

MUSCULOSKELETAL X-RAY WORKSHOP

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Musculoskeletal X-Ray Workshop Disclosure

- Neither I, Paul Cleland, MD, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.
- Neither I, Andrew Porter, DO, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.

Musculoskeletal X-Ray Workshop

- Wrist & Shoulder - Paul Cleland, MD
- Knee & Hip – Andrew Porter, DO
- Ankle - Paul Cleland, MD
- Elbow – Andrew Porter, DO

Wrist – PA View





Wrist – Oblique View



Wrist – Lateral View



Case

- 10 yo M presents after a FOOSH injury with swelling and pain at the wrist

Distal Radius Torus/Buckle Fracture



Distal Radius Greenstick Fracture



Torus/Greenstick Fracture

- Torus
 - Axial force causing compression fracture
 - Removable splint/cast for 2-4 weeks; remove when pain-free
 - Repeat XR 4 weeks
 - May protect for additional 2 weeks during activity
- Greenstick
 - Bending force
 - Volar surface usually broken, periosteum keeps other surface intact
 - Sugar tong splint followed by SAC/LAC for 4 weeks
 - Reduction:
 - If less than 9 yo: >20 deg dorsal angulation; >15 degrees lateral angulation
 - If 13 yo: >5 deg dorsal angulation; any lateral angulation

Case

- 16 yo M presents to the clinic after a FOOSH injury while skateboarding. His stated he felt a painful pop and his wrist is obviously swollen and deformed. He has normal pulses and sensation and he can move his fingers in all expected directions.



Distal Radius or Colles' Fracture

- Initial Treatment: Sugar Tong Splint
 - f/u 3-5 days
- Short arm cast 4-6 wks; LAC if displaced and reduced (6-8wks)
- Repeat XR q 2-4wks
- Reduction if:
 - >20 degrees dorsal angulation
 - Displacement >2/3 width of radius
 - >5 mm radial shortening or >5mm ulnar variance
- Refer if:
 - Severe Comminution
 - Intraarticular Extension
 - Inability to maintain reduction
 - NV compromise

Case

- 15 yo F presents to your clinic after a FOOSH injury to the L hand. She has tenderness and swelling over the anatomic snuff box.



Scaphoid Fracture



Scaphoid Fracture

- Unique Blood supply: Distal to proximal
- If suspected on XR but not confirmed: short-arm thumb spica and repeat XR 2 weeks, consider MRI
- Nondisplaced Fracture immobilization
 - Distal: 6 wks
 - Middle: 10-12 wks
 - Proximal: 12-20 wks
- Refer if:
 - Displaced
 - Non-union
 - Signs of AVN

Case

- 17 yo M presents to you after injury to his R hand. He admits to losing his temper and punching a wall. He has swelling, pain and a deformity over the ulnar side of his hand.



Boxer's Fracture (Metacarpal Head/Neck)

- Initial Treatment
 - Ulnar Gutter with wrist 30 deg extension, MCP 70-90 deg flexion
 - Immobilize 4-6 wks; avoid contact sports for another 4-6 weeks without protection
- Allowable Angulation:
 - 10-20-30-40 degrees for 2nd – 5th MC, respectively
 - Reduction attempt
- Refer if:
 - Displaced
 - Higher degrees of angulation (especially 2nd – 3rd)
 - Malrotation

Additional Views

- Scaphoid view
 - Wrist in 30 degrees of ulnar deviation
- Instability series
 - Fist clenched and the wrist in flexion, extension, and radial and ulnar deviation
- Carpal tunnel view
 - Better visualization of the **hook of the hamate**, pisiform, and trapezium.

Carpal Tunnel View



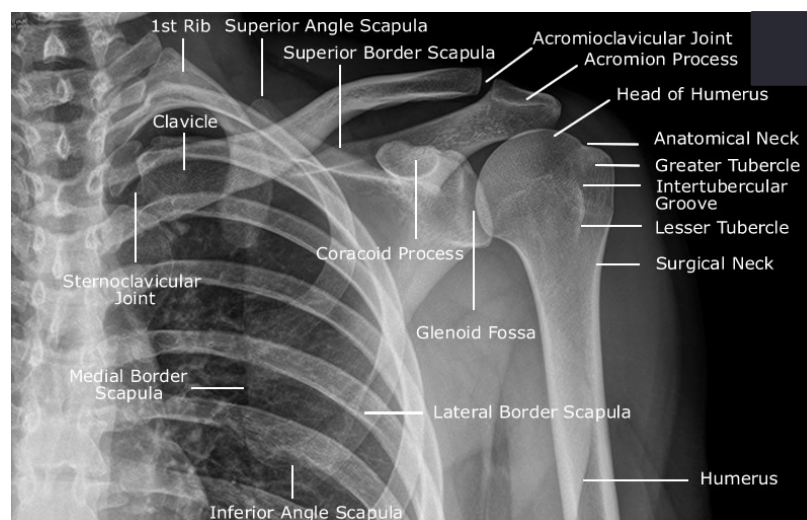
Shoulder X-rays & Cases

- AP Shoulder View
- True AP (Grashey) Shoulder View
- Axillary Shoulder View
- Scapula Y Shoulder View

