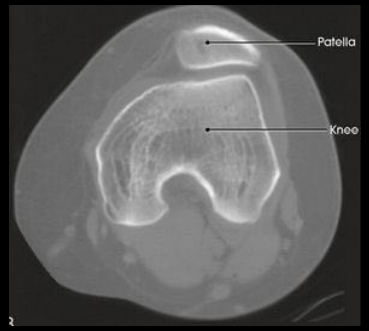
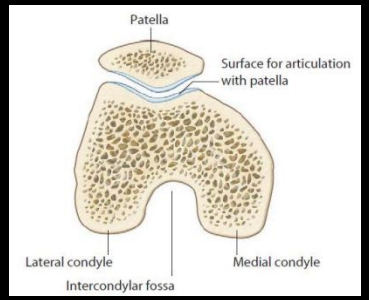
Knee - **Axial** View Key Structures







CT Scan



Sliced Anatomy

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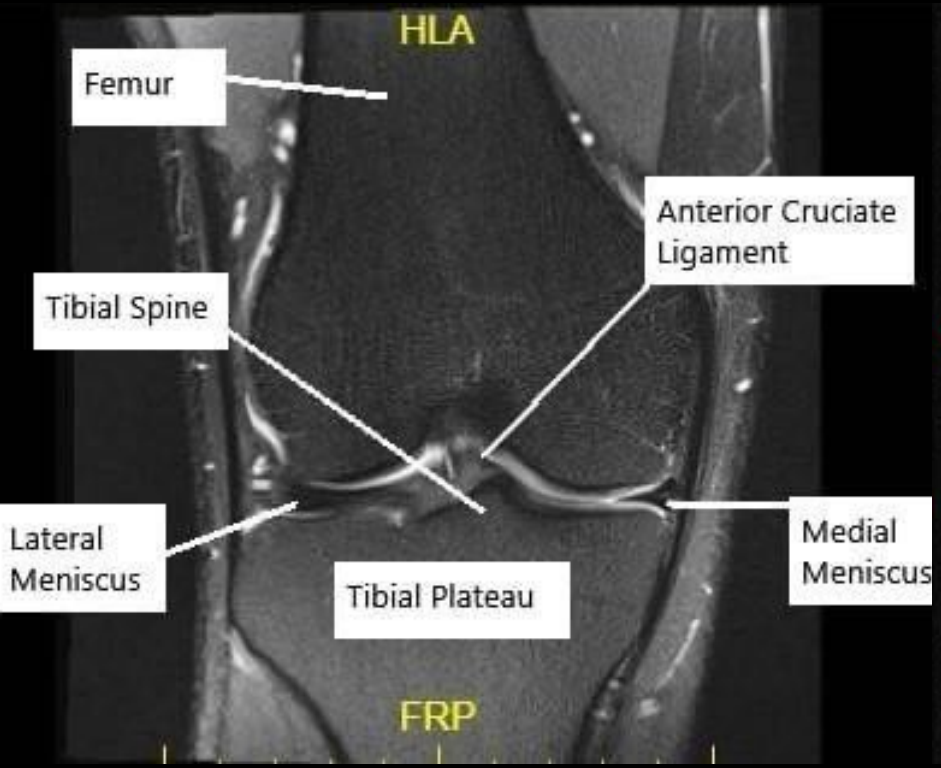
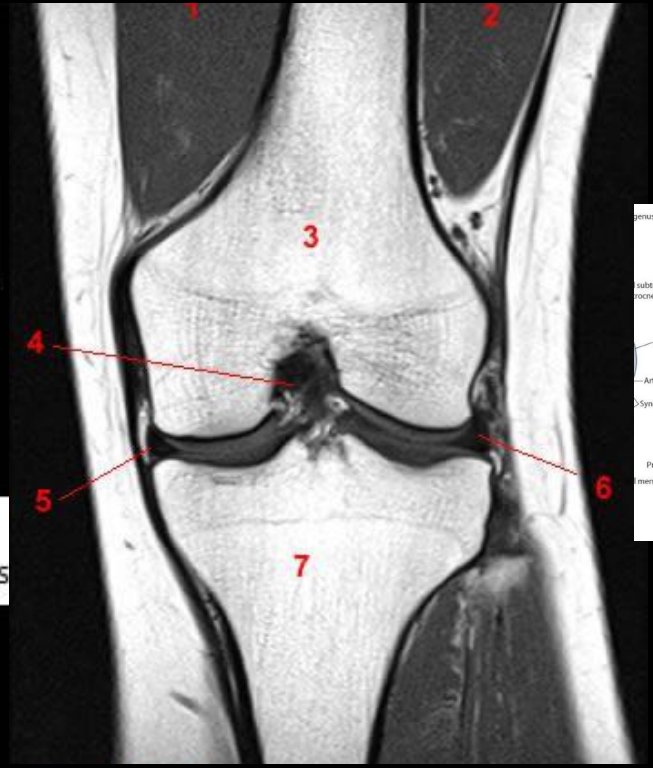
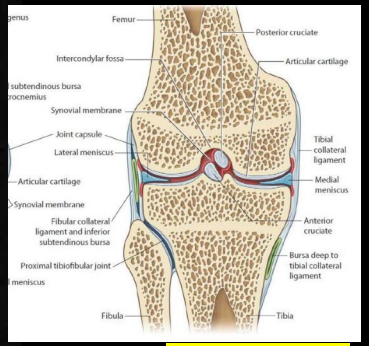
Knee - **Coronal** View Key Structures







Sliced Anatomy

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42

CT or MRI #2? View? (Answer each question, choose 2 options) - 45 sec

- [ ] * CT Scan
- [ ] * MRI Scan, T1 Sequence
- [ ] * MRI Scan, T2 Sequence
- [ ] * MRI Scan, T2 + Fat Suppression Sequence
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

YMS

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CT or MRI #2? What View? What Sequence for MRI?

CT Scan

MRI Scan

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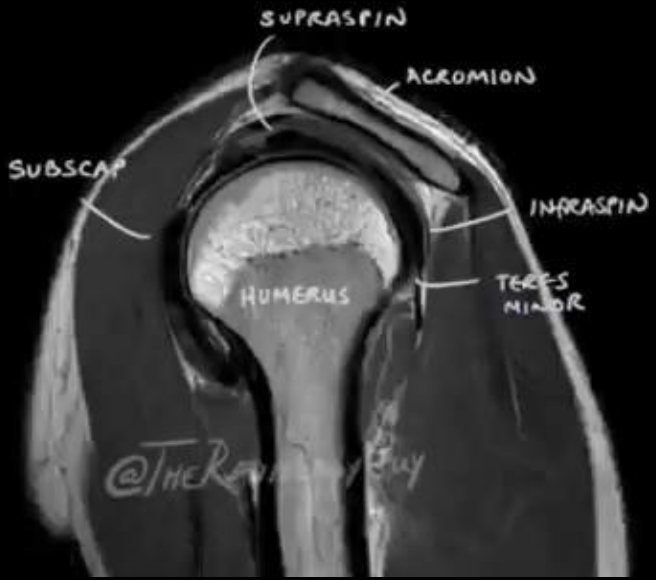
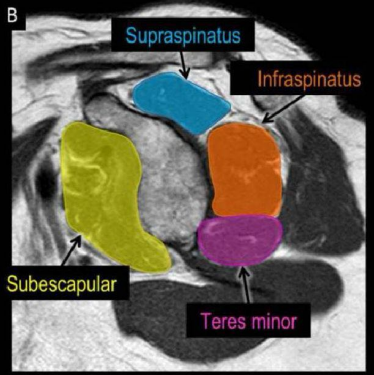
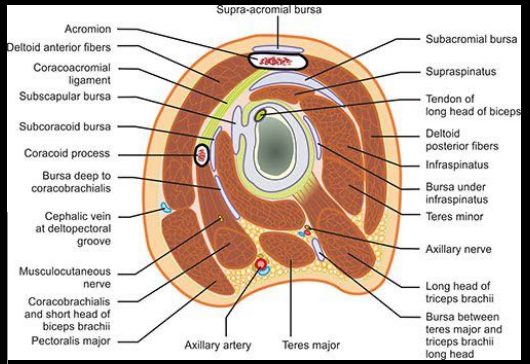
Shoulder - **Sagittal** View Key Structures





CT Scan



Sliced Anatomy

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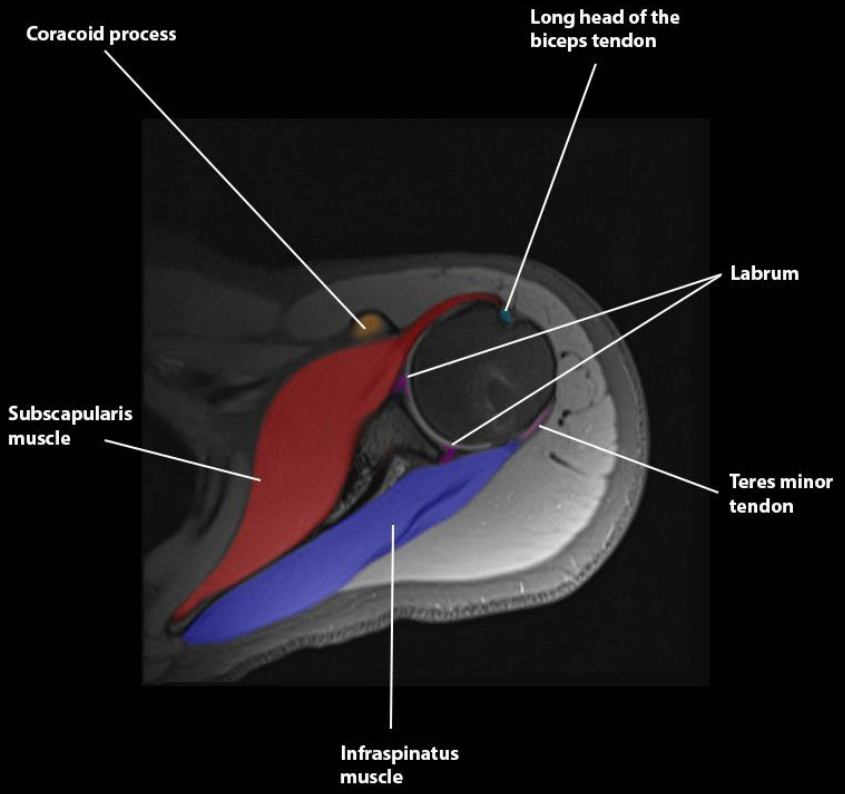
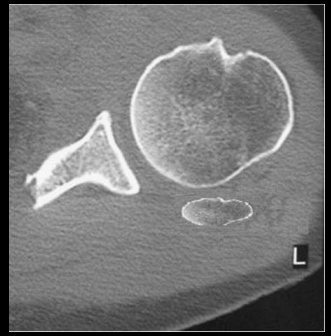
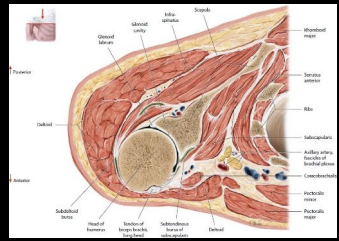
Shoulder - **Axial** View Key Structures





