Common Pediatric Orthopedic Injuries

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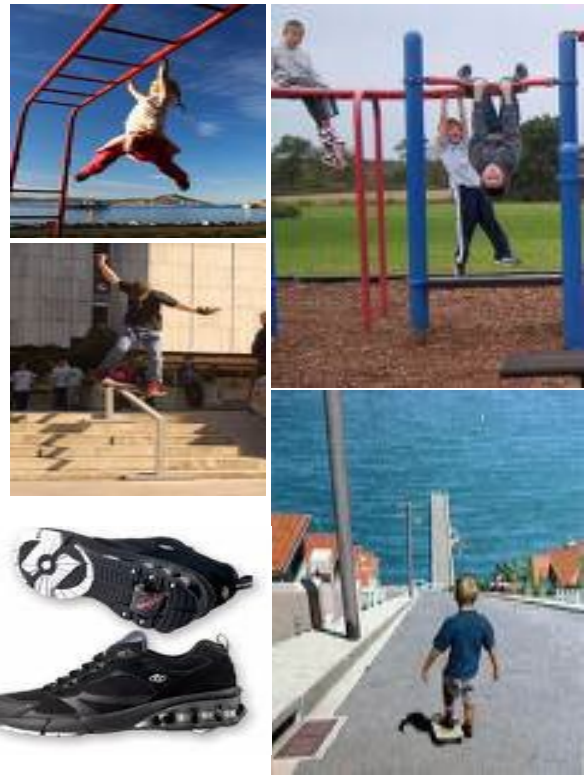
Objectives

- At the conclusion of this activity, participants should be able to identify the most common pediatric orthopedic injuries and describe their clinical presentation and treatment options.
- At the conclusion of this activity, participants should be able to explain the key physiologic differences between the pediatric and adult musculoskeletal systems and how these differences impact injury patterns and healing
- At the conclusion of this activity, participants should be able to recognize orthopedic injuries that are unique to the pediatric population and differentiate them from similar adult injuries
- At the conclusion of this activity, participants should be able to perform an initial evaluation and apply appropriate management strategies for common pediatric orthopedic injuries

Physiologic Differences in Child

- Periosteum thicker and stronger
- Bone more porous
- Higher incidence of plastic deformities
- Less ligament injury/ dislocation
- Remodeling is extensive
- 15% childhood fractures involve growth plate
- Radiographic evaluation more difficult due to growth plates
- Kids do stupid things!



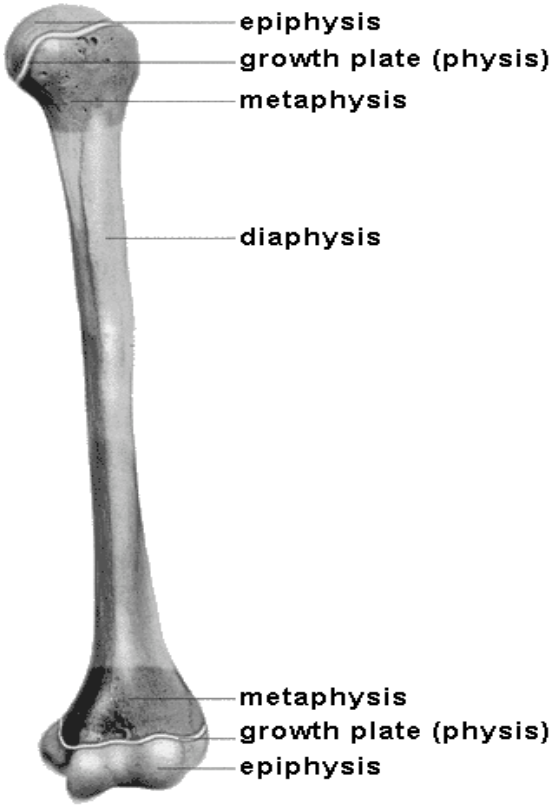
Pediatric MSK System

- Pediatric skeleton less densely calcified
  - Higher percentage of cartilage
- Bones are lighter and more porous
- More porous = more pliable →

  less strength → increase fractures
- Actively growing structure:
  - Long bones contain growth plates/physes
  - End of bones contain epiphysis
- Bones of child surrounded by thick and active periosteum
- Ligaments and periosteum stronger than bone itself

→ physis is weak link → **fractures more common than sprains**

- Response to trauma is age dependent

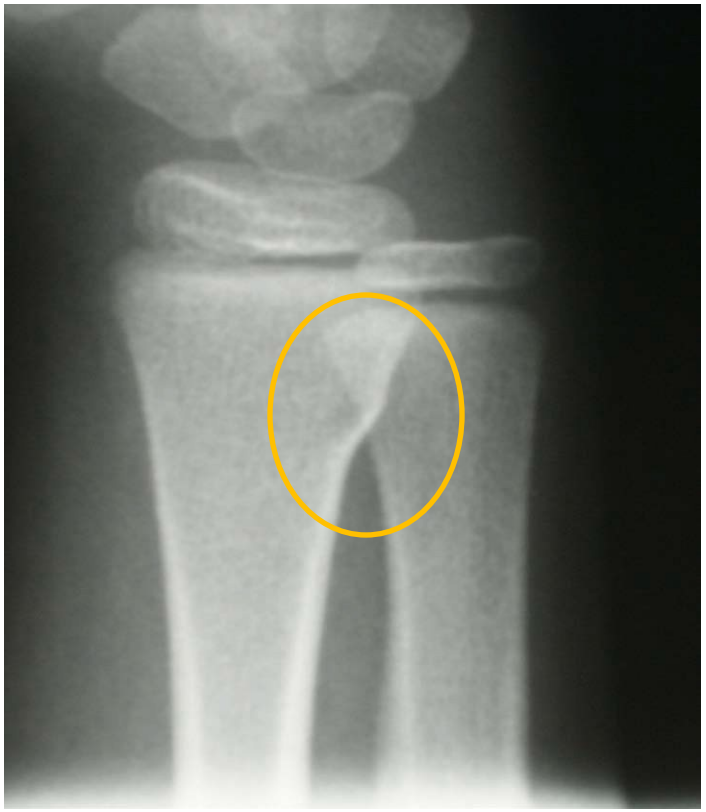


Uniquely Pediatric Fractures

- Physeal or Salter- Harris Fractures
- Plastic deformity fractures:
  - Buckle or torus fracture
  - Greenstick fracture
  - Bowing or bending fracture
- Avulsion fractures
- Toddler's Fracture

Buckle Fracture

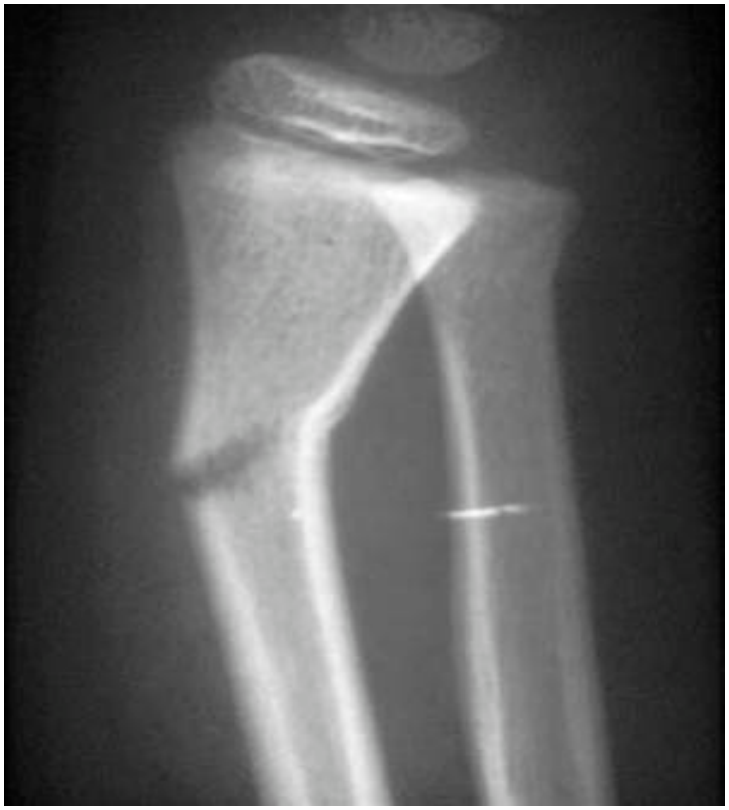
- Secondary to compression
- Usually metaphysis
- Stable fracture
- May be very subtle
- Quite common
- Requires splint and ortho follow up