AP Shoulder View



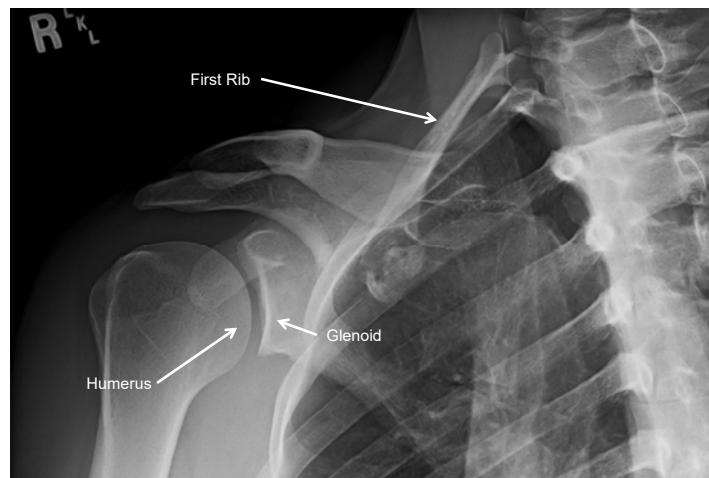
AP Shoulder View



True AP (Grashey) Shoulder View



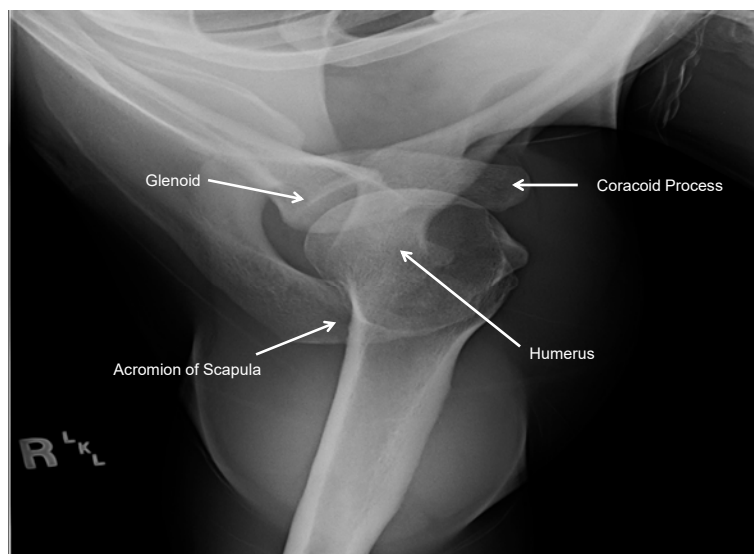
True AP (Grashey) Shoulder View



Axillary Shoulder View



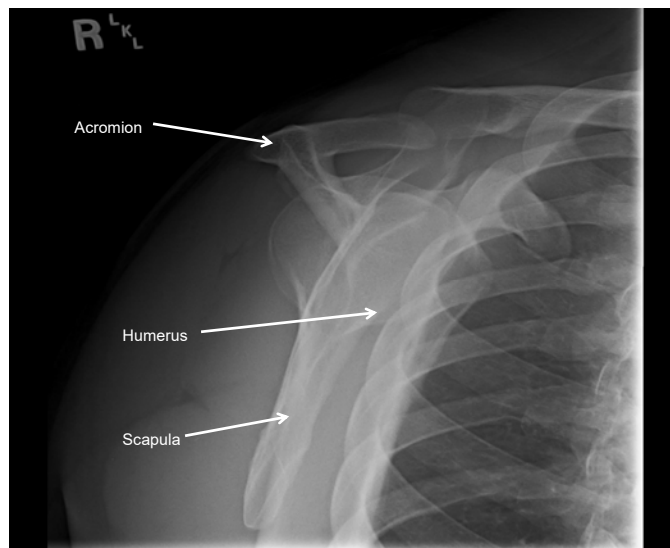
Axillary Shoulder View



Scapula Y Shoulder View

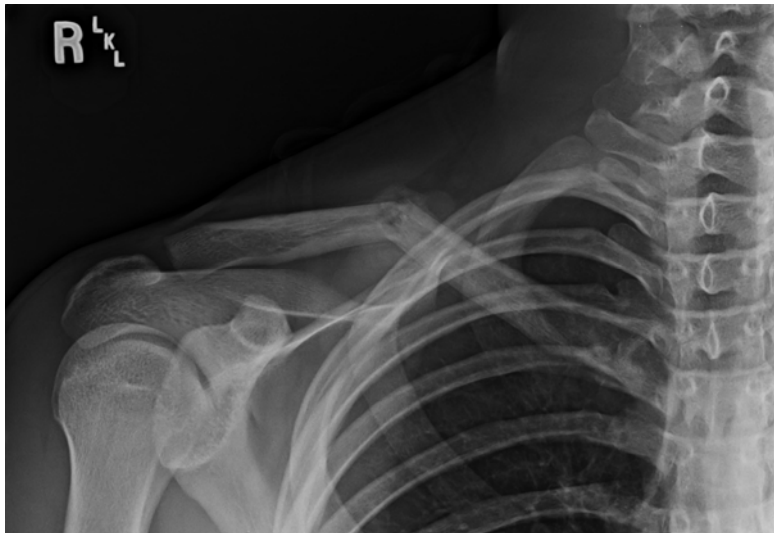


Scapular Y Shoulder View



Case

- 15 y/o football player was tackled, fell on his right shoulder. He felt a pop and had immediate pain in his right shoulder. He is swollen and tender over his clavicle.

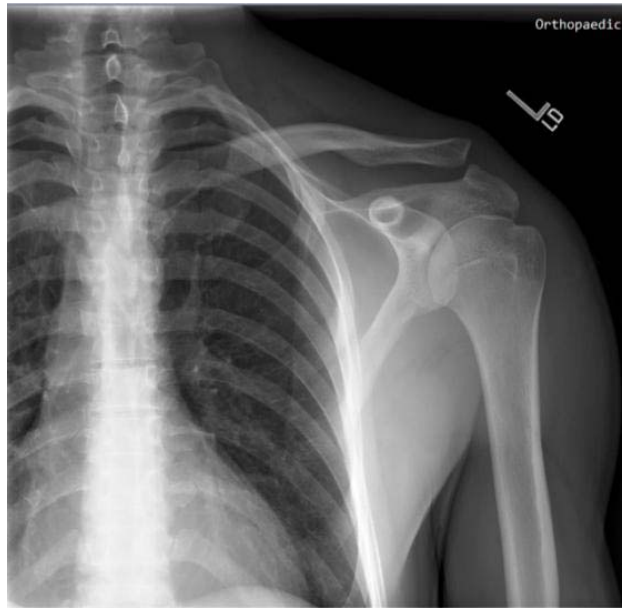


Clavicle Fractures

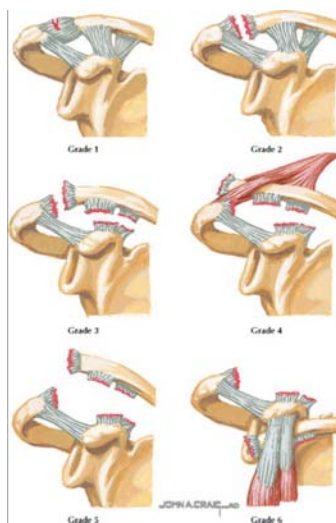
- Middle 1/3:
 - Initial Treatment
 - Figure of 8 or Arm sling 3-6 weeks in children or until nontender
 - Avoid contact sports for 1-2 months after clinical/radiographic healing
 - Refer if:
 - Displacement >1 bone width, significant shortening, severe comminution
 - Skin tenting, open
- Distal 1/3:
 - Type 1 and 3: conservative
 - Type 2: refer to ortho

Case

- 14 yo M tackled while carrying the football and states that he landed directly on the L shoulder. Now has pain at the shoulder and tenderness over his AC joint.



AC Separation



AC Separation/Sprain

- May use weighted XR view and compare to contralateral side
- Types 1 and 2:
 - RICE, Sling, PT
 - RTP when minimal pain, full strength and ROM
 - Injection +/-
- Type 3:
 - Same as above but controversial
 - Refer if concerned about cosmesis
- Types 4-6:
 - Refer

Case

- 12 yo M presents to your office for R Shoulder pain for the last 2-3 week. He is a RHD pitcher for his youth team and has been very active playing baseball this summer. It has gotten progressively worse with activity to the point that he can no longer throw and has with palpation.

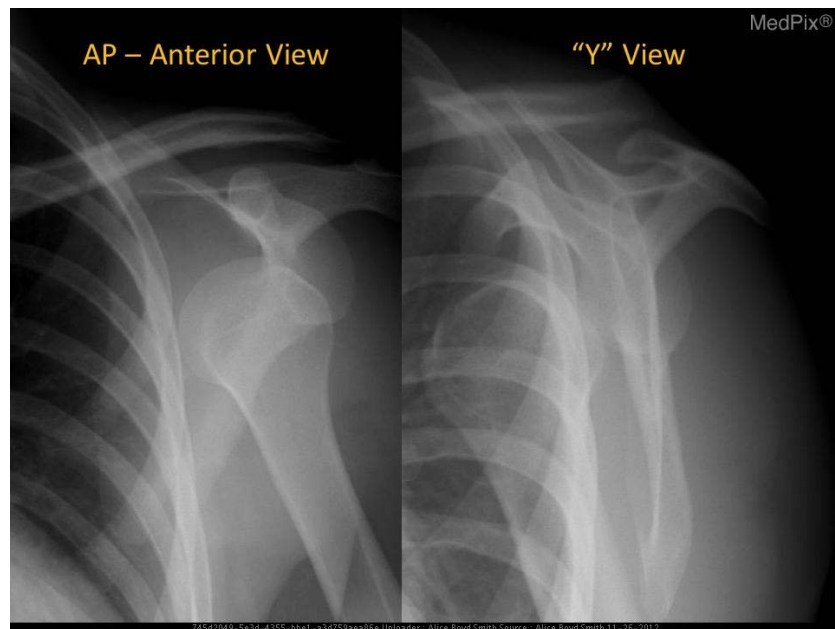


Little League Shoulder

- Overuse Injury to Proximal Humeral Physis
- Risk factors:
 - Year round pitching without at least 3 mo's of rest
 - Exceeding pitch counts and inadequate rest between games
 - Throwing mechanics
- Management
 - Cessation of all throwing for 3 mos
 - PT when pain-free
 - Throwing progression prior to return
- Repeat XR may take 12 mo's to return to normal

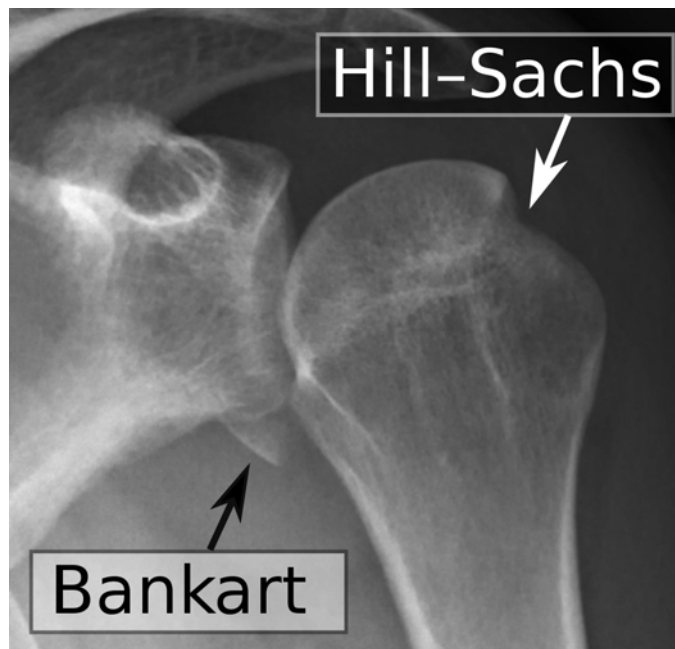
Case

- 15 yo M presents to the ER for shoulder injury while playing football. He reached to tackle another player with an outstretched arm and felt a loud pop. He is in severe pain and has a deformed appearing shoulder.