CT Scan



Sliced Anatomy

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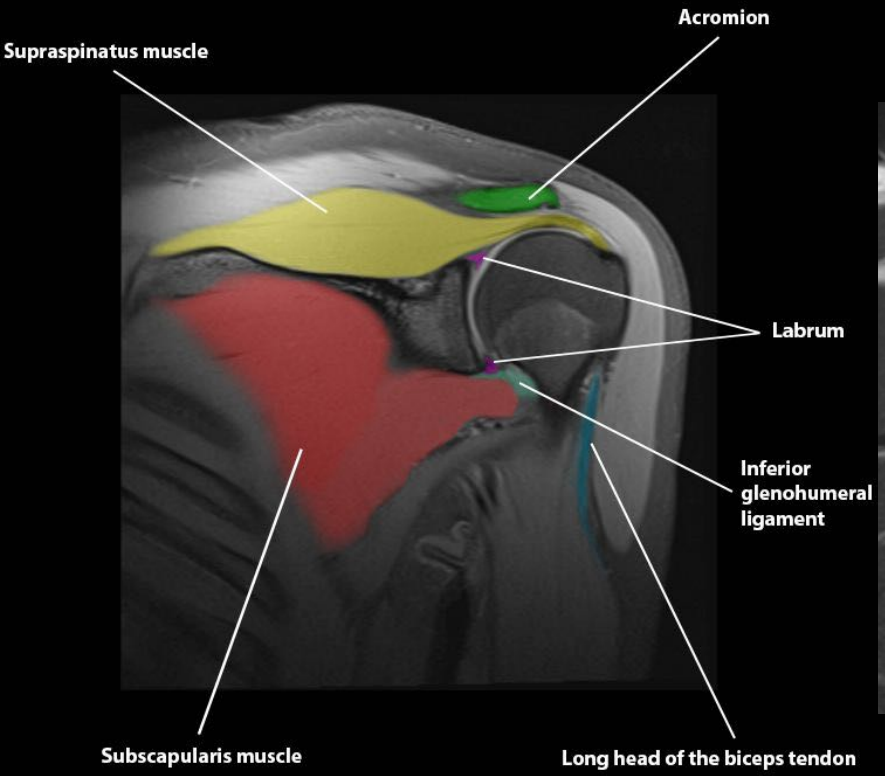
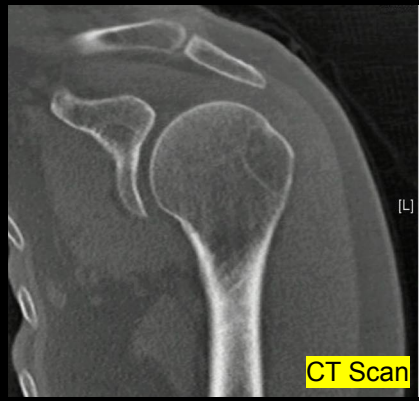
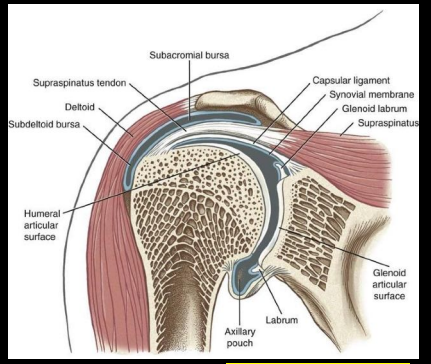
Shoulder - **Coronal** View Key Structures







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42

CT or MRI #3? View? (Answer each question, choose 2 options) - 45 sec

- [ ] * CT Scan
- [ ] * MRI Scan, T1 Sequence
- [ ] * MRI Scan, T2 Sequence
- [ ] * MRI Scan, T2 + Fat Suppression Sequence
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

YMS

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CT or MRI #3? What View? What Sequence for MRI?

CT Scan

MRI Scan

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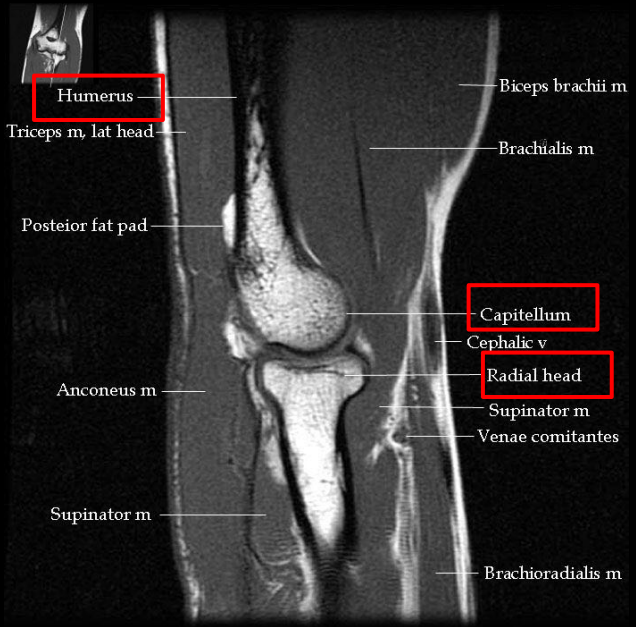
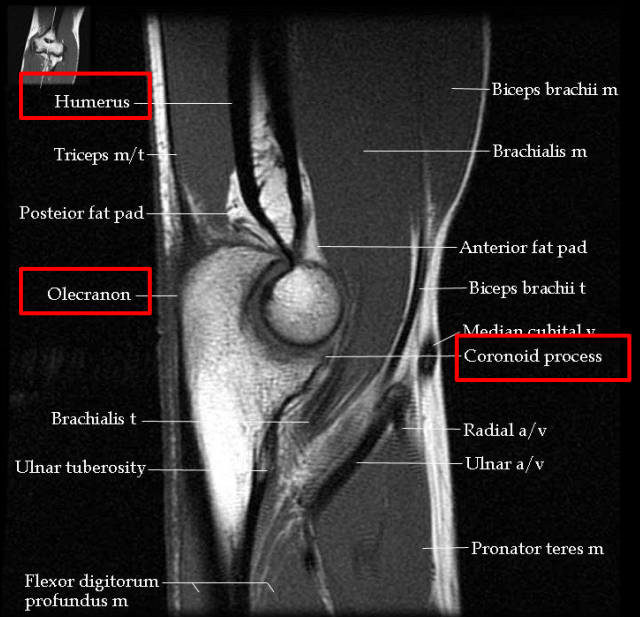
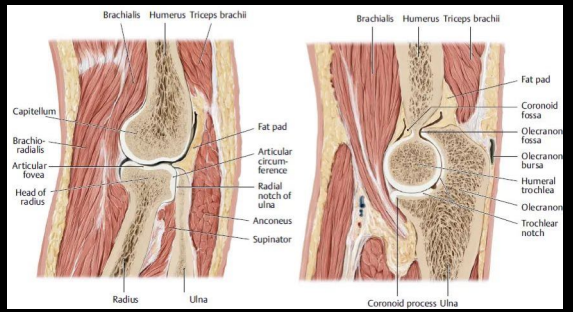
Elbow - **Sagittal** View Key Structures