Buckle Fracture

Greenstick Fracture

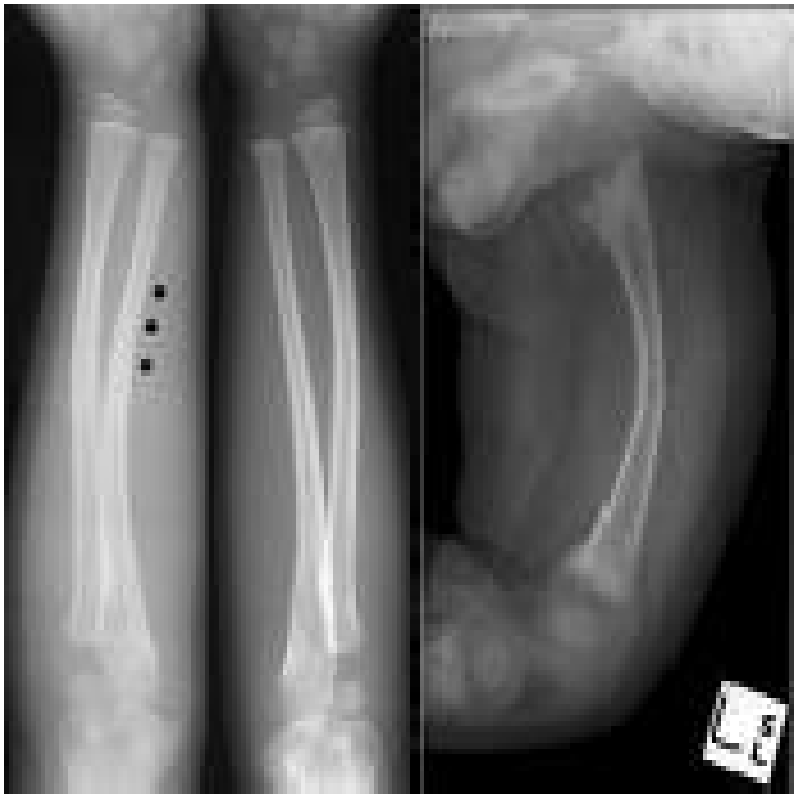
- Most common fracture pattern in children
- Incomplete fracture at metaphyseal- diaphyseal junction
- Angulation and rotation common
- 1 cortex remains intact
- Often must complete fx to achieve union



Greenstick and Bending Fx

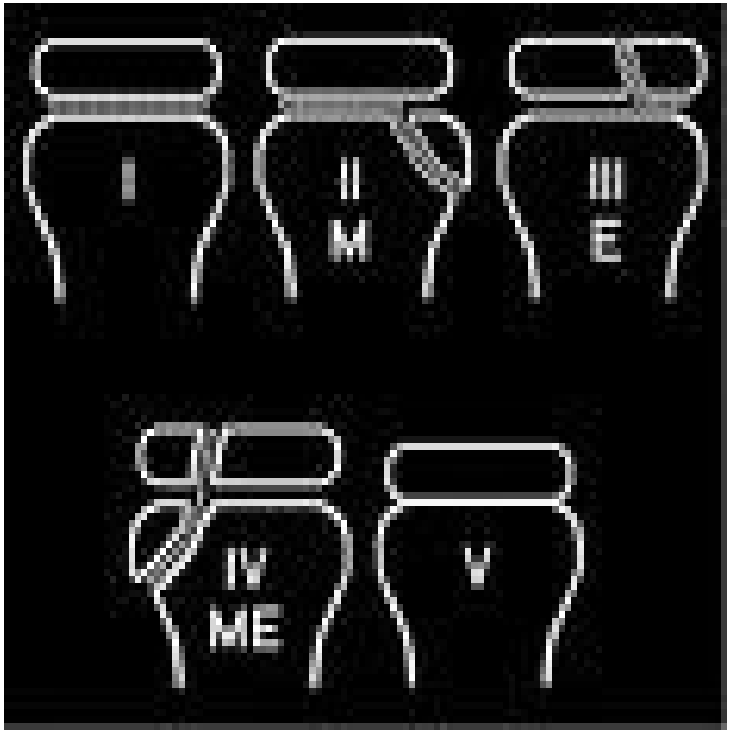
Bowing Fracture

- Forces on bone stops short of fracture
- Persistent plastic deformity can result
- Little remodeling
- Forearm, fibula common
- Functional and cosmetic deficits
- Requires ortho referral



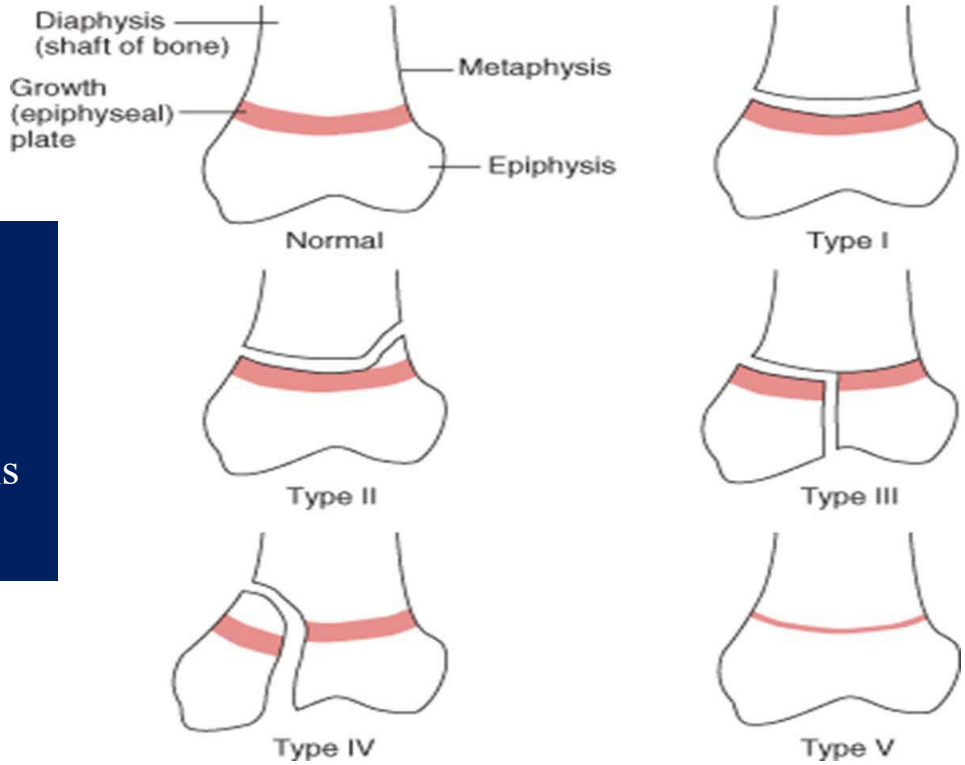
Physeal Fractures

- 18-30% of pediatric fractures
- Common adolescence
- Peak 11-12 yrs
- Usually upper extremity injury
- Physis = weak area
- Salter- Harris Classification
- Salter Harris type 2 most common