Shoulder Dislocation

- Anterior dislocation is most common
- Attempted reduction ASAP – many techniques available
 - May have to perform with conscious sedation if out for too long
- 90-95% chance of reoccurrence if continuing same activity
- MRI if concerned about labrum or RC injury
 - Arthrogram w/ ABER view
- Management
 - Sling for comfort
 - PT for protected ROM and RC/SCT strengthening
 - Refer if Bankart or Hill-Sachs



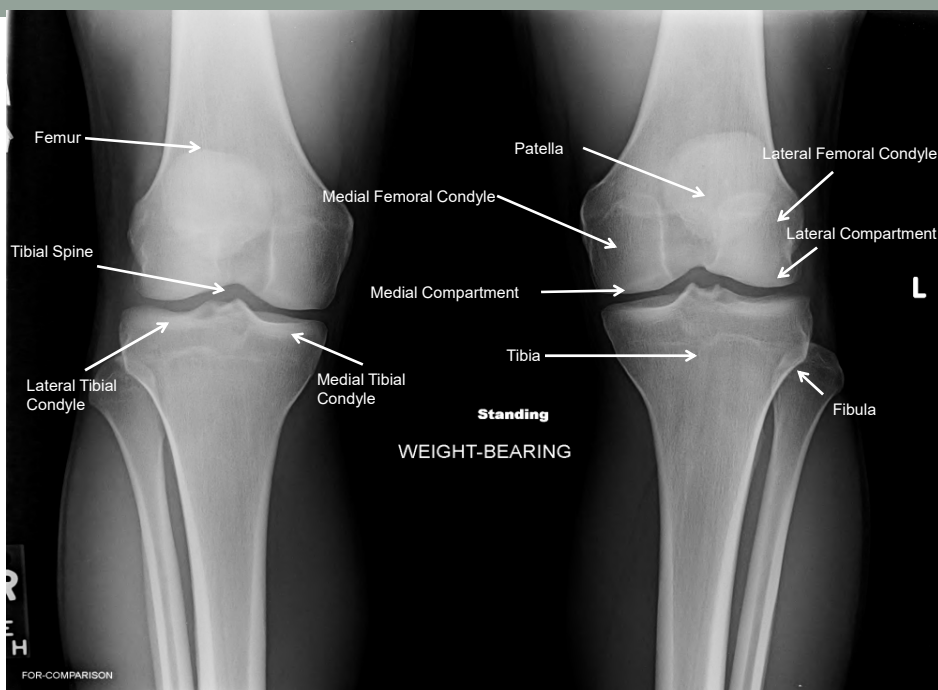
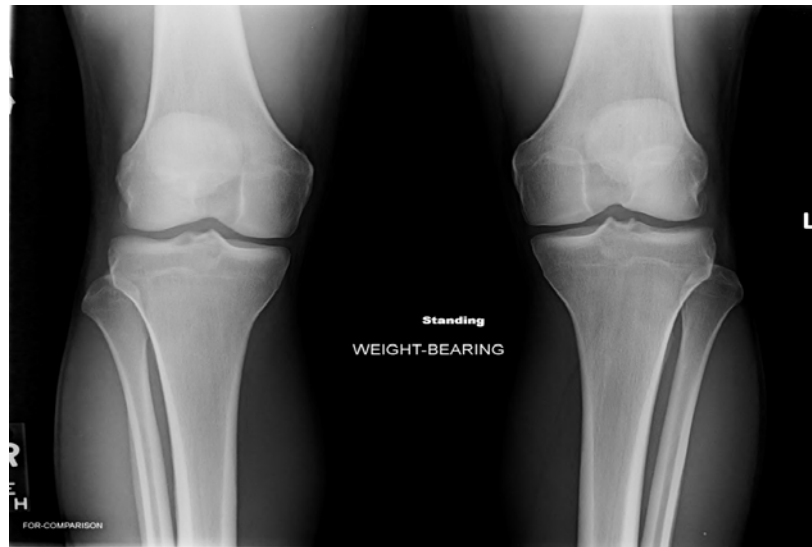
Knee X-Rays & Cases

- B/L Weightbearing AP
- B/L Weightbearing Bent Knee
- Lateral
- B/L Sunrise

B/L Weightbearing AP View



B/L Weightbearing AP View



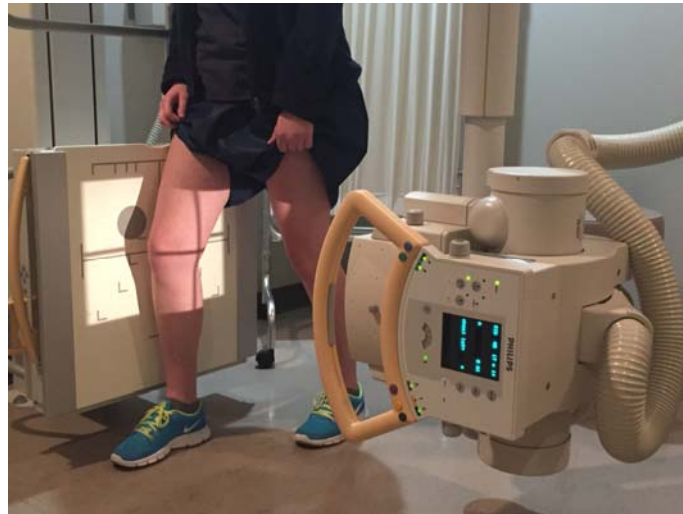
B/L Weightbearing Bent Knee View



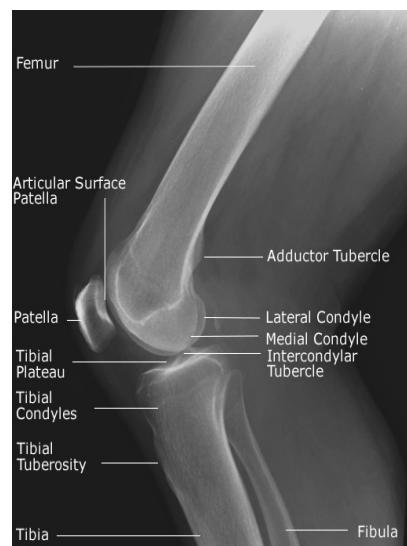
B/L Weightbearing Bent Knee View



Lateral Knee View



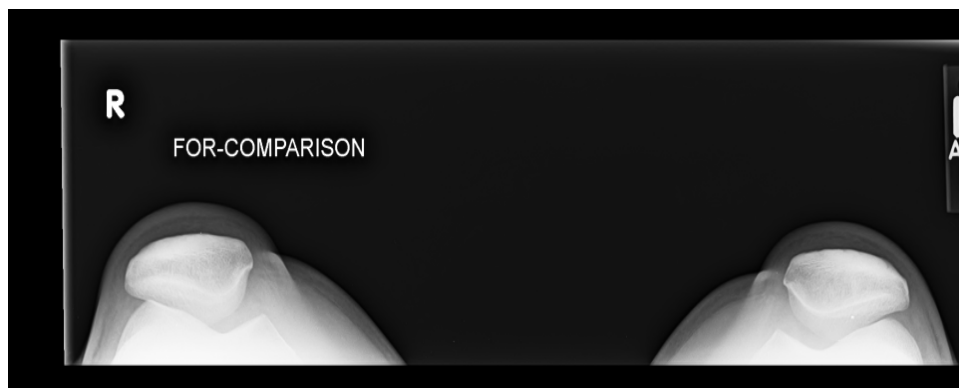
Lateral Knee View



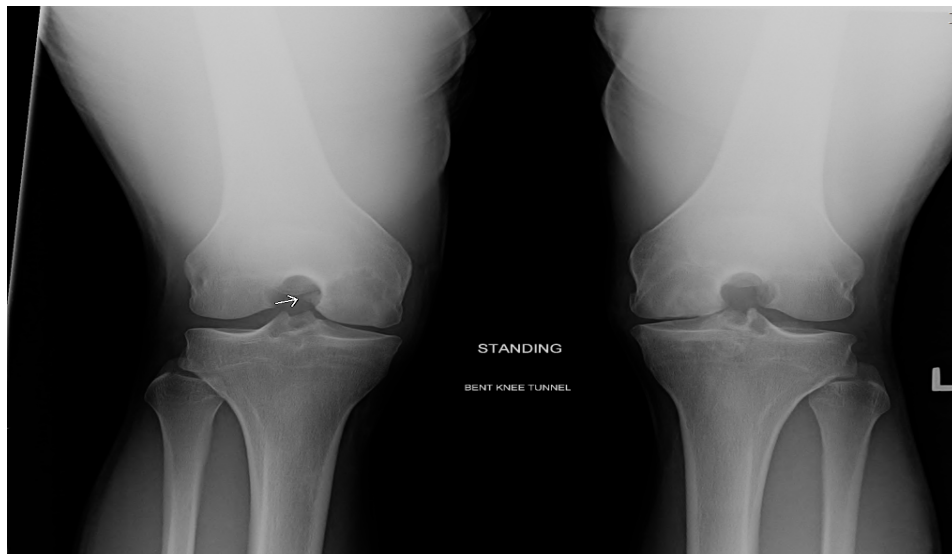
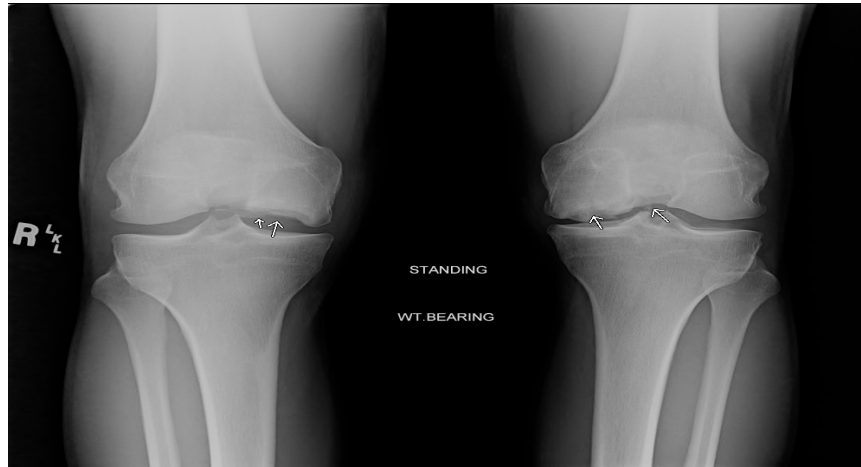
B/L Sunrise View