CT Scan



Sliced Anatomy

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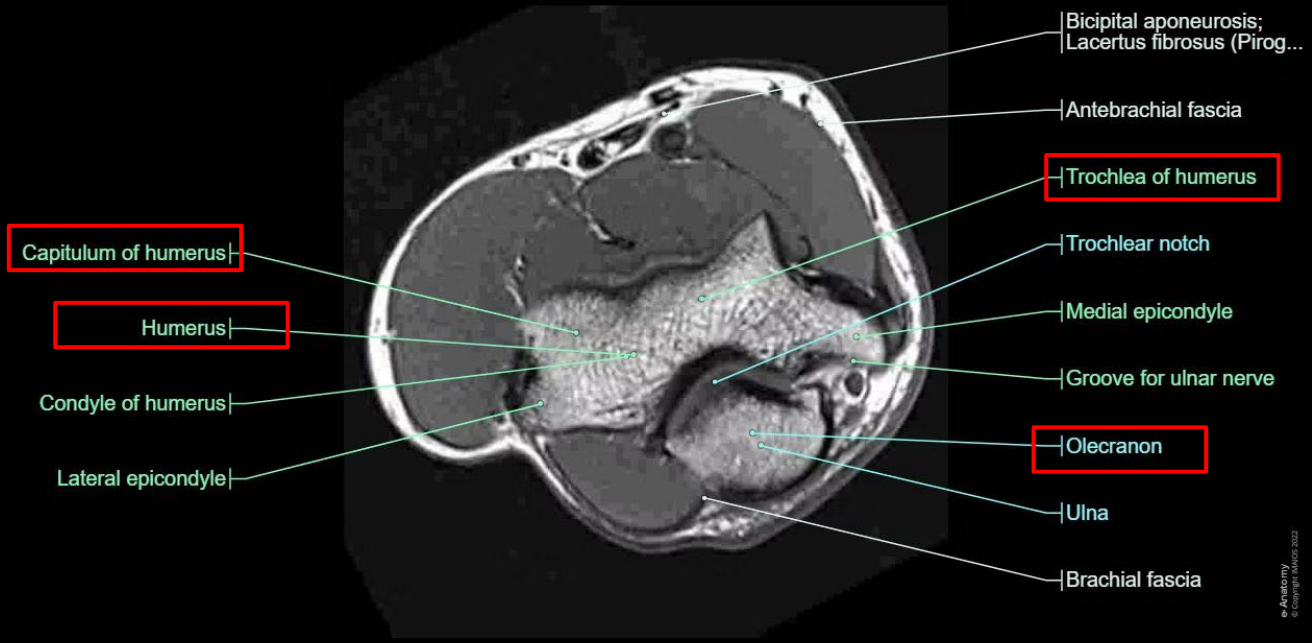
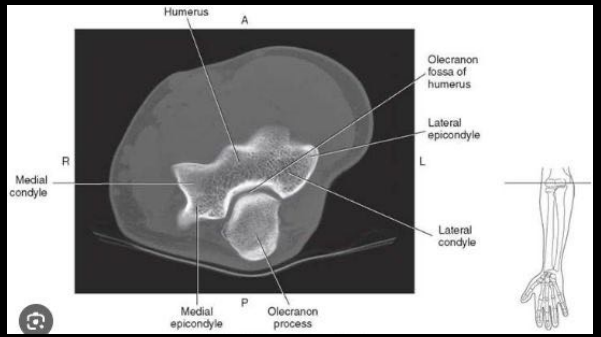
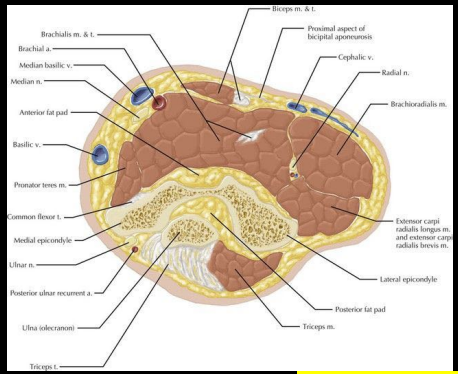
Elbow - **Axial** View Key Structures





CT Scan



Sliced Anatomy

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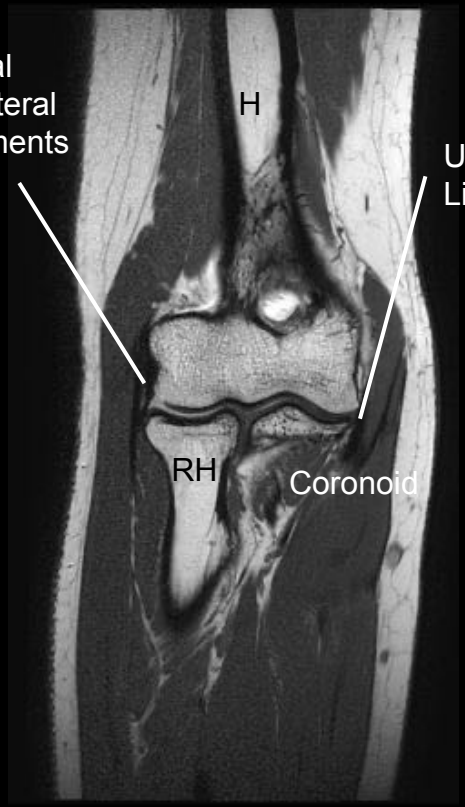
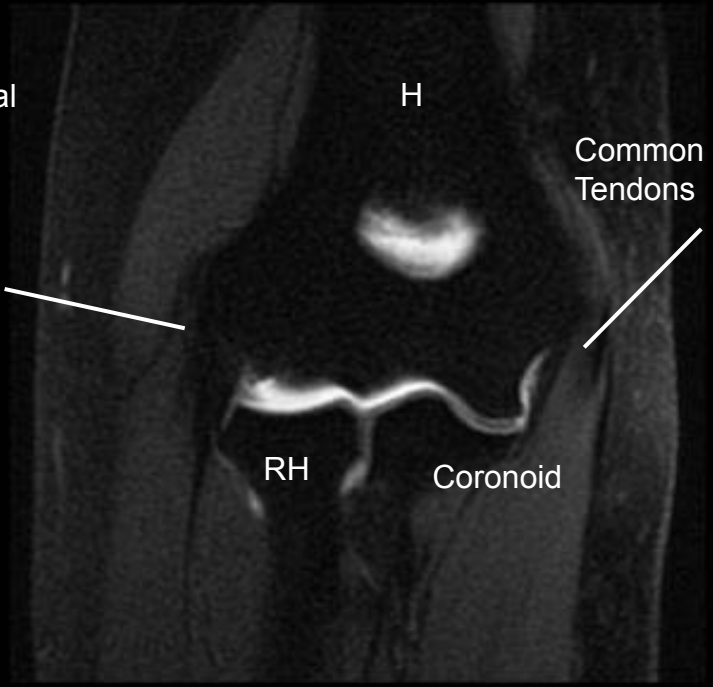
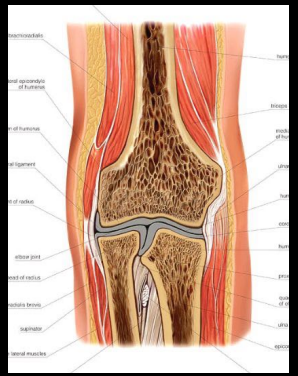
Elbow - **Coronal** View Key Structures





CT Scan



Sliced Anatomy

YMS

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28

CT or MRI #4? View? (Answer each question, choose 2 options) - 30 sec

- [ ] * CT Scan
- [ ] * MRI Scan, T1 Sequence
- [ ] * MRI Scan, T2 Sequence
- [ ] * MRI Scan, T2 + Fat Suppression Sequence
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

YMS

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CT or MRI #4? What View? What Sequence for MRI?

CT Scan

MRI Scan

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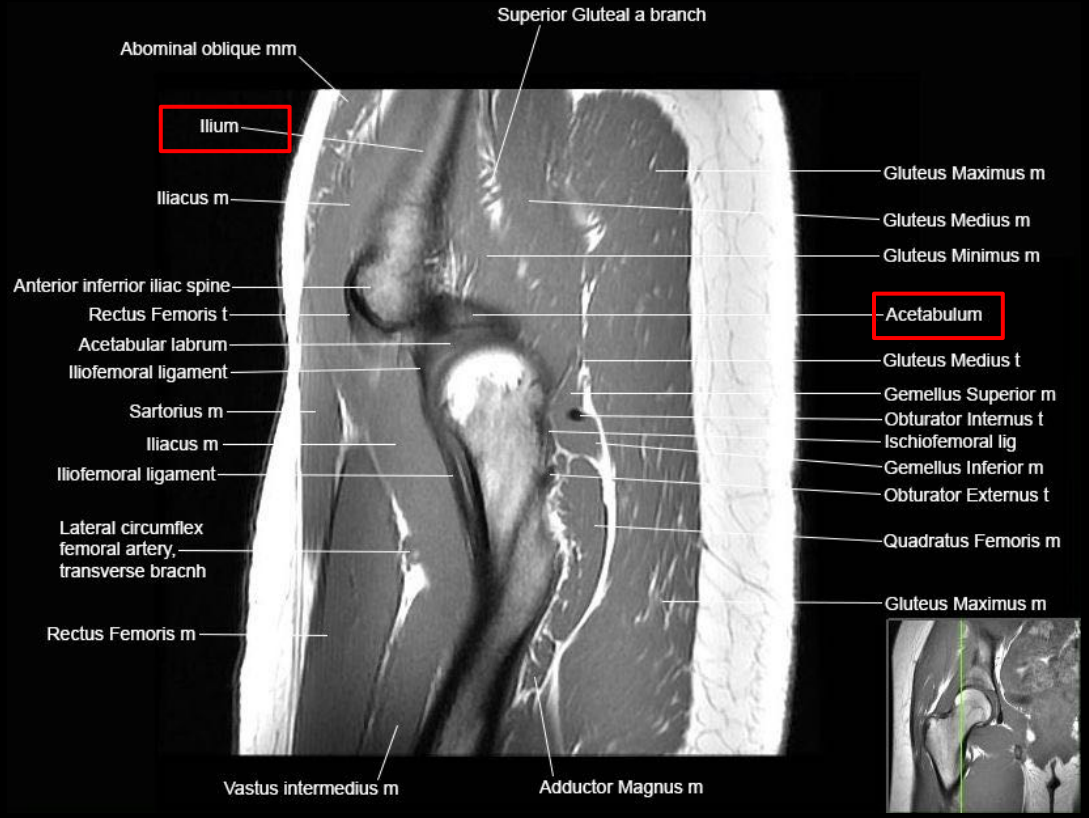
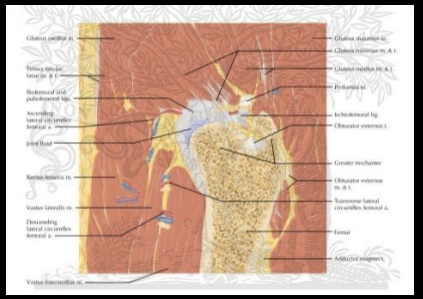
Hip - **Sagittal** View Key Structures