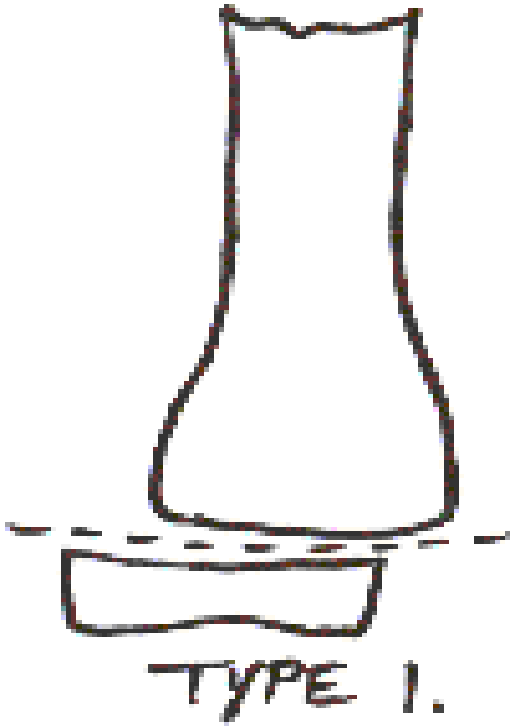


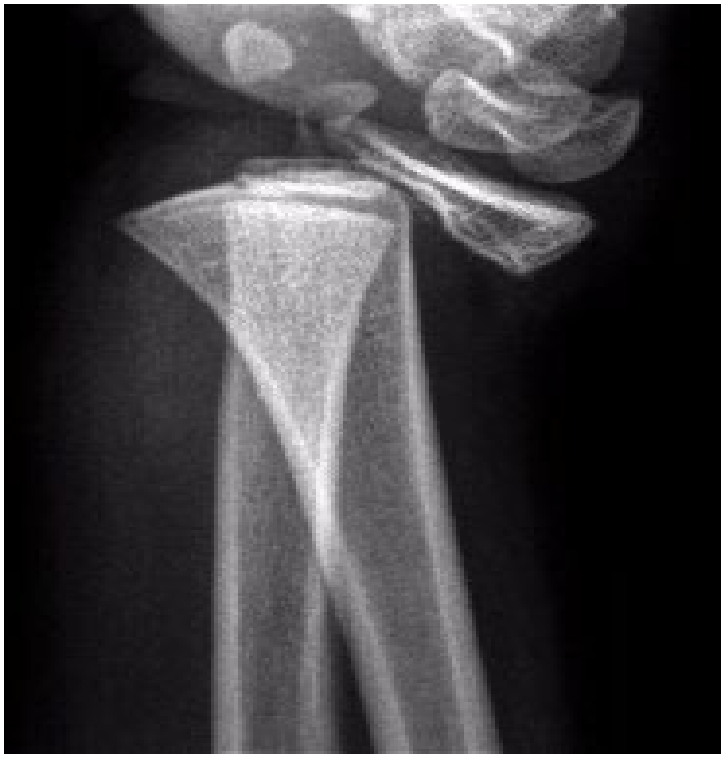
Salter-Harris Classification

- SH I: through physis
- SH II: through physis and metaphysis
- SH III: through physis and epiphysis
- SH IV: through physis, metaphysis, and epiphysis
- SH V: crush injury to entire physis