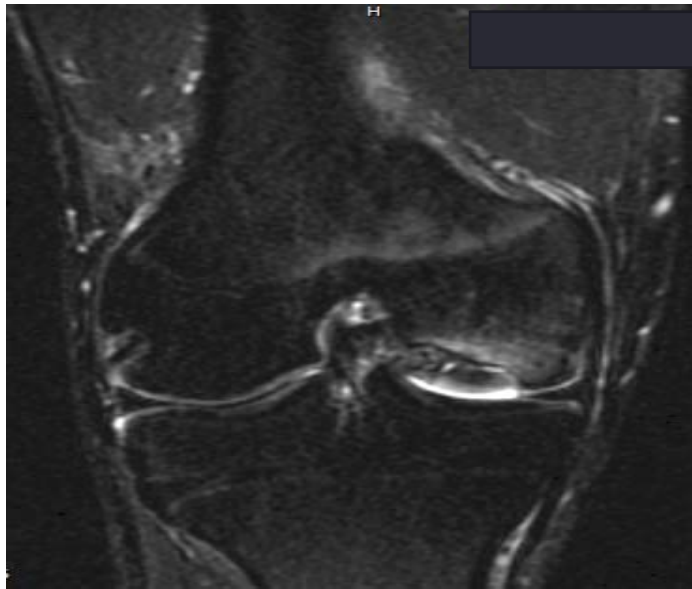


B/L Sunrise View

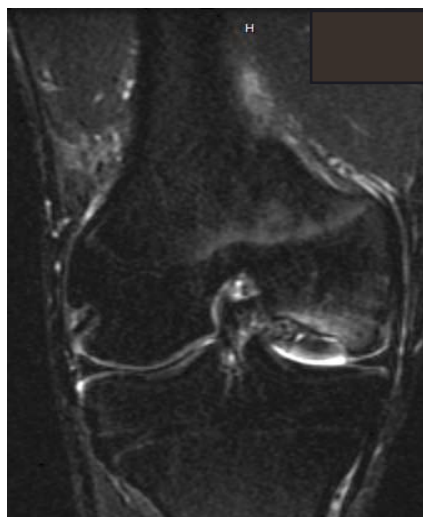


18 year old College Wrestler. Developed right knee pain after wrestling. + Effusion. + Mechanical sx's.





Grade 4 OCD Medial Femoral Condyle



Osteochondral Defect (OCD) Classification

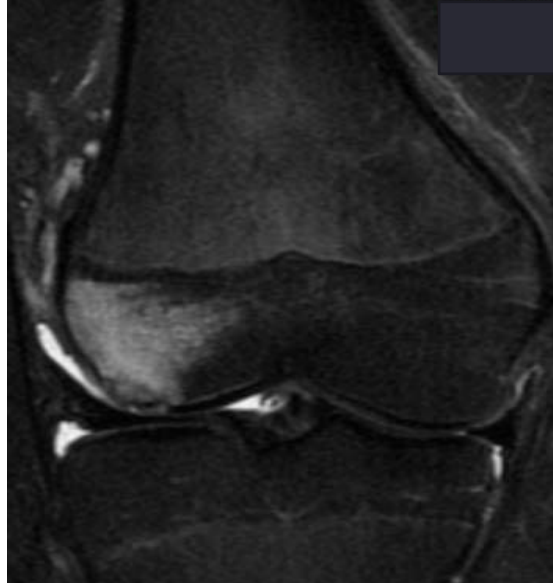
Stage	Plain X-ray findings	MRI Findings
1	Depressed osteochondral fragment	Articular cartilage thickening & low signal changes in subchondral bone
2	Osteochondral fragment attached by bone	Articular cartilage breached, No synovial fluid around fragment
3	Detached non-displaced fragment	Articular cartilage breached, synovial fluid around fragment
4	Displaced fragment	Loose foreign body

Berndt AL, Harty M. Transchondral fractures (osteochondritis dissecans) of the talus. J Bone Joint Surg Am. 1959;41-A:988.
Dipaola JD, Nelson DW, Colville MR. Characterizing osteochondral lesions by magnetic resonance imaging. Arthroscopy 1991; 7:101.

16 year old high school football player with right knee pain after getting hit by helmet in practice. Mild effusion. No mechanical sx's.



Pain did not improve with rest & Prednisone. MRI was completed



Subchondral impaction fracture of the lateral femoral condyle



17 year old high school wrestler with anterior knee pain. No effusion. + Clark's.



Patella Femoral Pain Syndrome

- Acetaminophen or NSAIDs for pain control
- Treatment targets the biomechanical factors that cause PFPS. Most patients improve with activity modification, footwear evaluation, ice after activity, and rehabilitation therapy
- VMO strengthening, VLO and IT band flexibility, core strengthening, pelvic stabilization, gluteus medius strengthening, hamstring stretching, shoe orthotics for those with pes planus and footwear replacement are commonly indicated

Patella Femoral Pain Syndrome

- In a randomized controlled trial, a combination of daily patellar taping and exercise was superior to exercise alone
- A patellar stabilizing brace may be useful, although bracing has not been shown to be significantly superior to non-bracing treatment
- If symptoms persist after at least 6-12 months of adequate conservative therapy, surgery may be considered
- Surgical treatments include lateral retinaculum release, VMO advancement, and realignment procedures

12 year old male soccer player. Insidious onset of anterior knee pain at tibial tubercle.
No effusion. No mechanical sx's.



Osgood Schlatter's



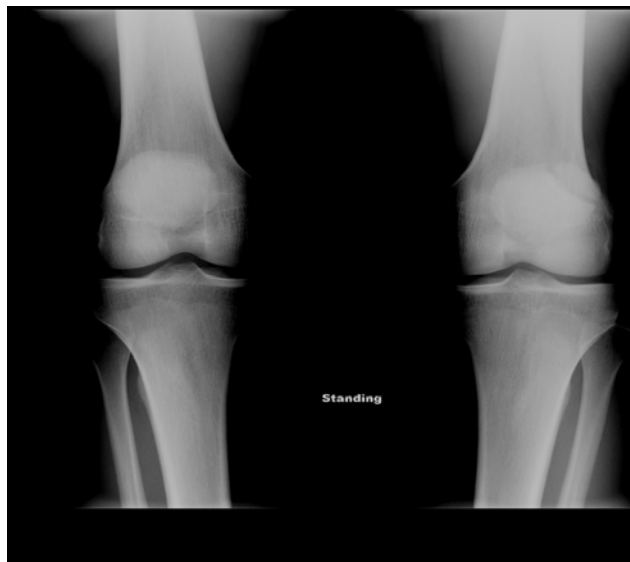
17 year old male with left knee pain. Insidious onset.
No effusion.