CT Scan



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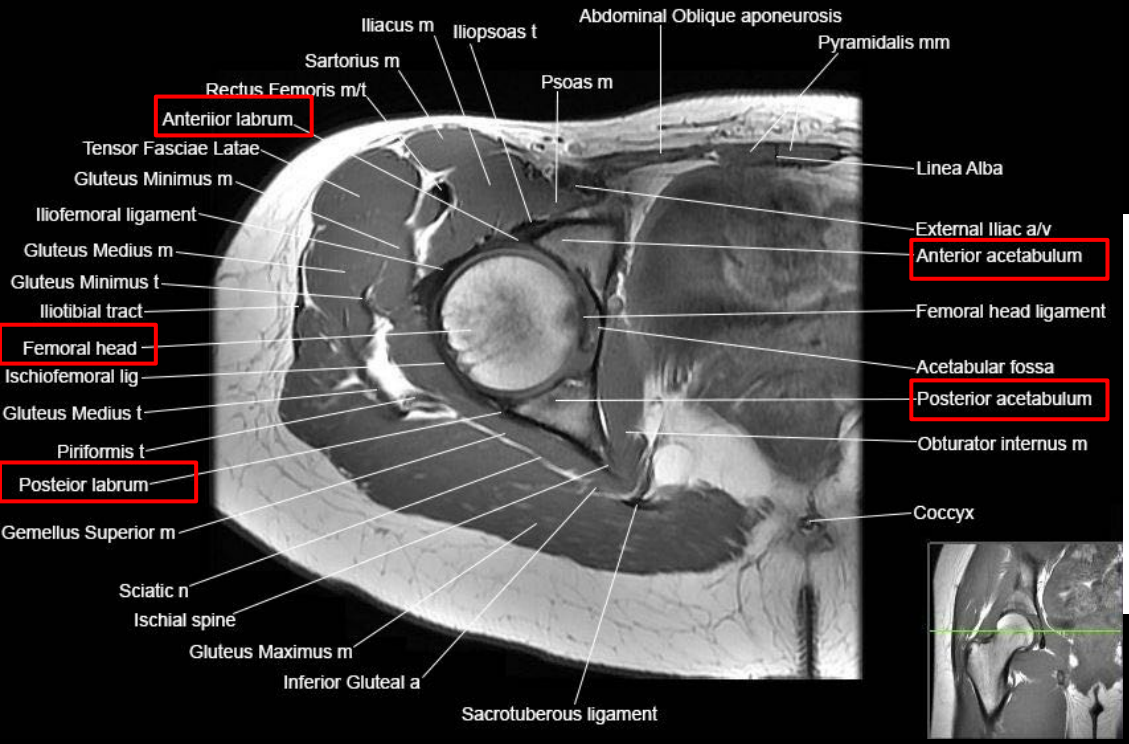
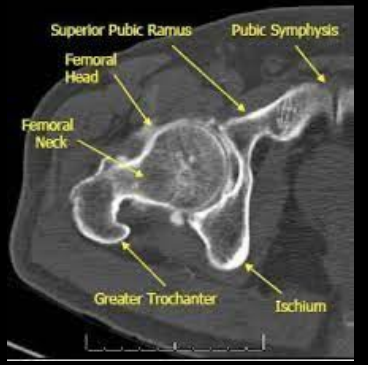
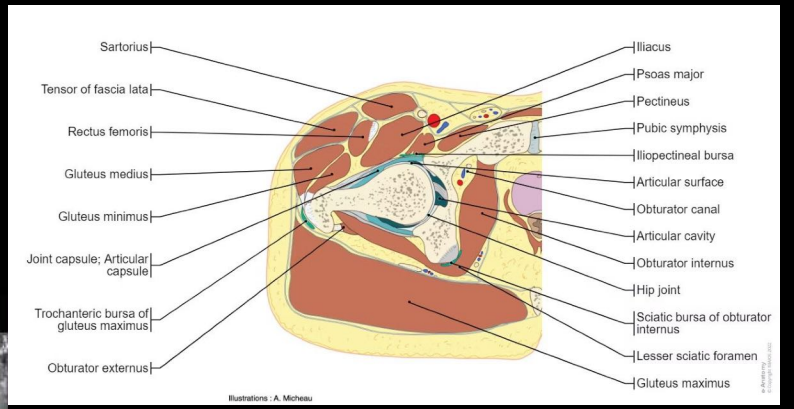
Hip - **Axial** View Key Structures





CT Scan



Sliced Anatomy

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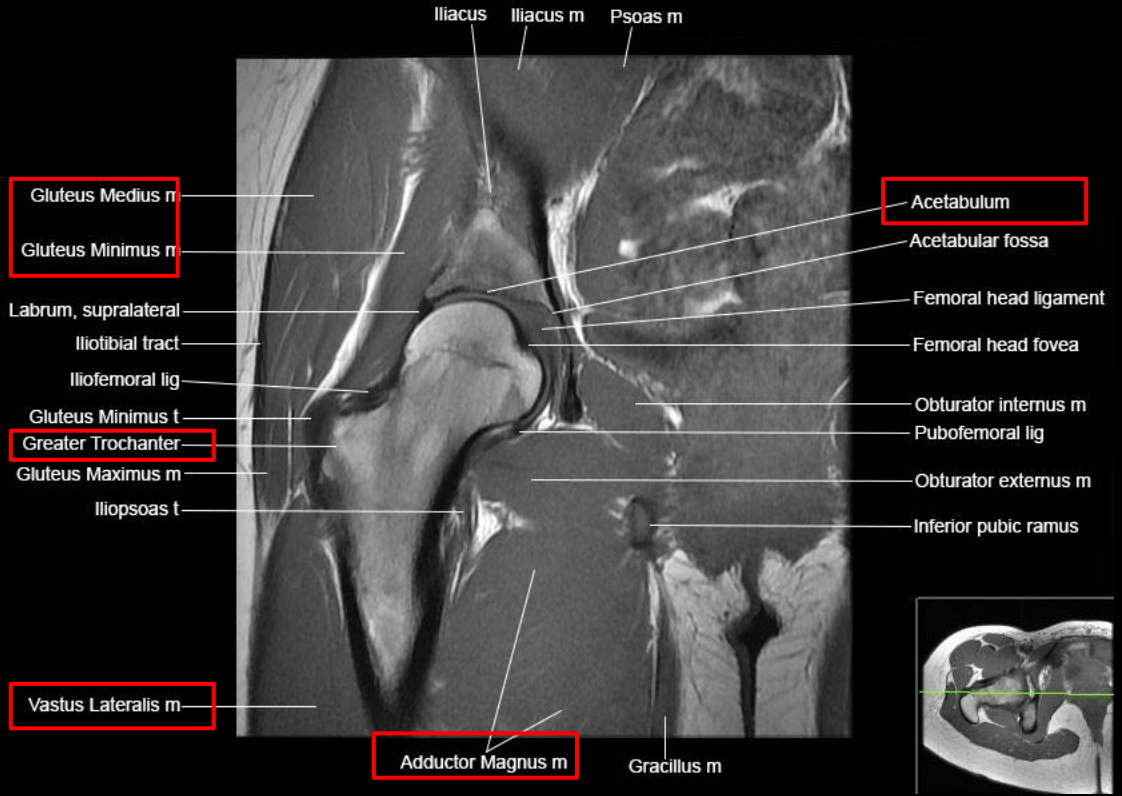
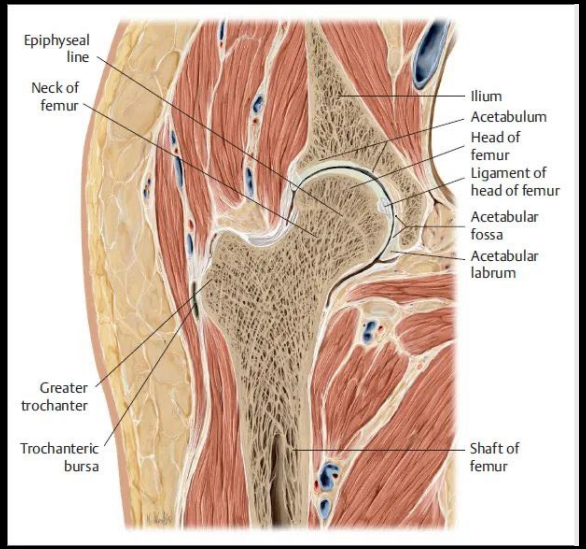
Hip - **Coronal** View Key Structures



CT Scan



Sliced Anatomy

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28

CT or MRI #5? (Answer each question, choose 2 options) - 30 sec

- [ ] * CT Scan
- [ ] * MRI Scan, T1 Sequence
- [ ] * MRI Scan, T2 Sequence
- [ ] * MRI Scan, T2 + Fat Suppression Sequence
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

YMS

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CT or MRI #4? What View? What Sequence for MRI?

CT Scan

MRI Scan

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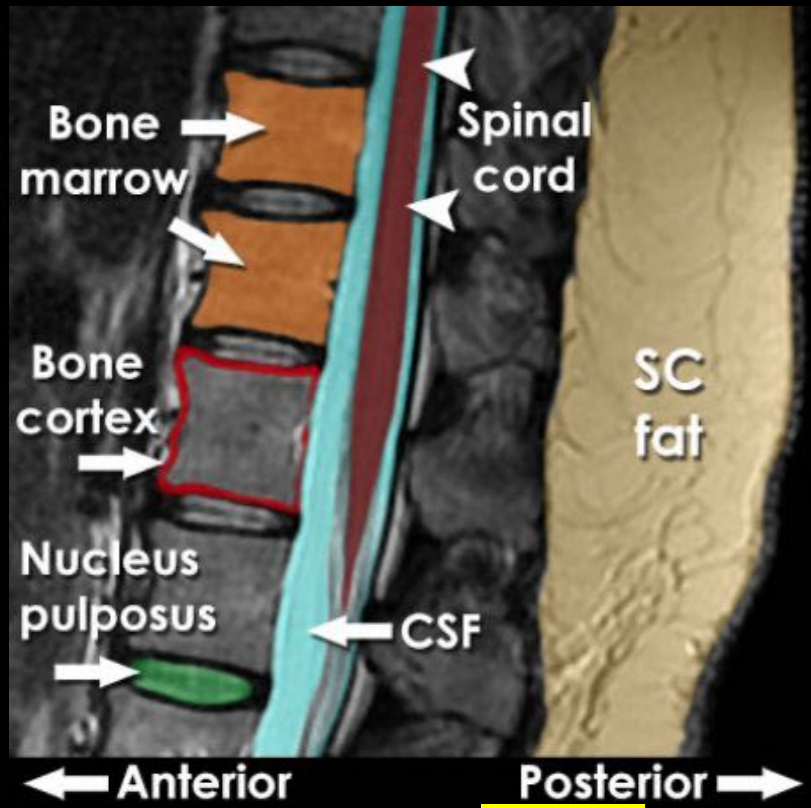
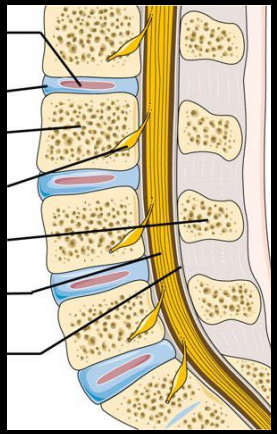
Lumbar Spine - **Sagittal** View Key Structures