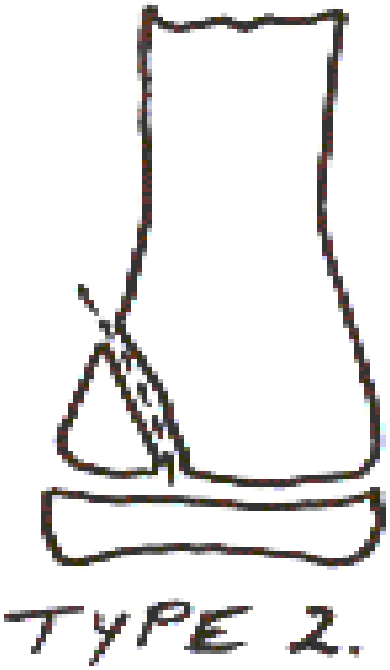


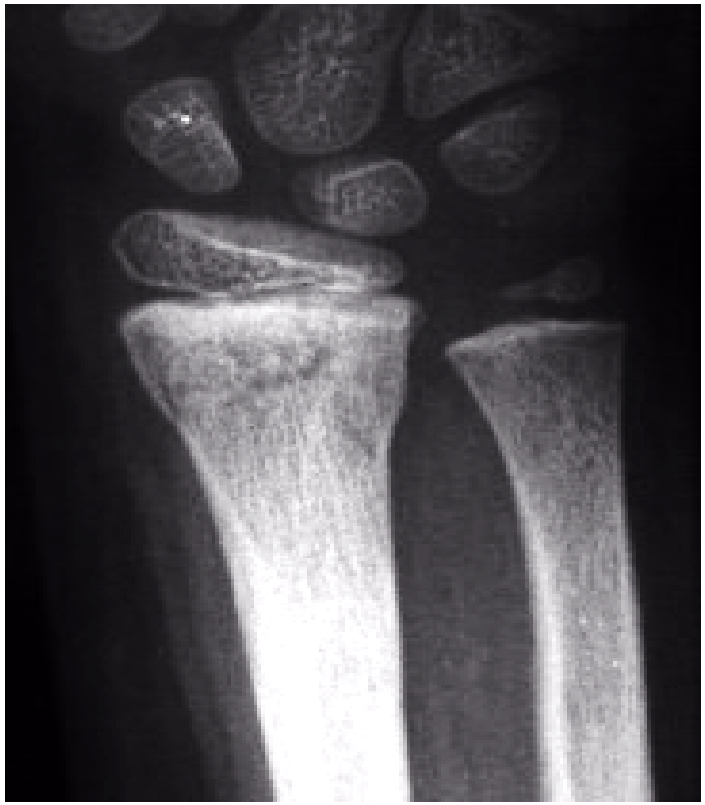
Salter-Harris I



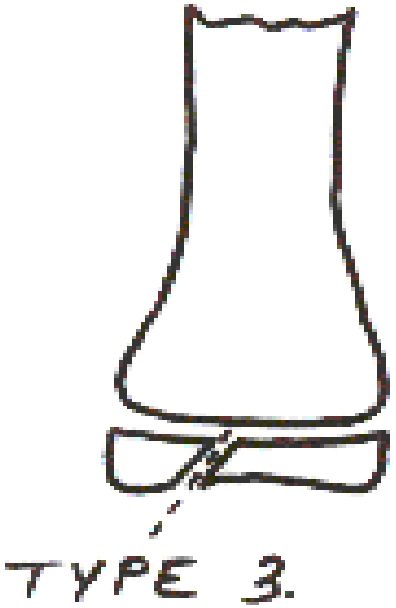


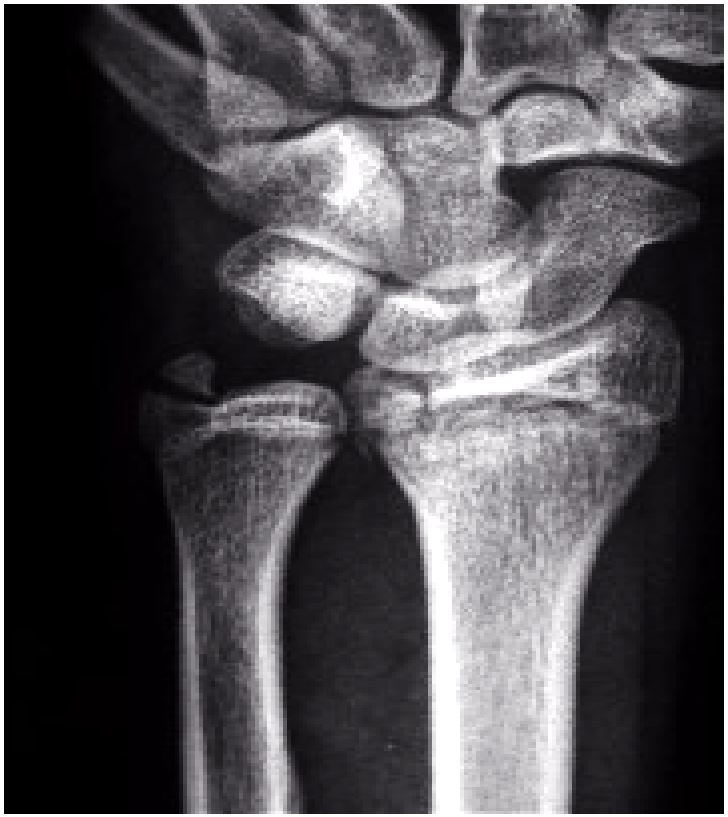
Salter-Harris II



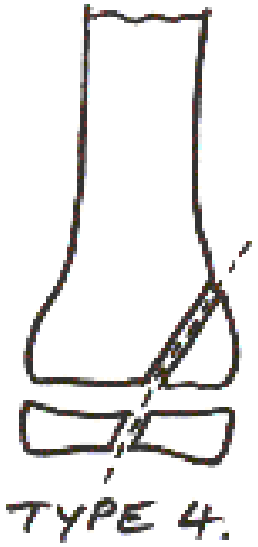


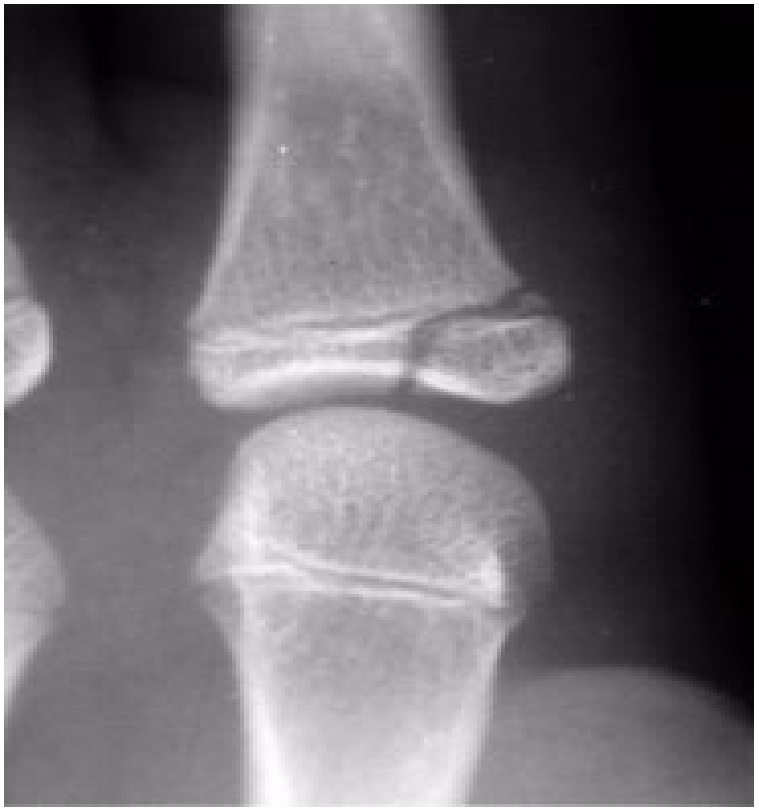
Salter-Harris III



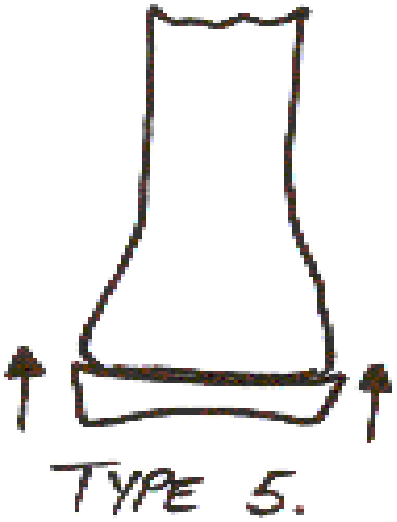


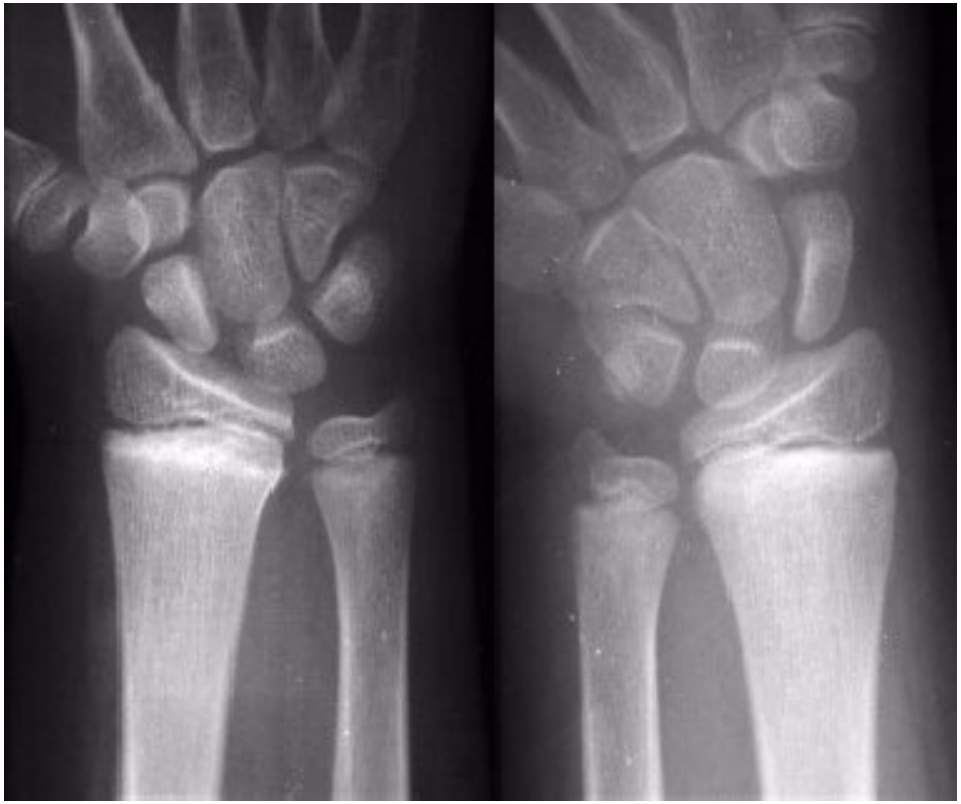
Salter-Harris IV





Salter-Harris V





Case 1

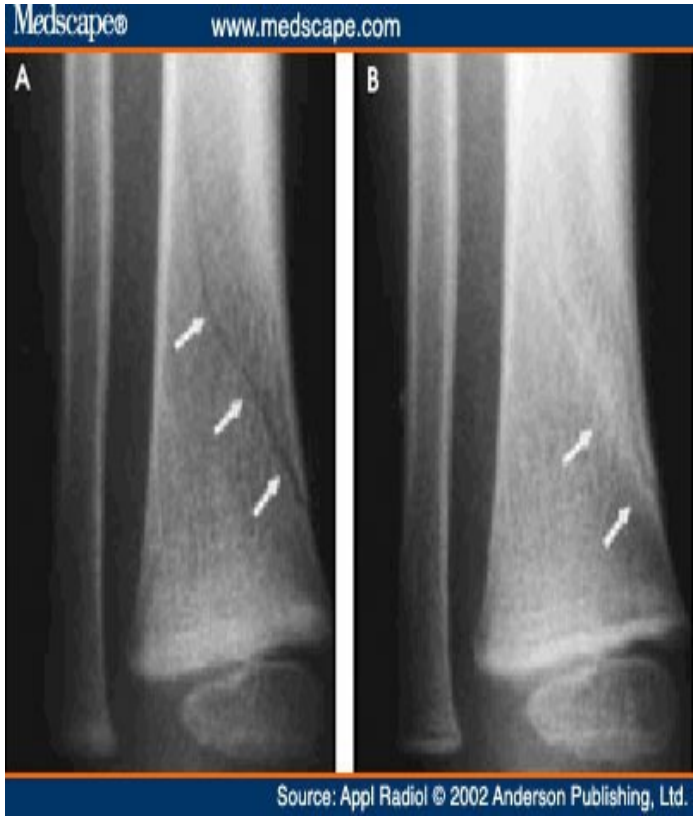
- 18 mth old brought in by mom because she won't bear wt on R leg. No fever. No recent illnesses. No witnessed trauma.
- Exam: afebrile, non toxic appearing no gross deformity, swelling, redness / warmth, bruising Draws leg up when standing