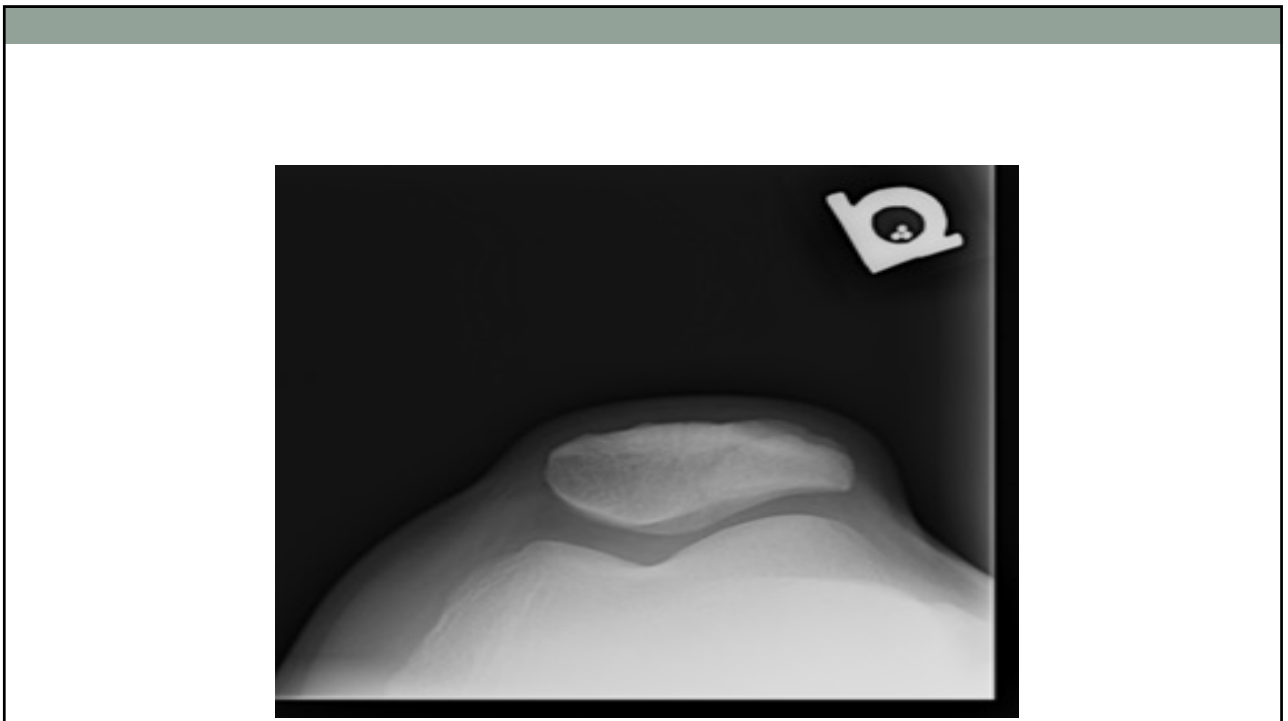


Tibia Osteochondroma

- Often an incidental finding
- Developmental dysplasia of peripheral growth plate which forms a cartilage capped projection of bone found near metaphyses of long bones
- Risk of sarcomatous transformation in solitary exostosis is about 1%

18 year old male with left knee pain. Pain is superior lateral patella. Insidious onset. No effusion.





Bipartite Patella

- A common congenital fragmentation or synchondrosis of the patella
- Occurs in approximately 1% of the population
- Classification: Type 1– inferior pole
Type 2– lateral margin
Type 3– superolateral type
- Direct trauma may disrupt the synchondrosis causing symptoms that mimic fracture
- Displacement or chronic pain requires surgical removal of fragment

Hip X-Rays & Cases

- **AP pelvis** (coccyx 1 cm above pubis without rotation) and **frog leg or cross-table laterals**
- False profile for ASIS or AIIIS avulsion fractures
- Dunn, 45 or 90 deg, for Cam-type FAI variant

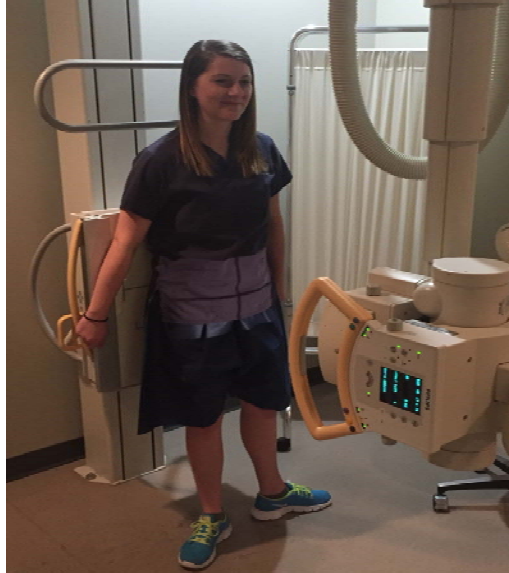
AP Pelvis View



Frog Leg Lateral Hip View



False Profile Hip View



90 Degree Hip View



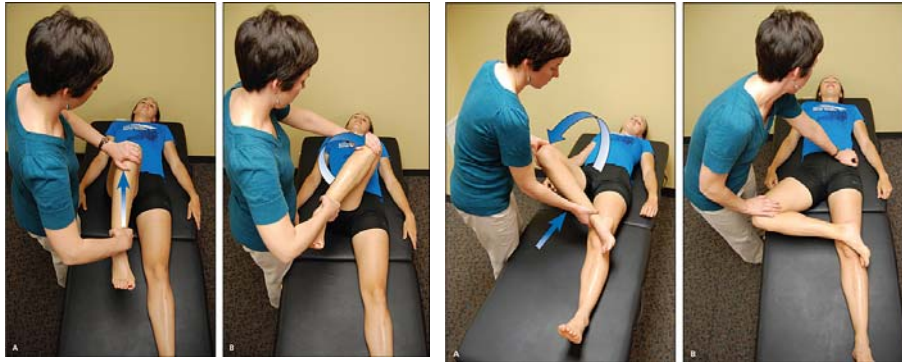
45 Degree Dunn View

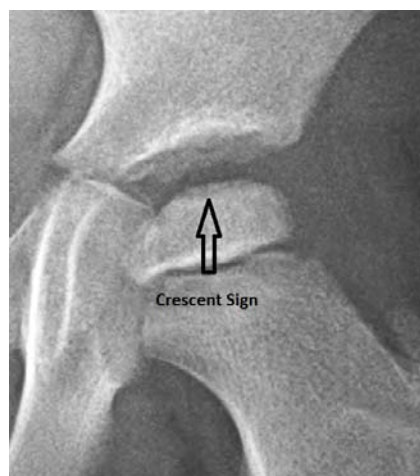


5 yo F, 1-2 months of left hip pain, limping,
no history of fever/chills

- Vitals normal
- Difficulty bearing weight on left side, FADIR +, FABER +, log roll +

FADIR vs FABER





Legg Calve Perthes
(LCP)

13 yo M, obese, 2 months of bilateral hip pain and knee pain, walks with limp

- Laying on exam table with hips flexed, externally rotated
- FADIR, FABER, log roll all positive





Slipped Capital Femoral Epiphysis
(SCFE)

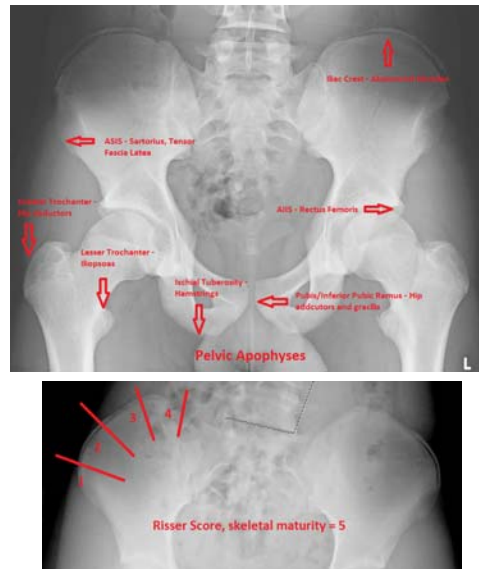
16 yo M soccer player, felt pop in right hip
when he kicked the ball at the same time
as his opponent

- Pain medication not helpful
- Hip flexed on exam table
- ROM/Strength limited by pain



AIIS Avulsion
Fracture

Hip Apophyses

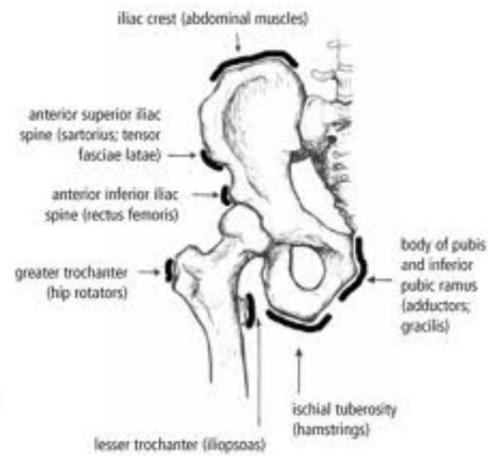


Apophysitis

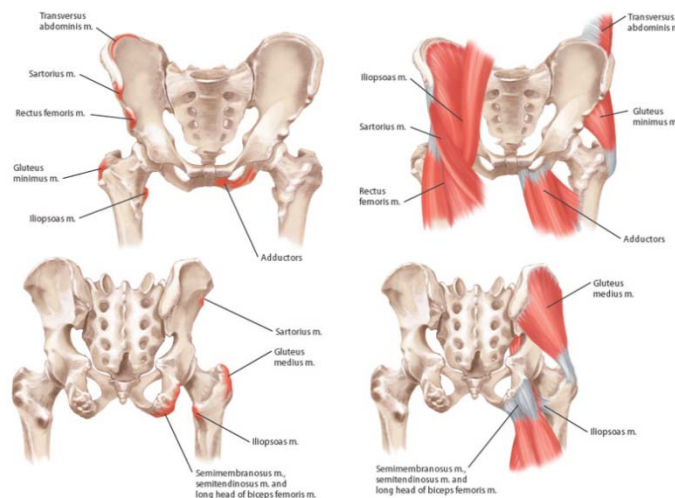
- Apophysis – site of tendon attachment prior to skeletal maturity
- Apophysitis – inflammation from repetitive microtrauma from traction by tendon
- Avulsion – traumatic contraction of tendon on apophysis
- Clinical diagnosis based on location of pain in an adolescent
- Hurts to stretch or contract
- XRs used to confirm widening to help with prognosis & RTP more than diagnosis