MRI Scan



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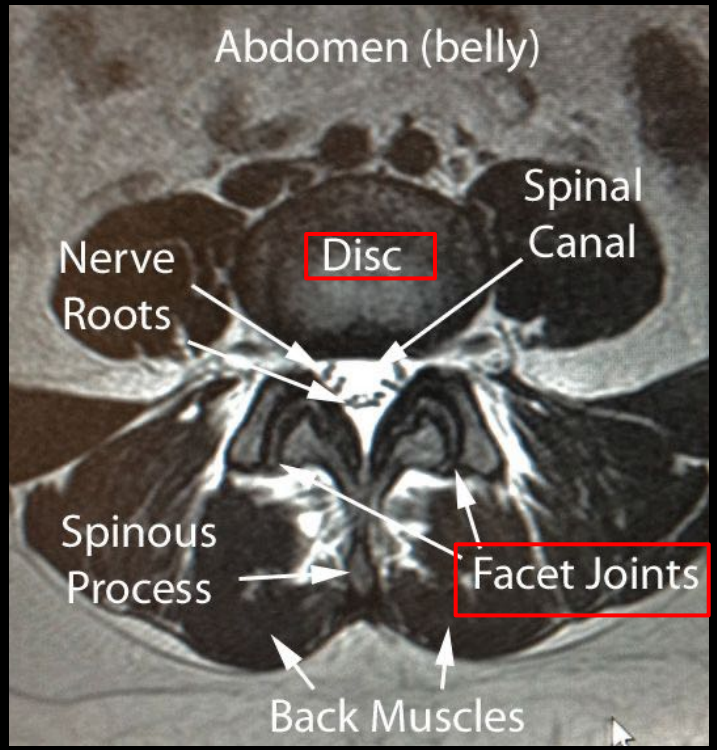
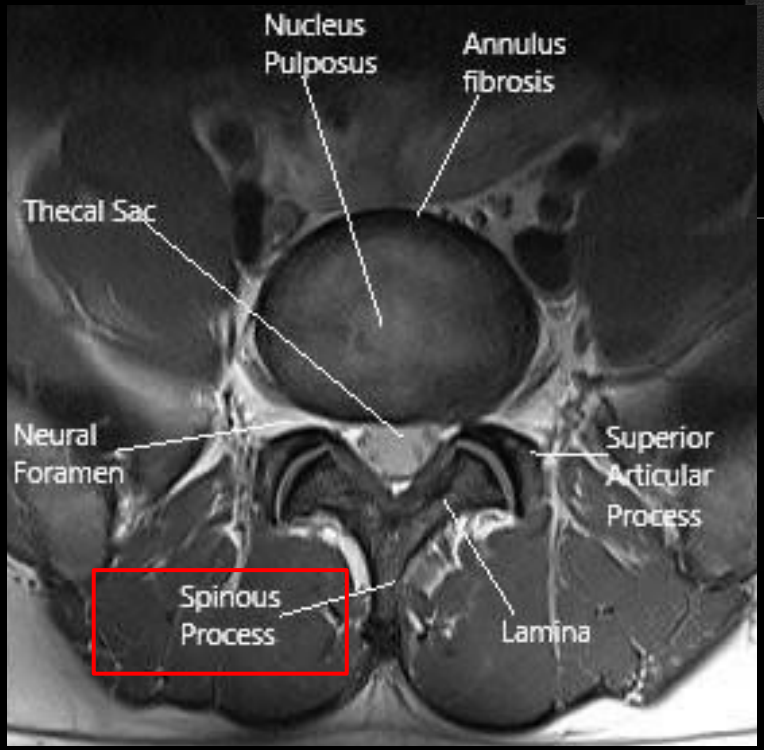
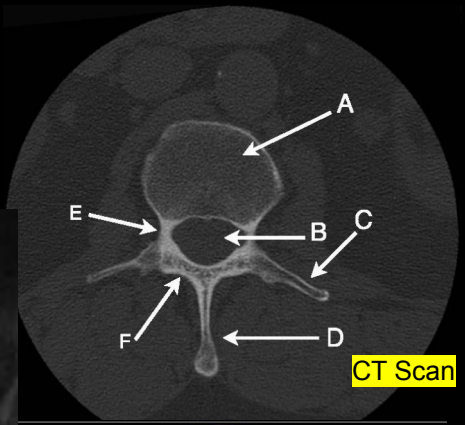
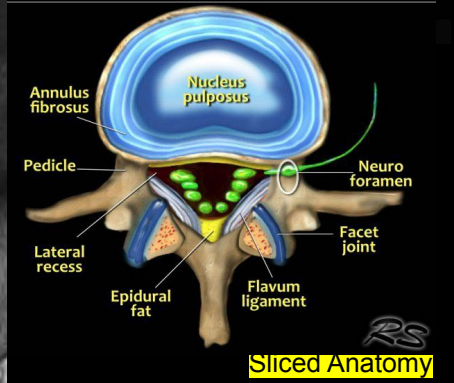
Lumbar Spine - **Axial** View Key Structures









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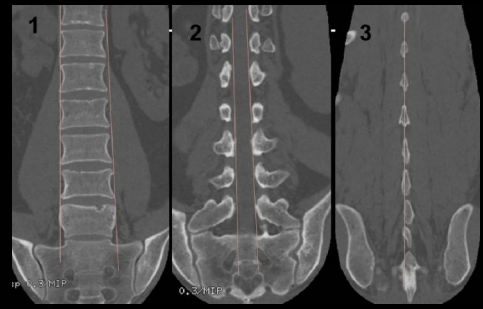
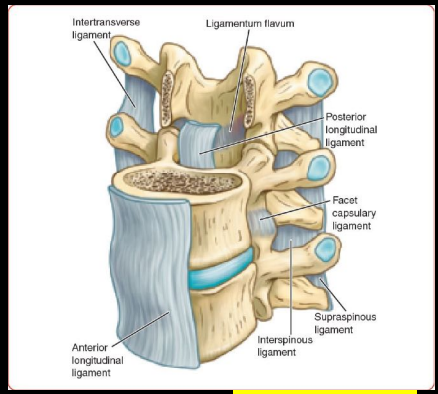
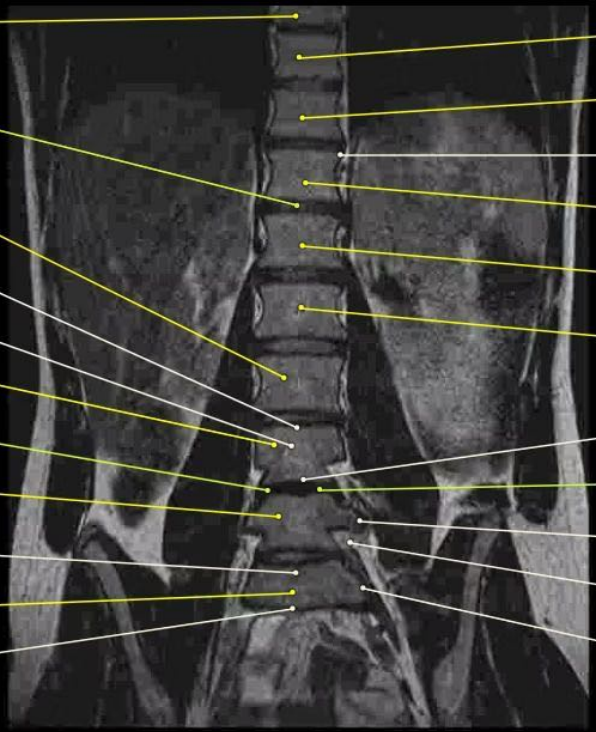
Lumbar Spine - Coronal View Key Structures



CT Scan



Sliced Anatomy



Vertebra T9
Nucleus pulposus
Vertebra L3
Intervertebral surface
Vertebral body
Vertebra L4
Anulus fibrosus
Vertebra L5
Base of sacrum
Vertebra S1
Pelvic surface

Vertebra T10
Vertebra T11
Anular epiphysis
Vertebra T12
Vertebra L1
Vertebra L2
Intervertebral surface
Intervertebral disc
Costal process
Intervertebral foramen
Sacrum

YMS

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44

CT or MRI #6? View? (Answer each question, choose 2 options) - 30 sec

- [ ] * CT Scan
- [ ] * MRI Scan, T1 Sequence
- [ ] * MRI Scan, T2 Sequence
- [ ] * MRI Scan, T2 + Fat Suppression Sequence
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

YMS

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CT or MRI #6? What View? What Sequence for MRI?