  Cries when you try to move lower R leg

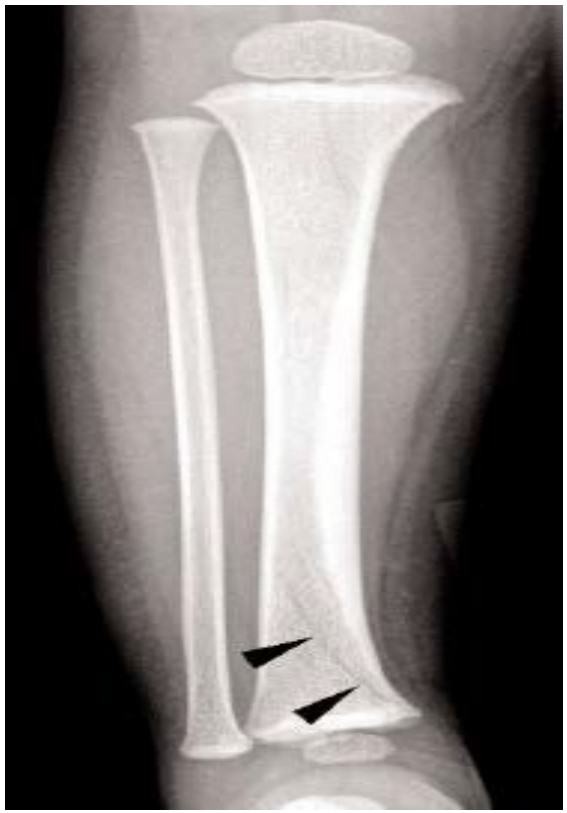
  No rash/ petechiae
- Mom and baby good rapport, eye contact
- What do you think is going on?
- What do you want to do?

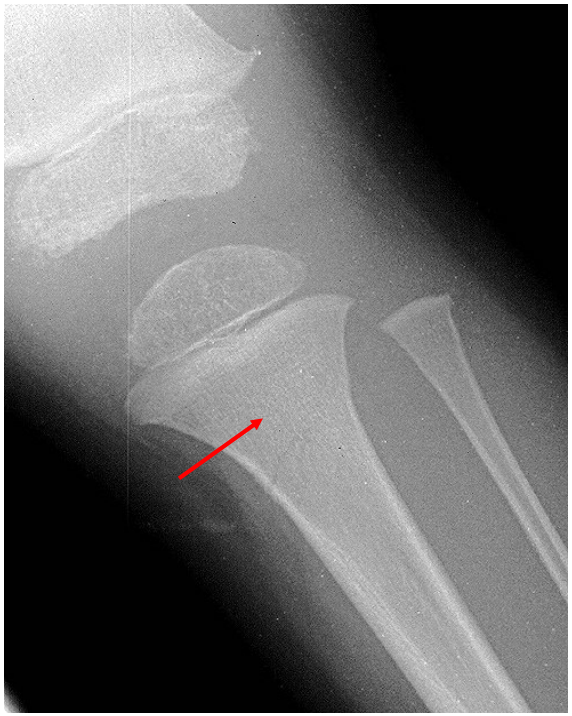
Toddler's Fracture

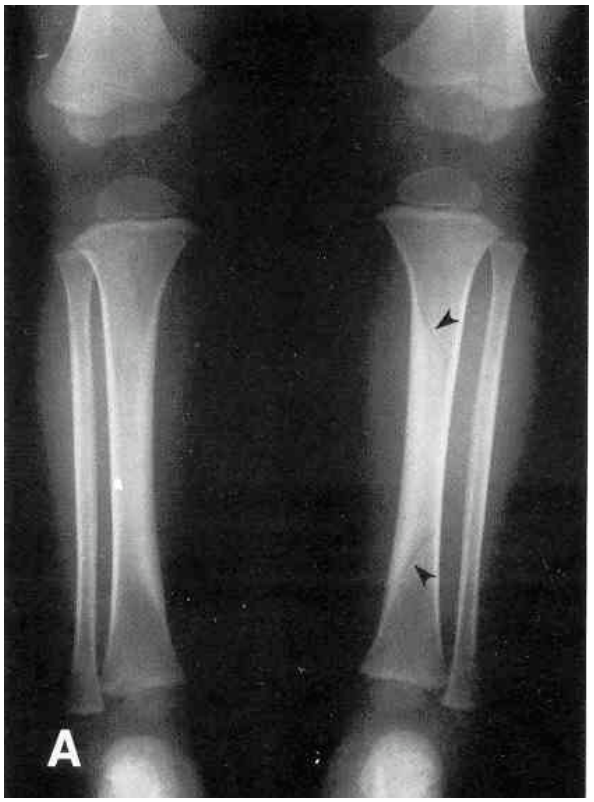
- Hairline, non displaced spiral or oblique fracture tibia
- Typically kids < 4 yrs
- Minor force- usually fall
- Subtle findings
- Does not = abuse



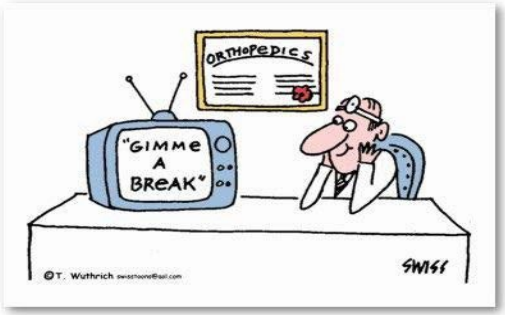
Toddler's Fracture







Initial Approach to Ortho Trauma



- ABC's
- Evaluate involved limb for:
  - neurovascular compromise
  - open vs closed fracture
  - compartment syndrome
- Evaluate for fx's at increased risk for significant bleeding/ hemodynamic instability (pelvic/ femur fractures)
- Search for associated injuries
- Pain control
- Immobilization
- Xray evaluation
- Miscellaneous: last meal, allergies/ meds, last period if female

Fracture Tx in Children: General Principles

- Children heal faster than adults
- Require less immobilization time
- Stiffness of adjacent joints less likely
- Vast majority- tx'd closed methods
- Exceptions: open fractures
- Salter Harris type III- IV injury multi-system trauma
- If any concern re: displacement → **keep NPO**
- Any **swollen elbow** is **displaced supracondylar fx** until proven otherwise
- Analgesia (morphine 0.1 mg/kg IV), then Xrays

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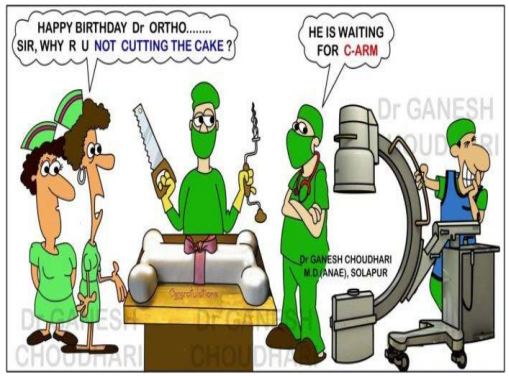
Who needs an XR?

- Point tenderness
- Large amount of swelling
- Severe pain
- Persistent symptoms after 3-5 days
- High risk mechanism
- Must include joint above and below
- Comparison views?
- All unstable and deformed fractures must be immobilized prior to transfer to radiology

What does Ortho need to know?

- Age and sex of patient
- Mechanism of injury
- Bone or bones involved in injury
- Type of fracture
- Neurovascular status of the extremity
- Presence and amount of displacement
- Presence and estimate of angulation
- Open or closed fracture

C'mon guys, it's not exactly brain surgery...