Apophyses

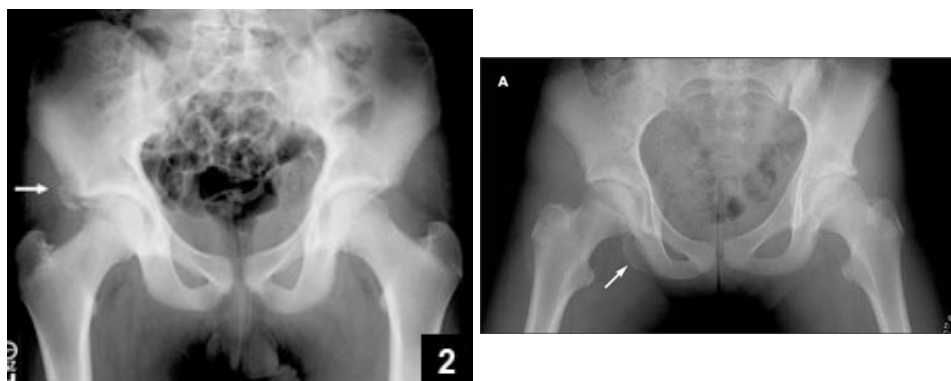
- Iliac Crest: abdominal (internal/external oblique and transversus abdominus)
- ASIS: sartorius
- AIIIS: rectus femoris
- Greater Trochanter: glut med/min
- Lesser Trochanter: iliopsoas
- Ischial Tuberosity: hamstring
- Inferior pubic ramus: adductors



Hip Apophyses



Pelvic Avulsions



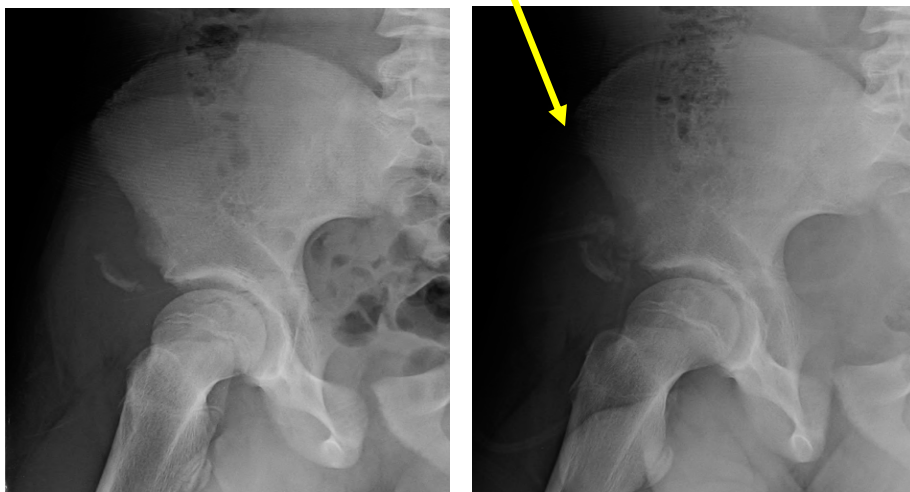
Treatment

- Avoid vigorous stretching
- **Relative** rest
- Crutches if needed
- NSAIDS/Prednisone ?
- RTP as long as no pain to stretch, good strength, and pass a functional progression without limping
- Risk is avulsion
- Hamstring Avulsions – trend to surgically fix now
- The rest should be treated conservatively
- Surgery if pain does not resolve, cosmetic reason, or >2 cm (in general)
- Manual Therapy, Tenotomy, Autologous Blood Injection (ABI) or Platelet Rich Plasma (PRP) prior to surgery

AIIS Avulsion Fx s/p treatment



AIIS Avulsion Fx s/p treatment



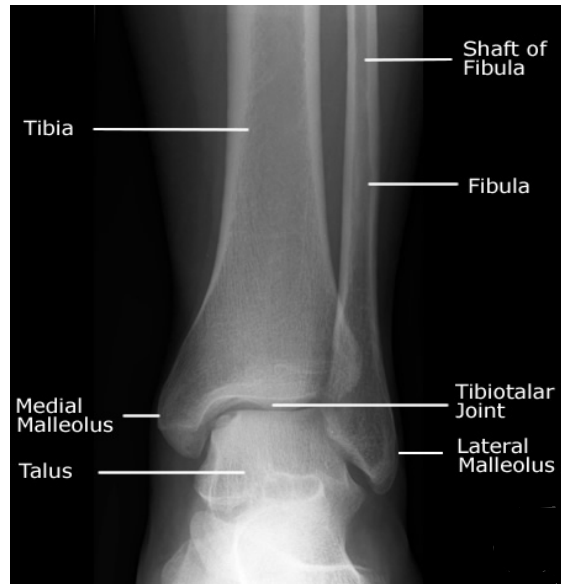
Ankle X-rays & Cases

- AP Ankle View
- Mortise Ankle View
- Lateral Ankle View
- Eversion Stress Ankle View

AP Ankle View



AP Ankle View



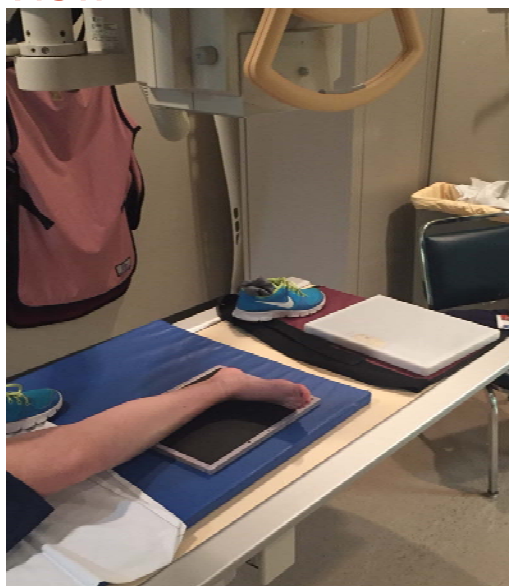
Mortise Ankle View



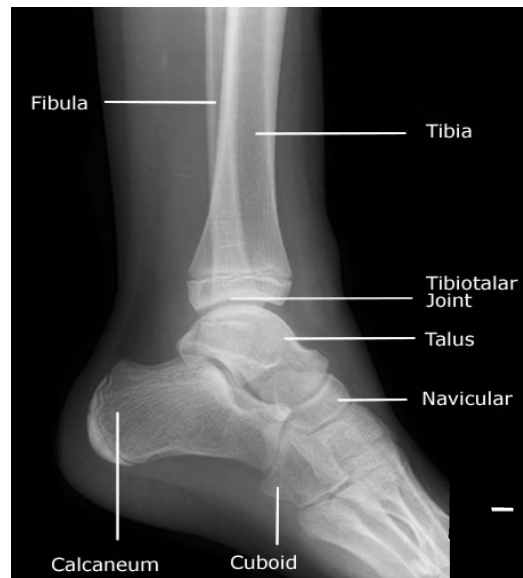
Mortise Ankle View



Lateral Ankle View



Lateral Ankle View



Eversion Stress Ankle View



Eversion Stress Ankle View Showing Instability



Inversion Stress Ankle View Showing Instability



Ankle XR

- Medial clear space
 - < 4mm
- Lateral Clear Space
 - Measured 1 cm above mortise
 - < 6mm
- Gravity Stress View is as good as Manual ER Stress
- Distal tibial and fibular physeal closure begins:
 - 12 yrs in F
 - 14 yrs in M

Case

- 8 yo F presents to the clinic after rolling her ankle while playing soccer. She reports pain and swelling around the distal fibula and is currently NWB with crutches due to pain.



Distal Fibula/Lateral Malleolus Fracture

- Management
 - Knowledge of SH system is useful because most pediatric fractures of the ankle involve the physis
 - SLC or WB for 4 wks for Type 1
 - SLC or WB for 6 wks for Type 2
 - Re-XR 2-4 wks and at 6 mo's to assess for growth arrest (2 years)
 - PT with ROM and exercises after immobilization
- Refer if:
 - Displaced SH Type 1-2
 - SH Type 3-5, Tillaux, Tri-malleolar

Ottawa Ankle Rules

- Bone tenderness at the posterior edge or tip of the lateral malleolus distal 6 cm
 - Bone tenderness at the posterior edge or tip of the medial malleolus distal 6 cm
- OR
- An inability to bear weight both immediately and in the emergency department for four steps
 - Bone tenderness at base of 5th MT or Navicular
-
- Very sensitive for fracture, not specific

Case

- 5 yo M presents to your clinic for worsening L foot pain and over the last month. Pain is located around the arch of the foot and the child has developed a limp.



Kohler's Disease

- Temporary avascular necrosis of the navicular
- Children 4-8 yo, male predominance
- Immobilization in cast or walking boot
- Tylenol or NSAIDs as needed for pain
- Usually self-limited

Case

- 15 yo F presents to the clinic for ankle pain. She states that she had an inversion ankle injury 3-4 weeks ago and has continued to have difficulty with WB. Swelling around the anterior and lateral ankle has subsided slightly since the injury. New development of occasional popping.