CT Scan

MRI Scan

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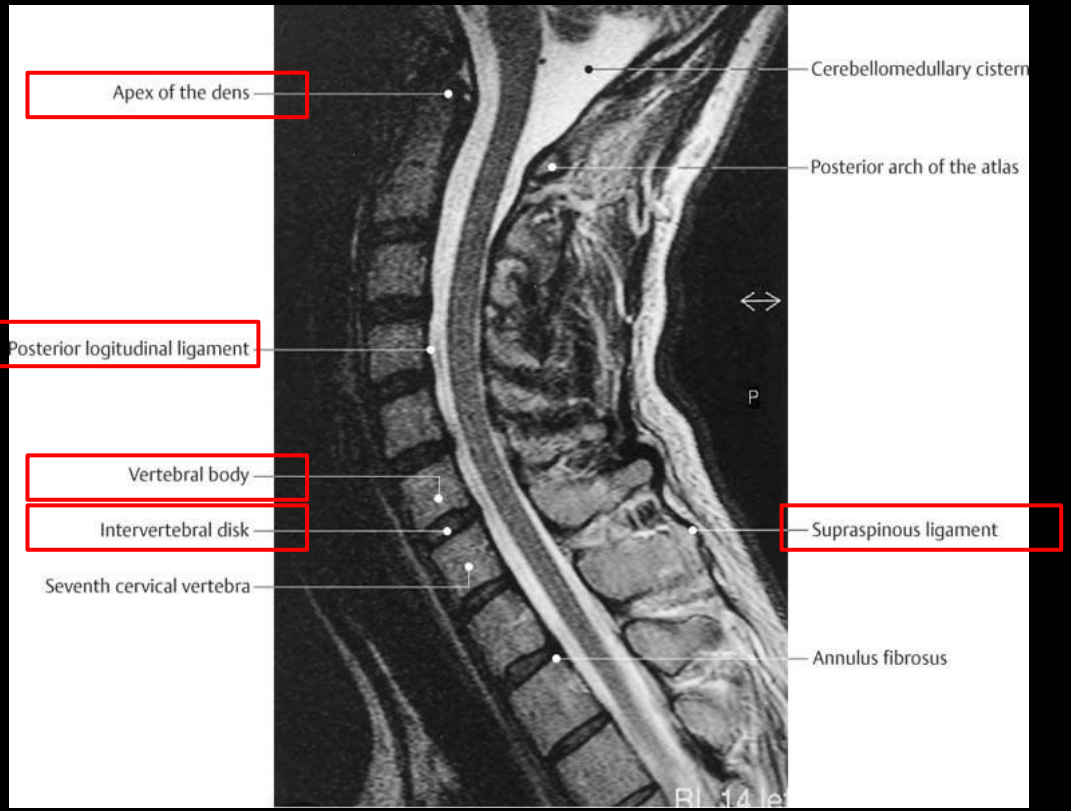
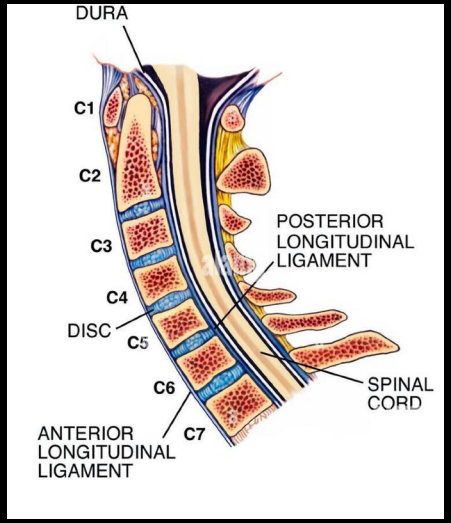
Cervical Spine - **Sagittal** View Key Structures



CT Scan



Sliced Anatomy

YMS

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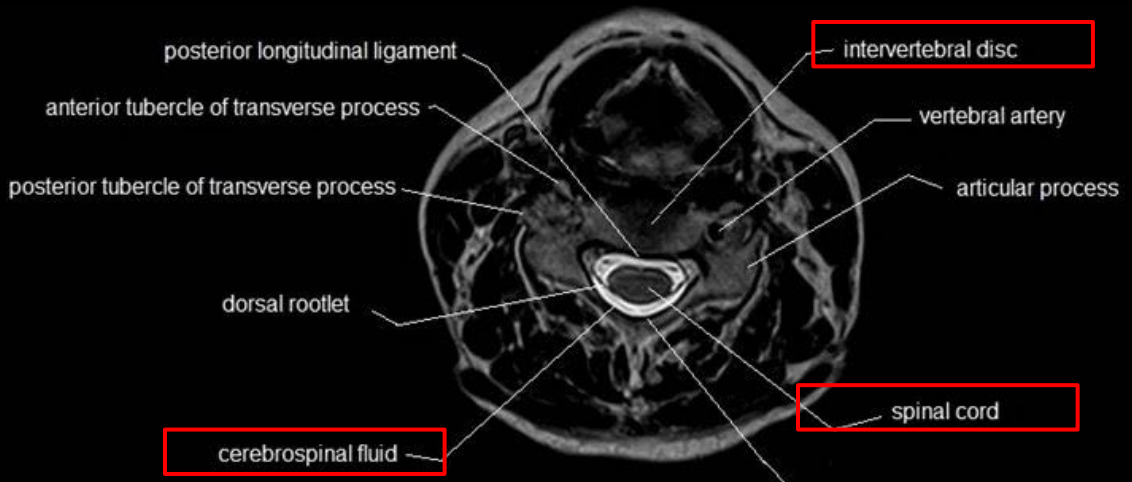
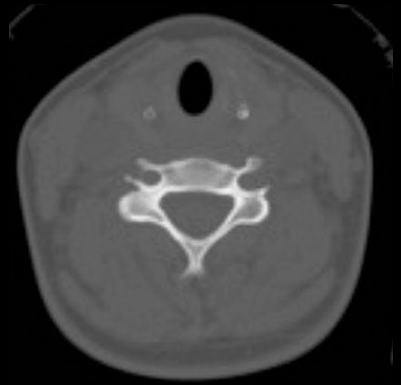
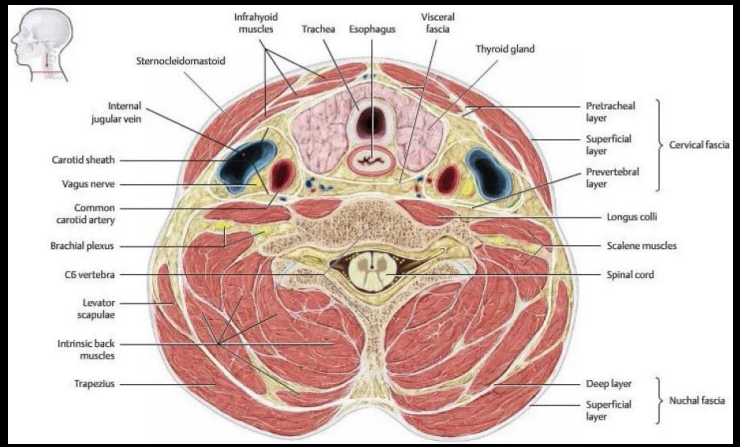
Cervical Spine - **Axial** View Key Structures





CT Scan



Sliced Anatomy

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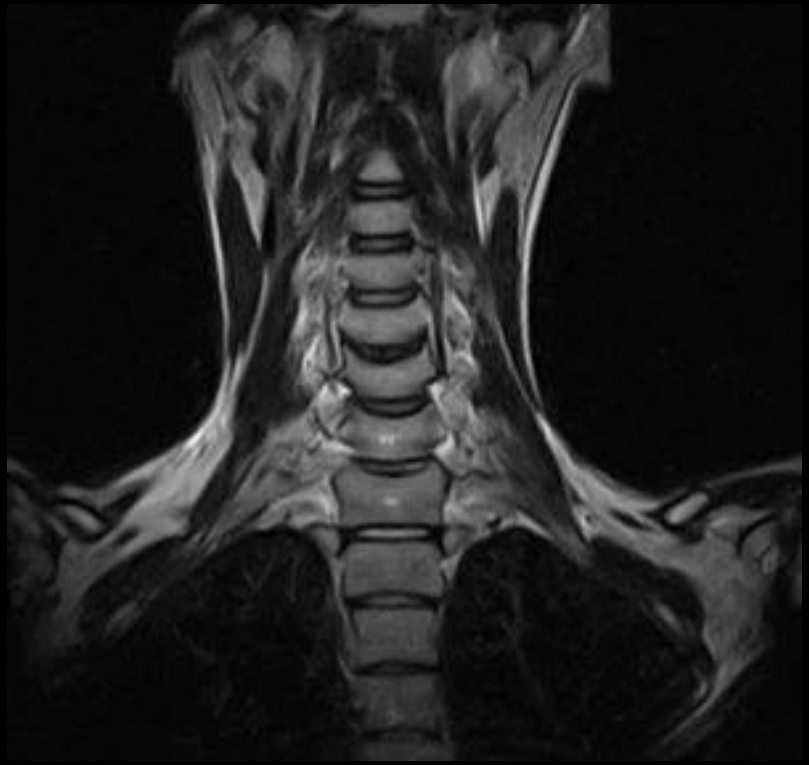
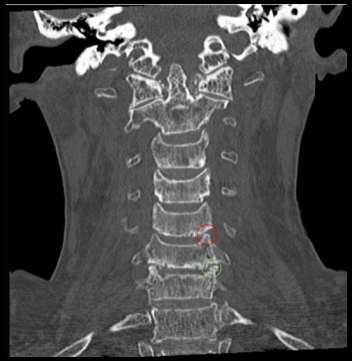
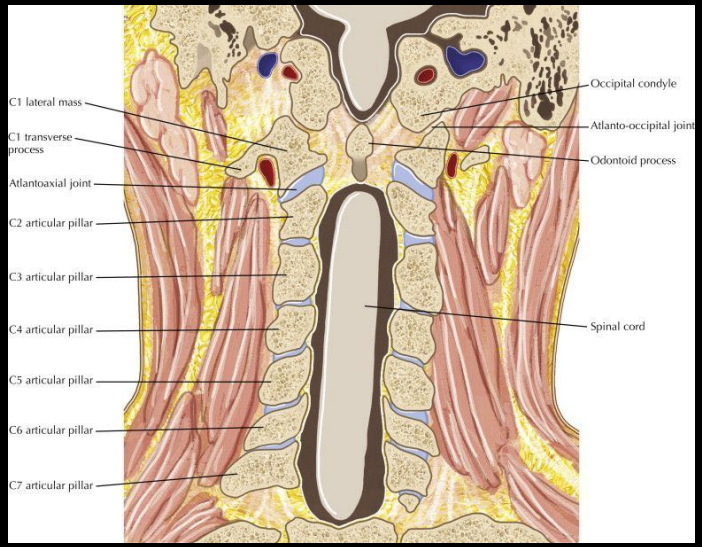
Cervical Spine - **Coronal** View Key Structures