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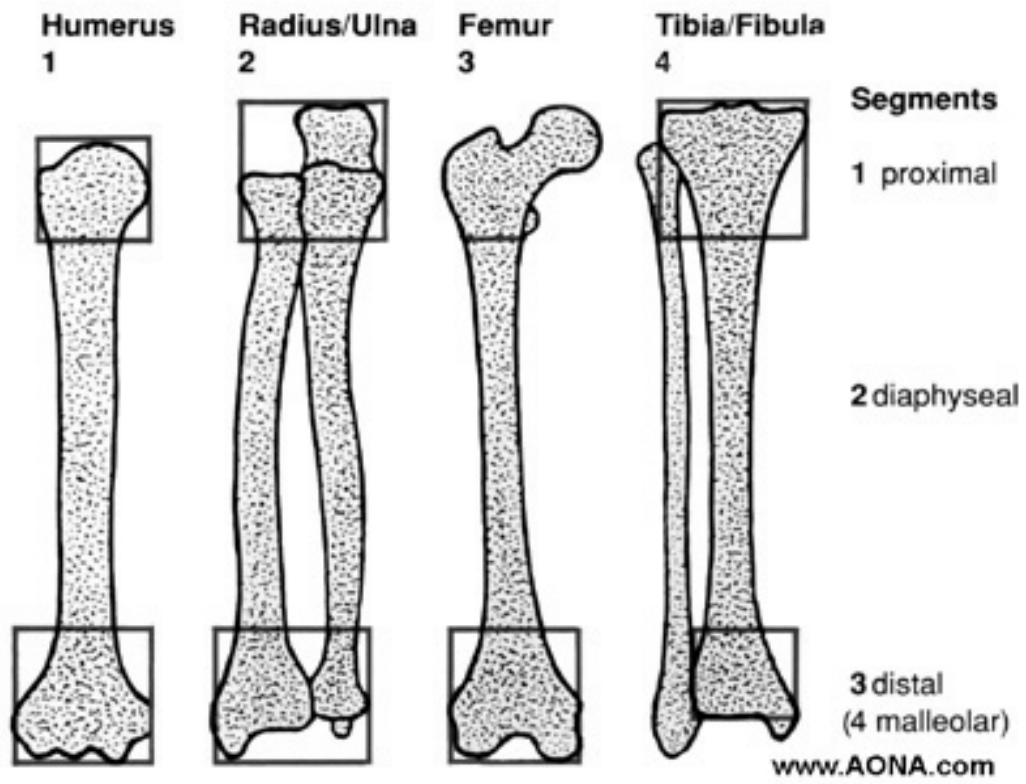
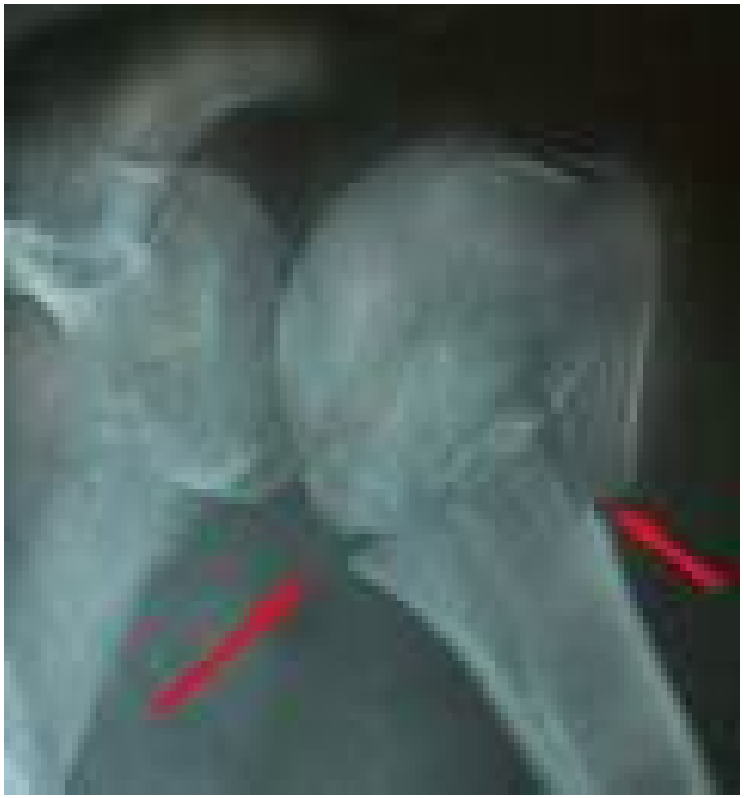
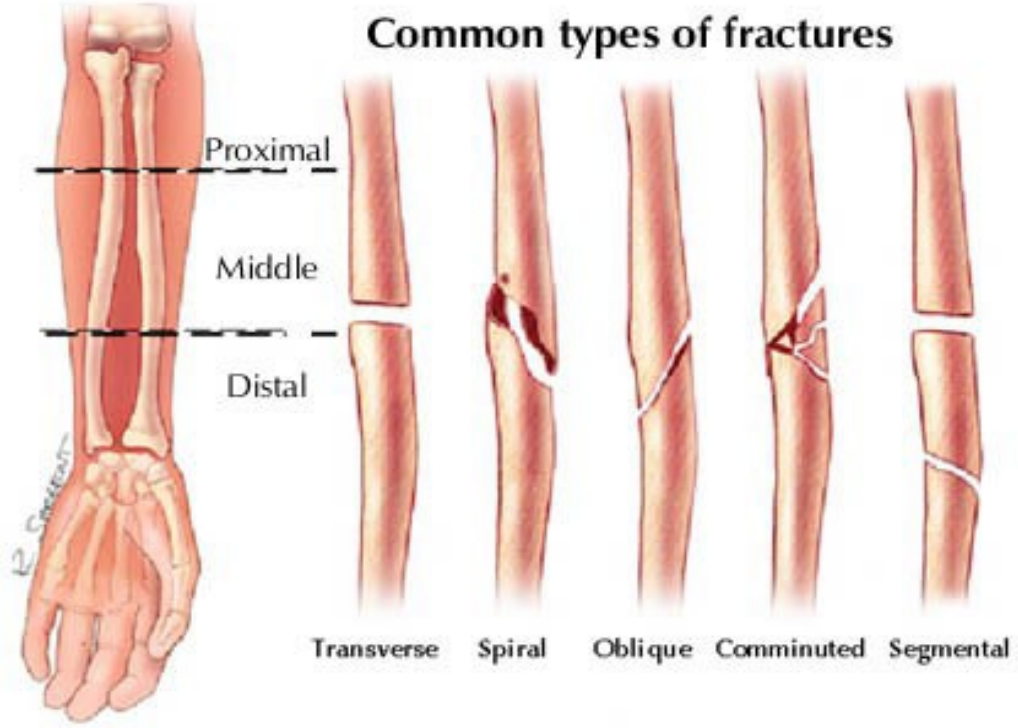
Description of Injury Location