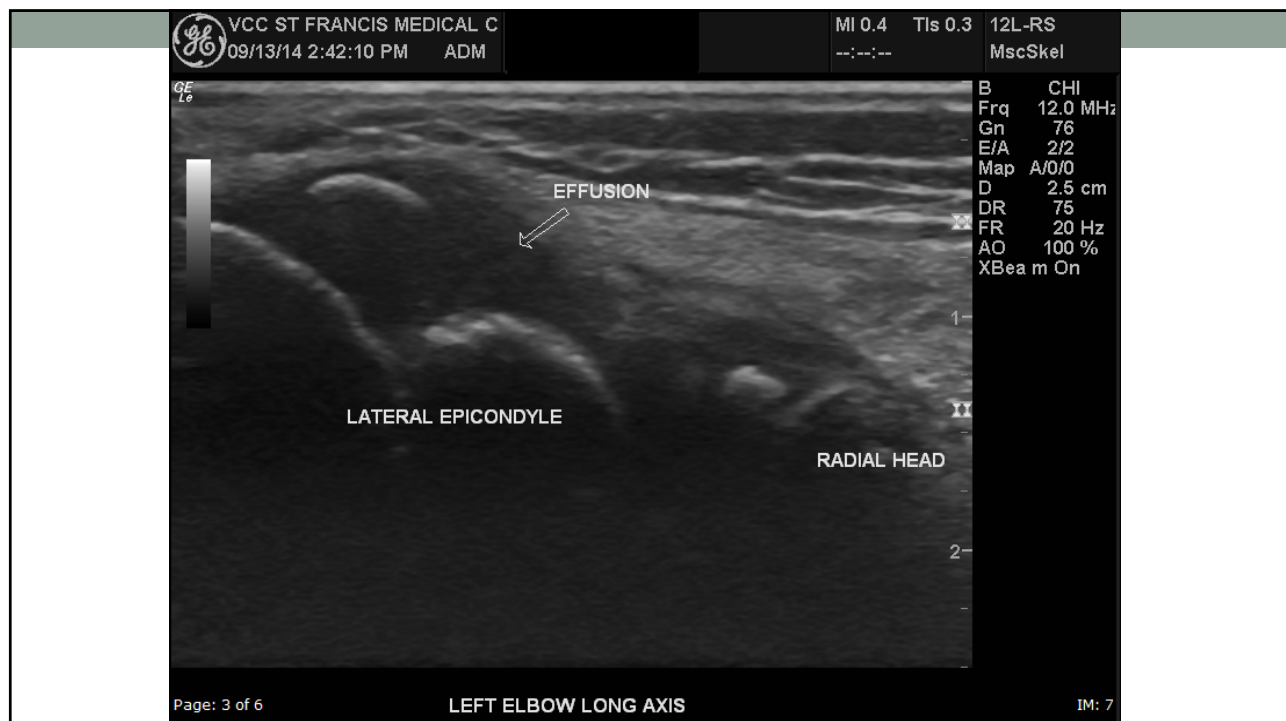


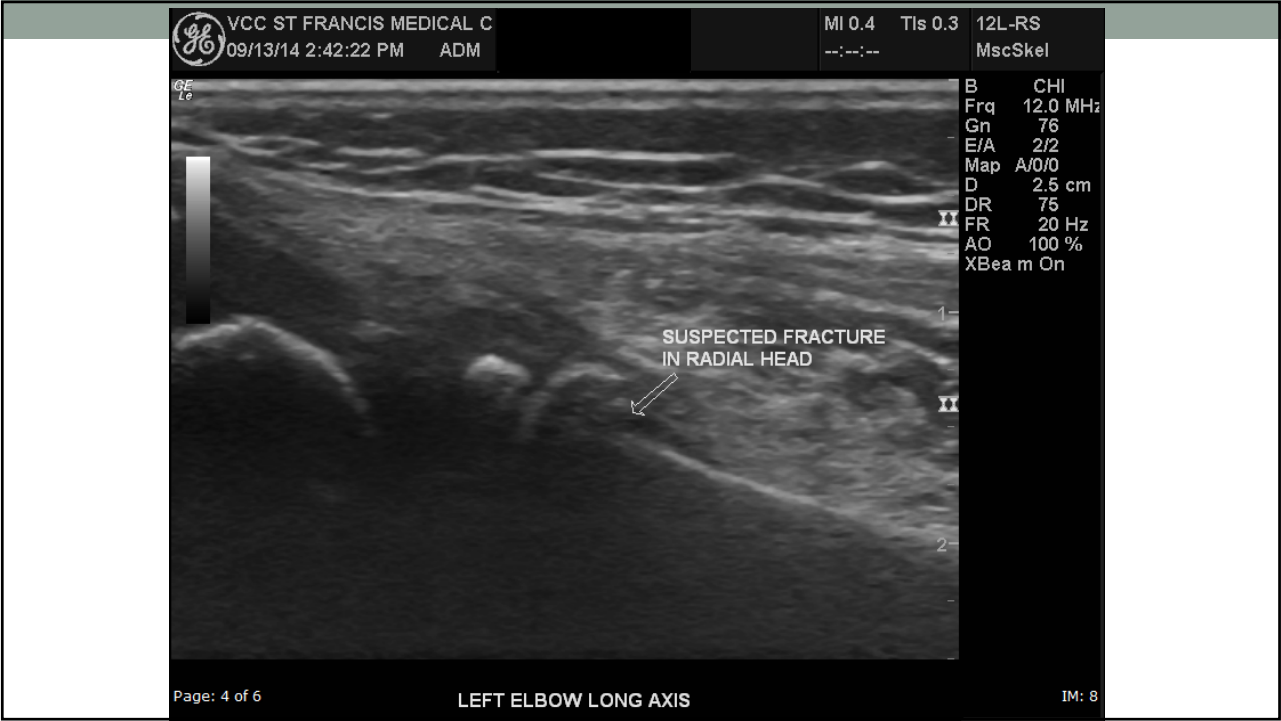
Talus Osteochondral Lesion (OCL)