CT Scan



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What we Have Gone Through

- **CT** is just a better XR with 3 dimensions
  - Able to provide a 3D reconstruction
- **MRI** utilizes a magnetic field and radiofrequency
  - Beware of cochlear implants, pacemakers, other metal implants
  - Has 3 main sequences
    - **T1** = Only Fat is White
    - **T2** = Both Fat and Water is White
    - **T2** Fat Suppressed = Only Water is White
- CT and MRI both has 3 views - **Sagittal**, **Axial**, **Coronal**
- When to order which?
  - [Trauma] XR can see fracture near joint (think proximal or distal) → **CT scan** for better evaluation
  - [Trauma] XR no fracture → **MRI scan** to look for soft tissue injury/ occult fracture
  - [Some Elective Surgeries] **CT scan** for pre op planning e.g. Shoulder replacement
  - [Tumor and Infection] MRI with **contrast**

Normal Scans

- Knee
- Shoulder
- Elbow
- Hip
- Lumbar Spine
- Cervical Spine

YMS

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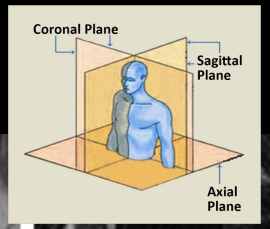
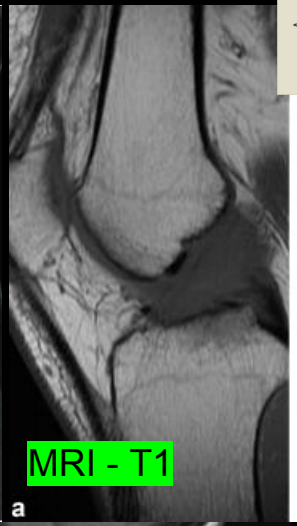
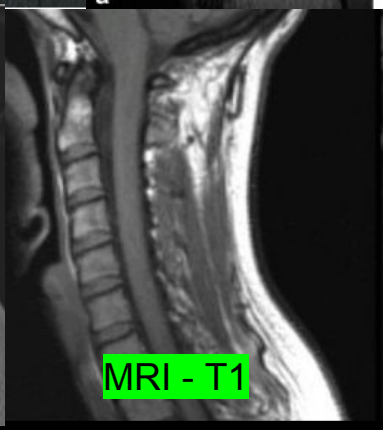
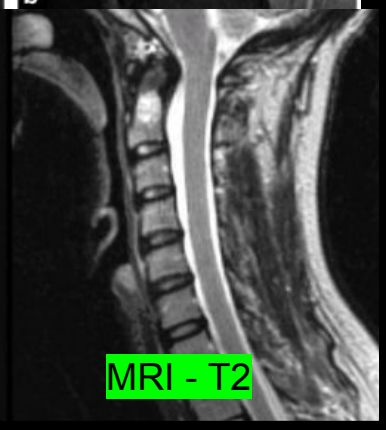
Approaching the Advanced Imaging - MRI/ CT

1. What scan is this?
   a. If MRI scan, what sequence?
      - T1 - only Fat is “white”
      - T2 - Both Fat + Water “White”
      - T2+ Fat suppressed = only Water is “white”
2. What body part is this?
3. What view is this?
   a. Sagittal, Axial or Coronal?
4. What is the abnormality?









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2 Abnormal Scans

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44

What Sequence/ View? Spot the Abnormality! (Answer each question, choose 3 options) #1

- [ ] * T1
- [ ] * T2
- [ ] * T2 + Fat Suppression
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View
- [ ] + PCL Tear
- [ ] + Patella Tendon Rupture
- [ ] + ACL Tear
- [ ] + Quadriceps Tendon Rupture

YMS

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Spot the Abnormality #1.

1. What scan is this?
   a. If MRI scan, what sequence? T1 or T2 Fat suppressed
2. What view is this?
   a. Axial, Sagittal or Coronal?
3. What body part is this?
4. What is the abnormality?

1. MRI, T1 Sequence
2. Sagittal View
3. Of the Knee
4. ACL complete rupture

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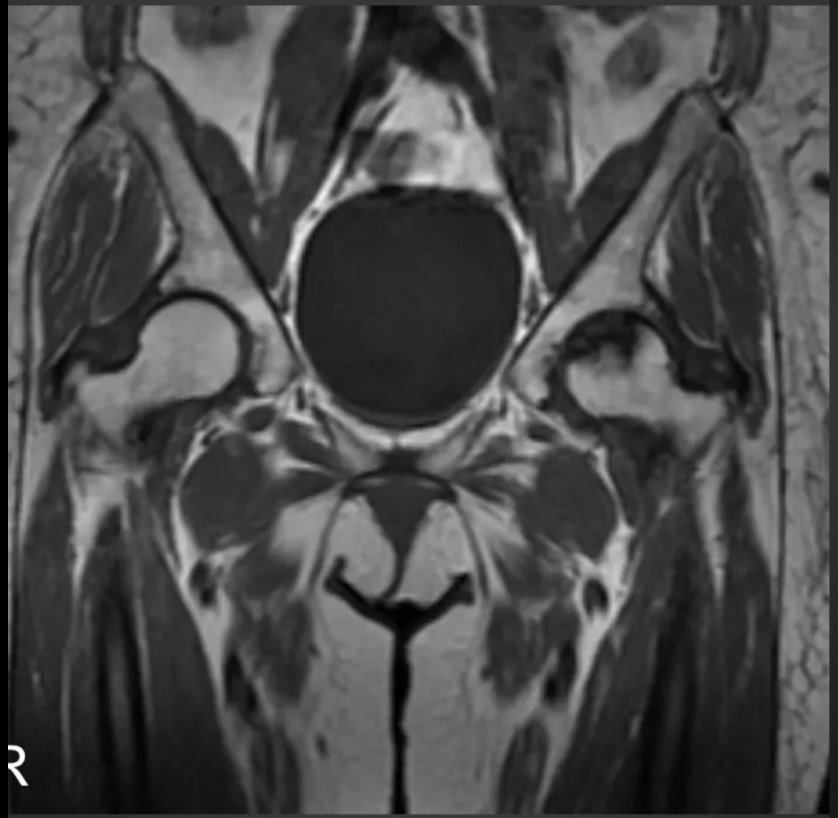

43

What Sequence/ View? Spot the Abnormality! (Answer each question, choose 3 options) #2

- [ ] * T1
- [ ] * T2
- [ ] * T2 + Fat Suppression
- [ ] - Sagittal View
- [ ] - Axial View
- [ ] - Coronal View

- [ ] + Occult Hip Fracture
- [ ] + Pubic Rami Fracture
- [ ] + Hip Labral Tear
- [ ] + AVN Hip

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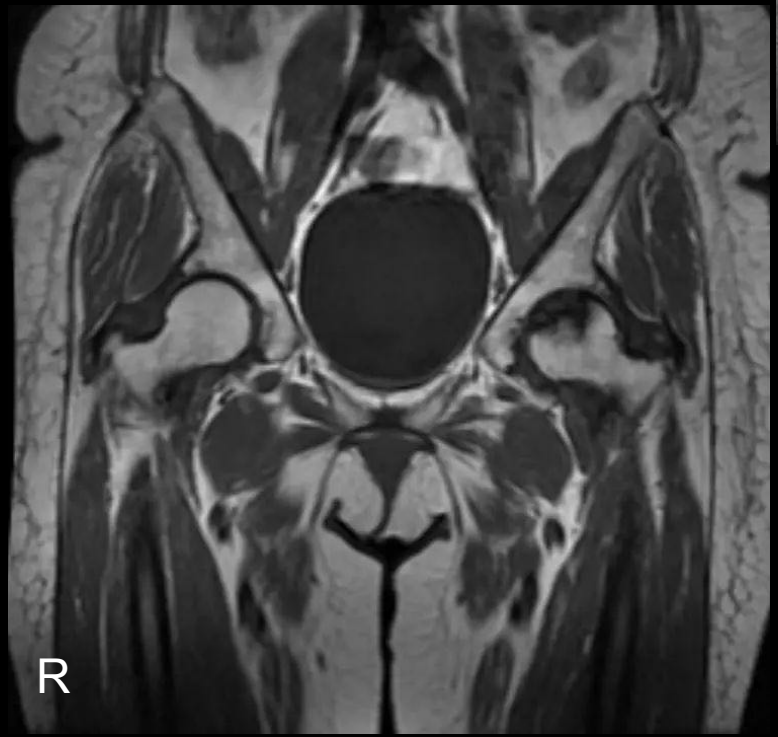
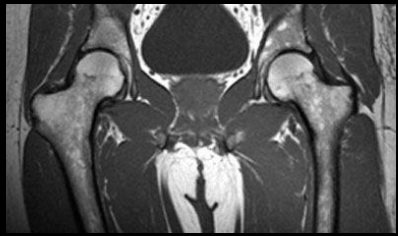
Spot the Abnormality #2.

Normal XR





Normal MRI

1. What scan is this?
   a. If MRI scan, what sequence? T1 or T2 Fat suppressed
2. What view is this?
   a. Axial, Sagittal or Coronal?
3. What body part is this?
4. What is the abnormality?