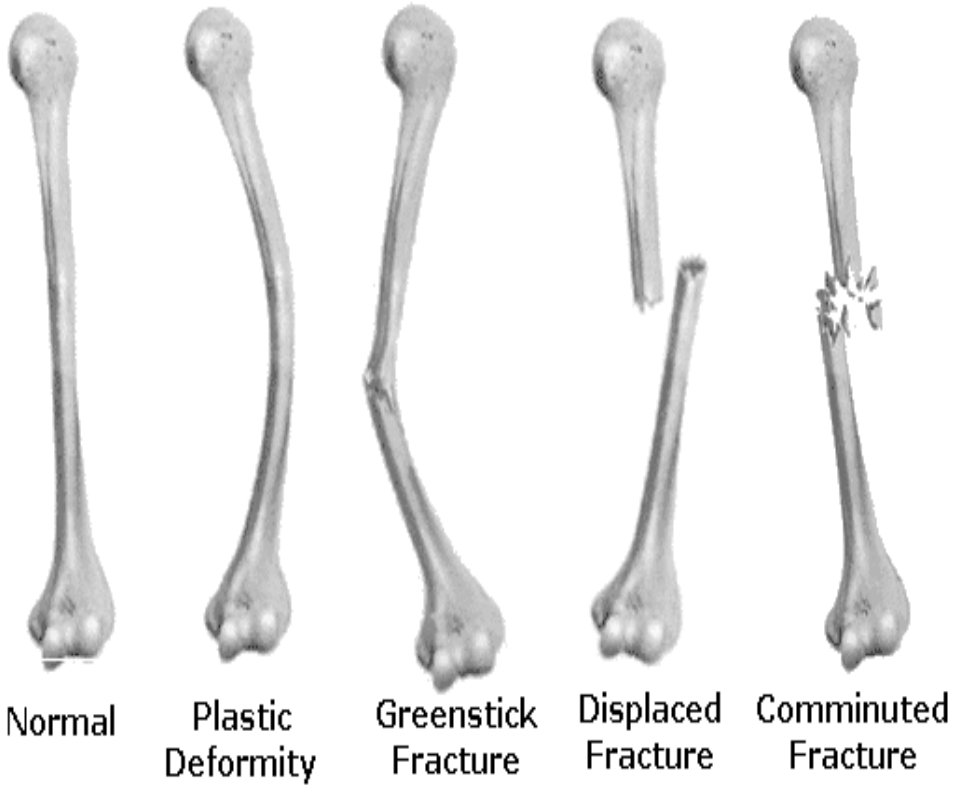


Fracture Descriptions

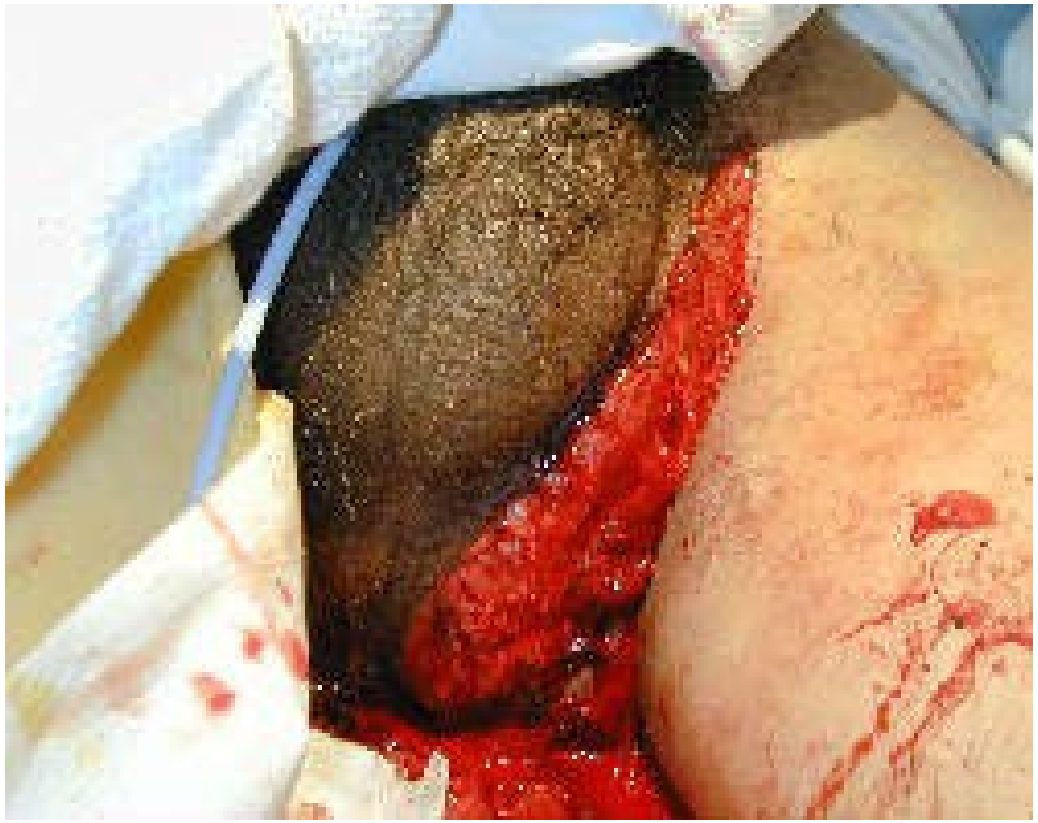
- Fracture pattern:
  - Spiral (twisting)
  - Oblique (bending)
  - Transverse (direct)
- Displacement
- Angulation
- Comminution