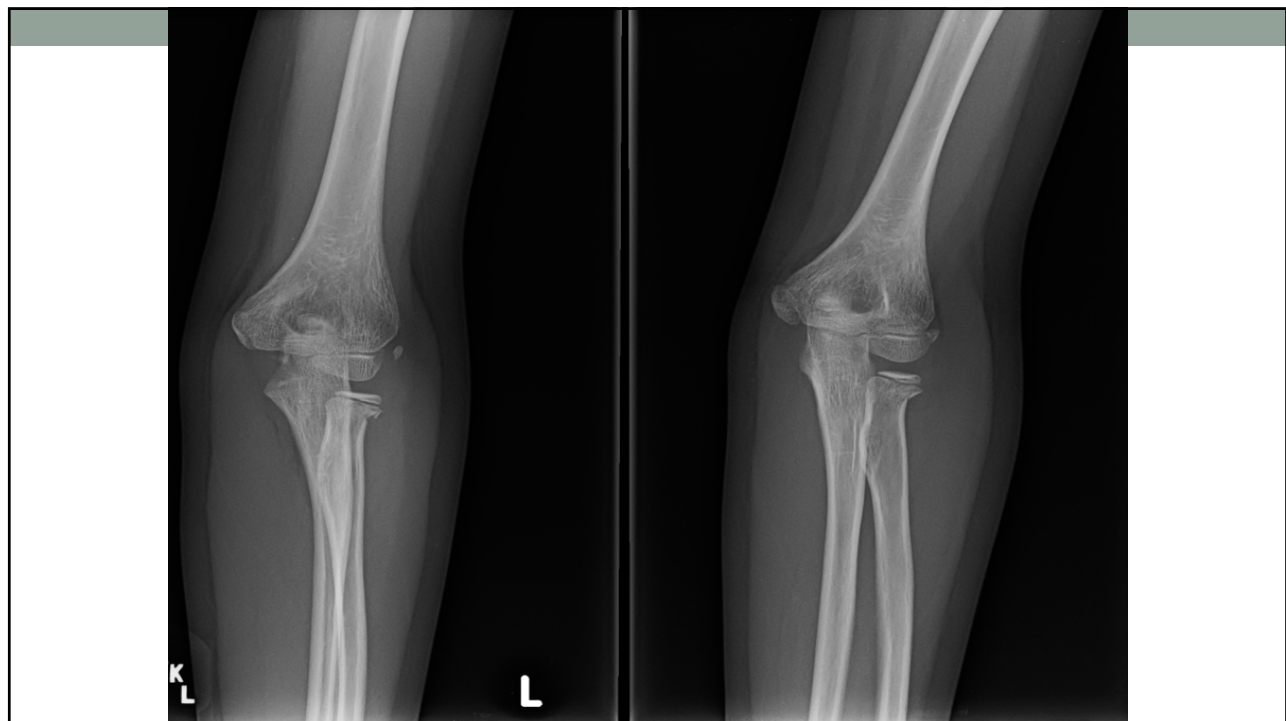
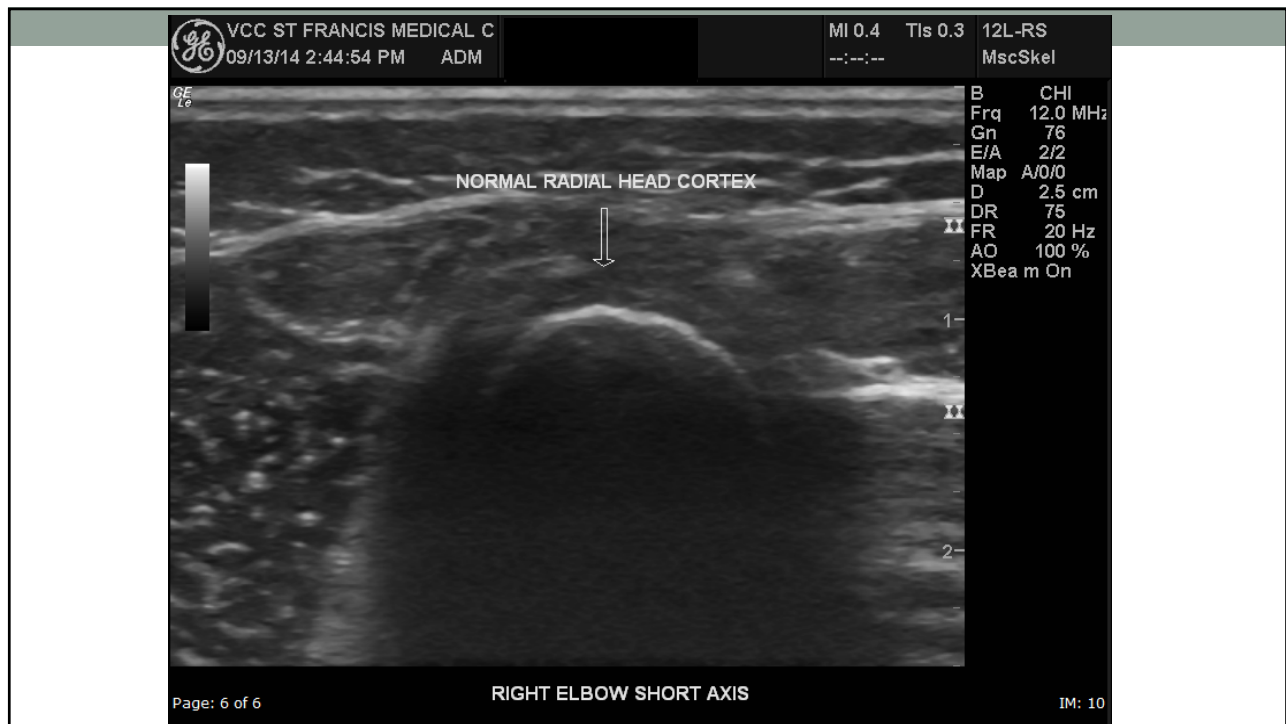
- Usually have a traumatic history
- Damage to cartilage and subchondral bone
- XR may be normal
 - MRI very useful for ankle sprains that do not heal in normal time
- History of chronic swelling and may develop mechanical sx of popping, clicking or catching
- NWB in SLC or WB for 6 weeks and PWB subsequently
- Referral to ortho if higher grade
 - Unstable appearing or loose fragment (Grade 3-4)
 - > 1cm
 - Chronic

9 year old female suffered a FOOSH injury while dancing

- Immediate pain in her left elbow with mild effusion

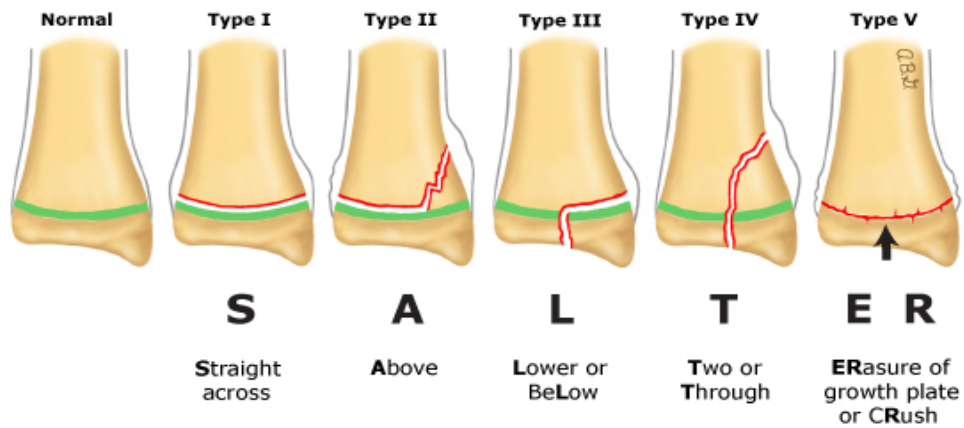












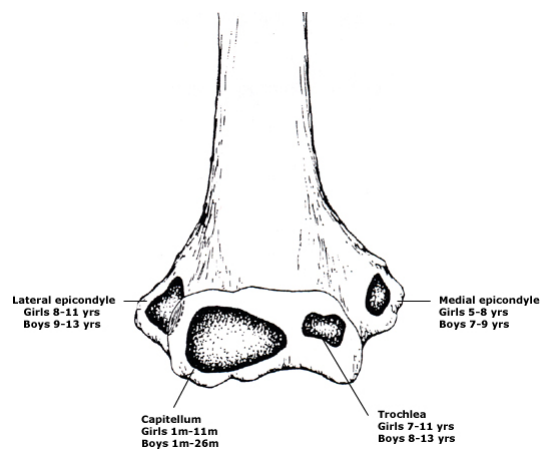
Diagnosis

- Left elbow radial head fracture, Salter Harris Type 2, adequate alignment for conservative care
 - <30 degrees of ulnar apex angulation and < 4 mm of translocation
 - Her fracture has 10 degrees of ulnar apex angulation and is 1 mm translocated

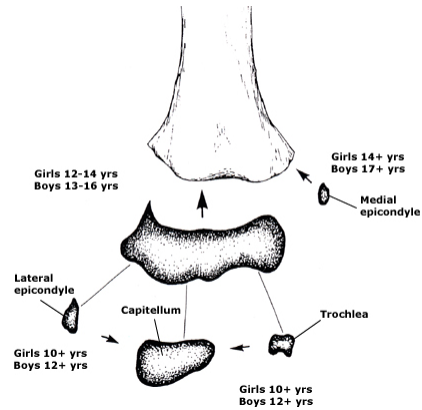
Elbow Growth Plates

Secondary ossification center	Girls	Boys
	Age (range) of appearance	
Capitellum	5 (1 - 11) months ~ 1 year	7 (1 - 26) months ~ 2 years
Radial head	4 (3 - 6) years ~ 3 years	5 (3 - 6) years ~ 4 years
Inner (medial epicondyle)	5 (5 - 8) years ~ 5 years	7 (7 - 9) years ~ 6 years
Trochlea	8 (7 - 11) years ~ 7 years	9 (8 - 13) years ~ 8 years
Olecranon	9 (8 - 10) years ~ 9 years	10 (8 - 11) years ~ 10 years
External (lateral epicondyle)	11 (8 - 11) years ~ 11 years	12 (9 - 13) years ~ 12 years
	Approximate age of fusion	
Trochlea	10 years	12 years
External (lateral epicondyle)	11 years	13 years
Capitellum	12 years	14 years
Olecranon	13 years	15 years
Radial head	14 years	16 years
Inner (medial epicondyle)	15 years	17 years

Elbow Secondary Ossification sites



Fusion of Elbow Ossification sites



Case Treatment

- Treatment
 - Elbow sling for next 1-2 weeks
 - Needs to sleep in sling during this time if able to
 - Expect full recovery to be 3-4 weeks
 - Come out of sling 3-4 times per day and work on gentle AROM of the elbow
 - Avoid NSAIDs as NSAIDs can slow bone healing. Acetaminophen as needed for pain
 - Recommended consuming 1200 mg Calcium + 800 IU Vitamin D daily through diet and supplement with OTC Caltrate + D as needed to help promote bone healing
 - May perform all activities as tolerated in the sling

4 weeks later



Resources

- <http://www.cmaj.ca/content/188/7/527>
- <https://radiopaedia.org/images/5806094>
- <https://www.physio-pedia.com/File:Colles-fracture.jpg>
- https://www.uptodate.com/contents/evaluation-of-wrist-pain-and-injury-in-children-and-adolescents?search=pediatric%20wrist%20pain&source=search_result&selectedTitle=1~90&usage_type=default&display_rank=1#H24
- <https://www.orthobullets.com/foot-and-ankle/7034/osteochondral-lesions-of-the-talus>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4912125/>
- <https://www.orthobullets.com/shoulder-and-elbow/3056/little-leaguers-shoulder>
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THANK YOU

QUESTIONS?