1. MRI, T1 Sequence
2. Coronal View
3. Of the Pelvis
4. AVN of Left Hip

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What we Have Gone Through

- **CT** is just a better XR with 3 dimensions
  - Able to provide a 3D reconstruction
- **MRI** utilizes a magnetic field and radiofrequency
  - Beware of cochlear implants, pacemakers, other metal implants
  - Has 3 main sequences
    - **T1** = Only Fat is White
    - **T2** = Both Fat and Water is White
    - **T2** Fat Suppressed = Only Water is White
- CT and MRI both has 3 views - **Sagittal**, **Axial**, **Coronal**
- When to order which?
  - [Trauma] XR can see fracture near joint (think proximal or distal) → **CT scan** for better evaluation
  - [Trauma] XR no fracture → **MRI scan** to look for soft tissue injury/ occult fracture
  - [Some Elective Surgeries] **CT scan** for pre op planning e.g. Shoulder replacement
  - [Tumor and Infection] MRI with **contrast**

Normal Scans

- Knee
- Shoulder
- Elbow
- Hip
- Lumbar Spine
- Cervical Spine

Abnormal Findings

- Knee - ACL Tear
- Hip - Early AVN

YMS

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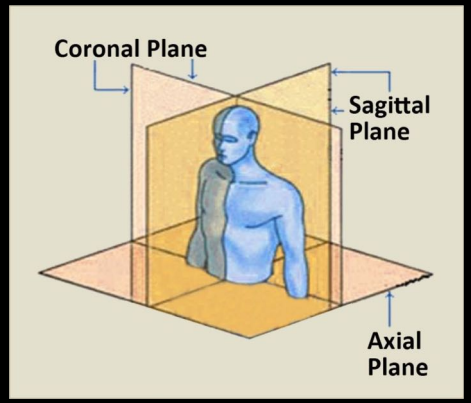
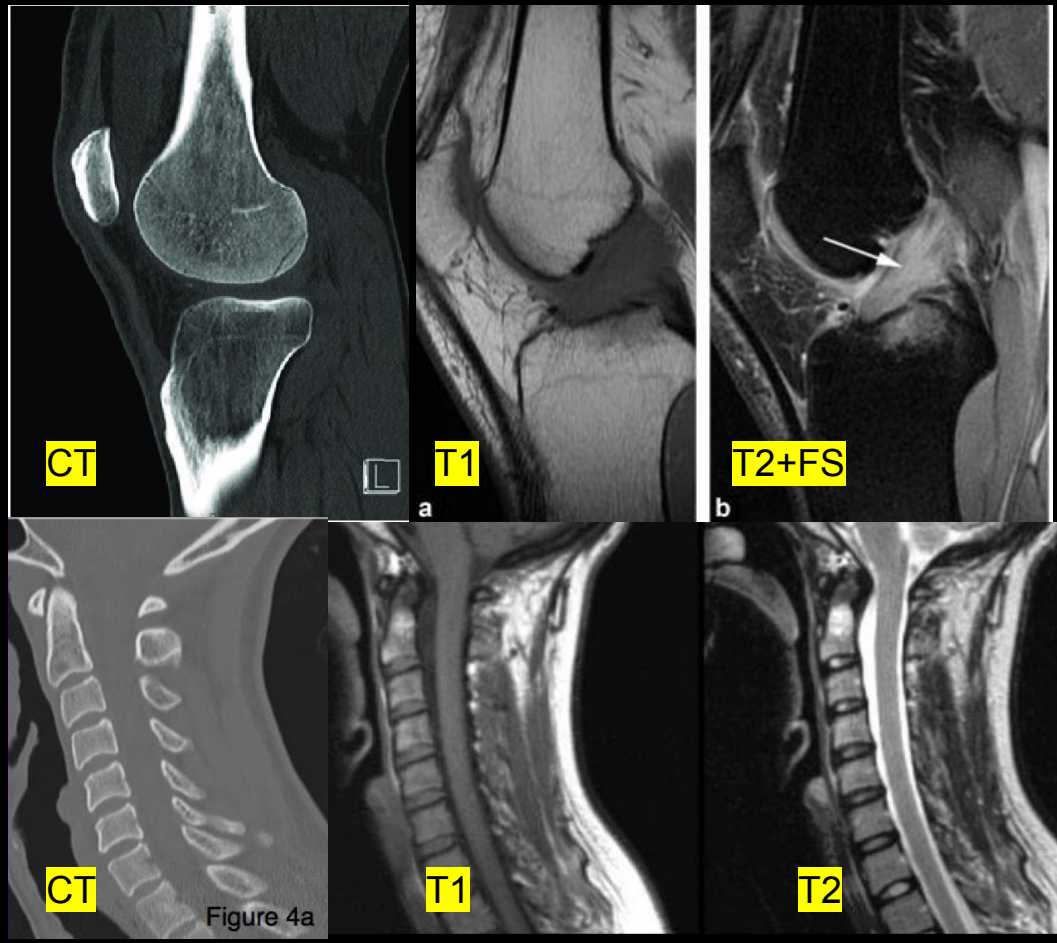
Approaching the Advanced Imaging - MRI/ CT

1. What scan is this?
   a. If MRI scan, what sequence?
      - T1 - only Fat is “white”
      - T2 - Both Fat + Water “White”
      - T2+ Fat suppressed = only Water is “white”
2. What view is this?
   a. Sagittal, Axial or Coronal?
3. What body part is this?
4. What is the abnormality?





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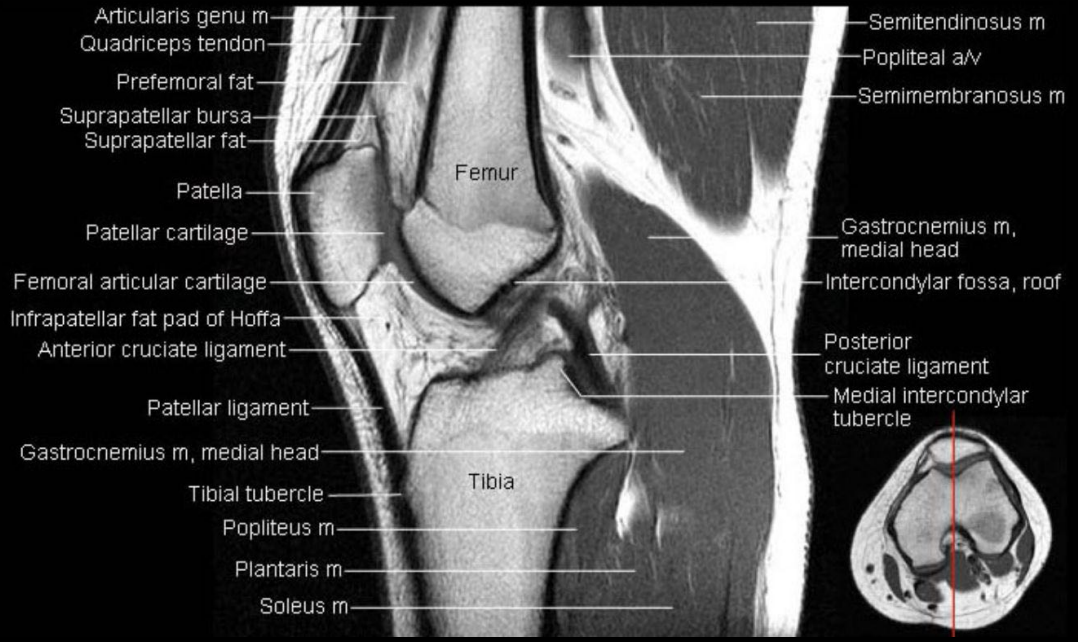
Resources

https://www.freitasrad.net/

MRI Resource: Freitasrad.net



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Maximising our Time!

- Post Lecture Quiz for OMS Radio Part 3 = Advanced Imaging
- https://docs.google.com/forms/d/e/1FAIpQLSeklaxzAoj-GDjeIzP8GnlmDdHkqdMVtqEM7ea6ruq5CBQrYw/viewform?usp=sf_link

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Goals in our 3- Part Lecture Series

- Part 1 - Normal XR
  - Review of normal XRs
  - Understand the key principles in ordering XRs
- Part 2 - Abnormal XR
  - Approach to reading common XR - Vocab training
  - Application to Trauma - Fractures
  - Application to Trauma - Dislocations
  - Application to Arthritis
- Part 3 - Abnormal XR + Advanced Imaging
  - Application to Tumor
  - Application to Misc. - Osteomyelitis, Charcot
  - **Advanced Imaging - CT and MRI scans**
    - Basic Principles
    - Ordering of Advanced Imaging
    - Approach to Reading Advanced Imaging

Maximise the next few weeks!

- Revise Physical Examination skills - watch and practise on one another again and again.
- Refine your own sequence/ technique

Ortho Made Simple - Physical Examination of the Knee

Updated 4/11/22

1. Inspection	2. Special Tests I	3. Range of Motion	4. Palpation

• Expose, on Standing
  • Front - Varus/ Valgus/ Scars, Patella squint
  • Side - Flexion deformities
  • Back - Popliteal swelling
• On Walking (Gait)
  • Comment on presence/ use of walking aid
  • Type of gait e.g., varus thrust, antalgic
	• On Sitting at edge of bed
	  • J-sign (individually)
	  • Crepitus
	• On lying Supine
	  • Temp/ Warmth
	  • Fluid bulge test (only do cross fluctuance and patellar tap if positive)
	  • Patella OA tests - Medial and lateral facet pain, Patella grind, *Clark's Test (optional)*
	  • Apprehension test
		• Self Active SLR first - look at side for flexion deformity
		  • If not full extension, extend passively
		  • If still cannot extend fully = "Fixed Flexion Deformity" (FFD)
		  • If can extend fully passively = "extension lag"
		• Check Flexion
		• At the end of flexing knee, do Hip IR and ER, comment hip screen no pain
			• Put knees back to 90 deg on couch
			• Look from side - comment on posterior sag
			• Sit on feet
			• Then palpate knee systematically
			  • Tibial Tuberosity → Patellar tendon → Patella → Superior Pole → Medial and Lateral joint Line → Gerdy's Tubercle → Fibula Head

5. Power	**6. Special Tests II**	**7. Neurovascular**	**8. Complete/ Offer**

• NIL	• Knees still bent
	  • Medial tibial step off
	  • Posterior Drawer Test
	  • Anterior Drawer Test
	• Extend Leg
	  • Lachman at 30 deg
	  • MCL at 0 and 30 degrees
	  • LCL at 0 and 30 deg
	• If ACL/ PCL tests positive (Postgrad)
	  • Recurvatum Test
	  • Turn Prone for Dial Test
		• DP and PT pulses
		• Ask patient to dorsiflex foot against you - "no foot drop"
			• Hip examination

OMS Physical Examination

What you see here is my own synthesis of the various physical examinations for my own Exams. You will definitely see variations among surgeons. Feel free to modify and come up with your own sequence! 😊

- OMS PE Summaries Compiled
- OMS Shoulder Examination
- OMS Elbow Examination
- OMS Knee Examination
- OMS Hip Examination
- OMS Cervical Spine Examination
- OMS Lumbar Spine Examination
- OMS Hand Examination

Knee - Physical Examination Explanation

www.youtube.com

Knee - Physical Examination Run-Through