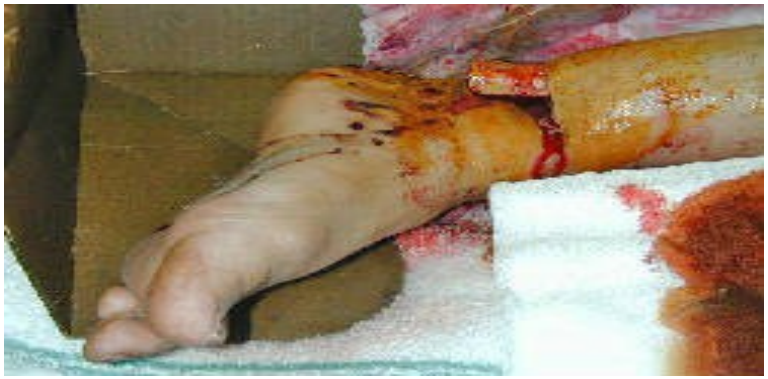


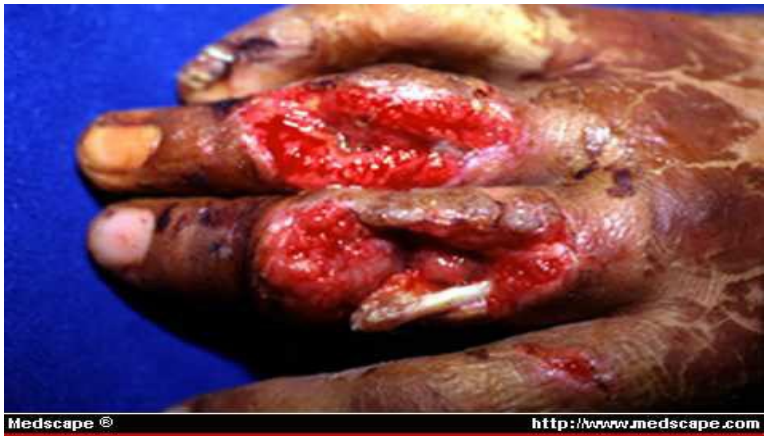
Fracture Types



Open Fractures

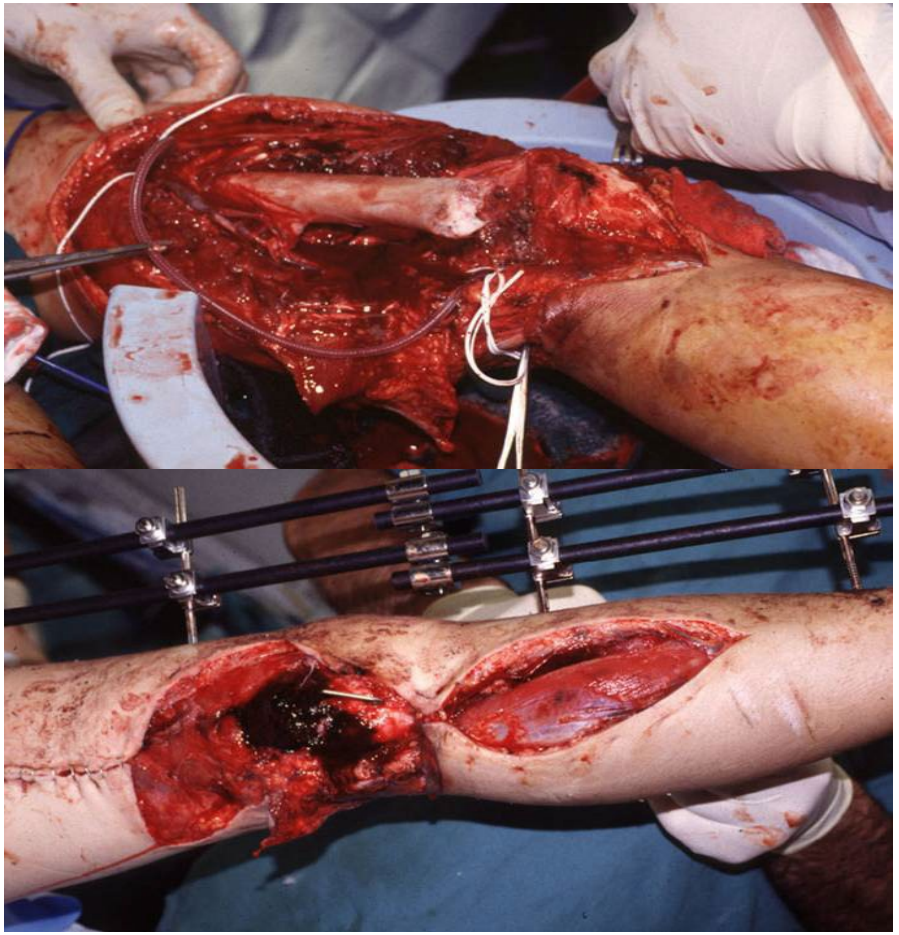






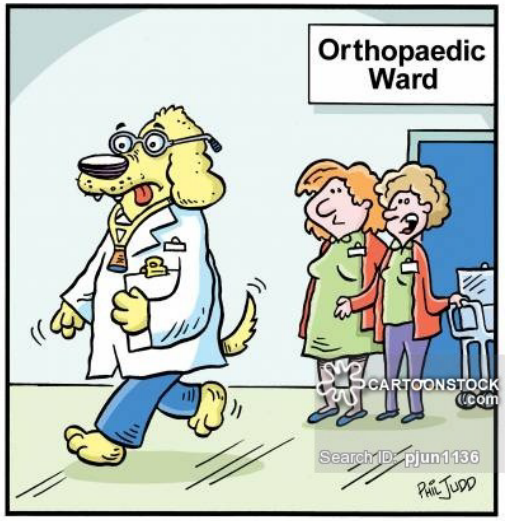
Open Fractures

- IV Antibiotics, Tetanus Prophylaxis
  - Cefazolin, Gentamicin
  - TdaP
- Emergent I&D
  - 6-8 hrs
- NPO



Ped. Extremity Injuries Requiring Emergent Ortho Evaluation

- Femur Fractures
- Pelvic fractures
- Open fractures
- Spinal fractures
- Complete fracture of long bones of lower extremities
- Neurovascular compromise
- Dislocation of large joint
- Fractures with significant displacement
- Fractures involving large joint



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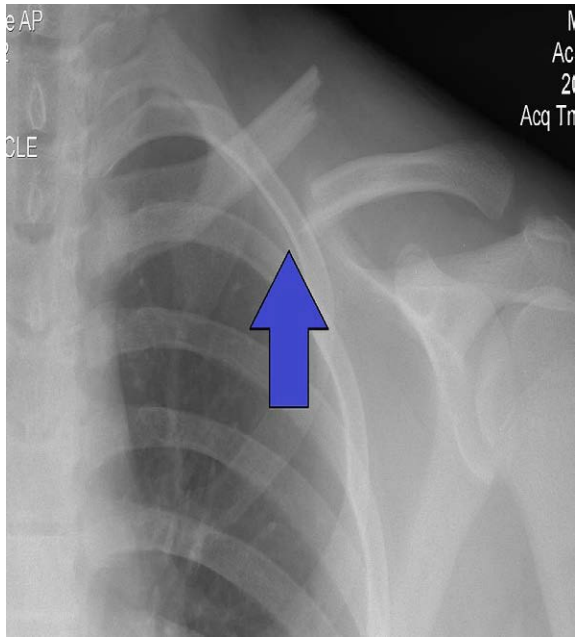
Injuries to Upper Extremity

- Clavicle
- Shoulder
- Humerus
- Elbow
- Forearm
- Wrist and hand

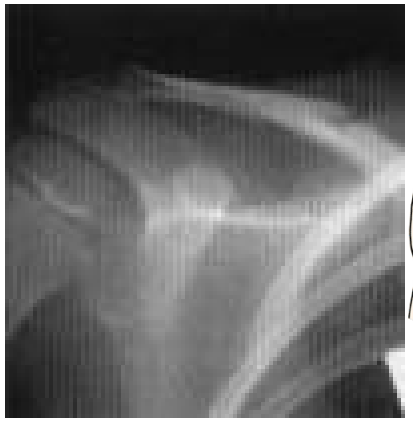
UH OH! What's Wrong?

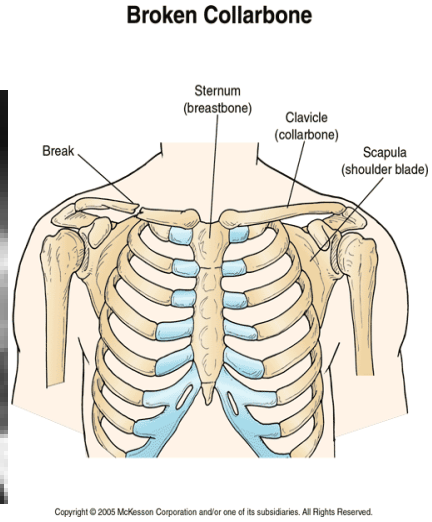
- 14 yr old male wide receiver with l shoulder pain
- Fell to ground trying to make catch, landing on shoulder
- Now increased pain, can't lift arm
- Tender mid shaft clavicle
- NV intact
- Skin intact
- What doe films show?

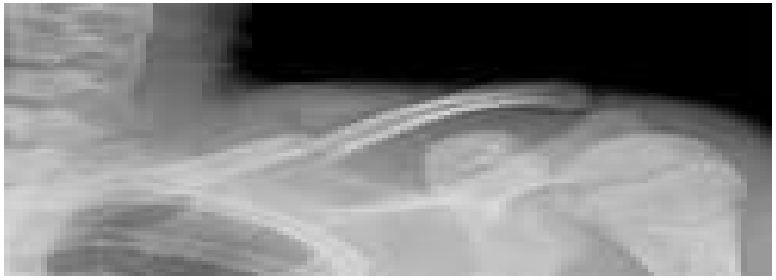


Clavicle Fracture

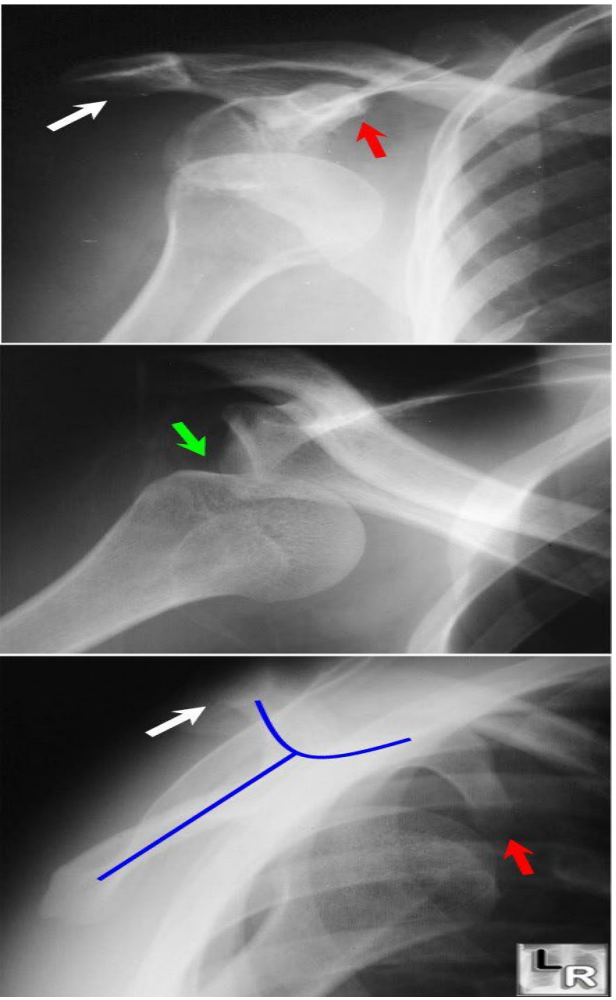
- Most common childhood fracture
- Direct trauma and indirect forces
- > 50% kids less than 10 yrs of age
- Symptoms:
  - point tenderness/ pain
  - decreased mobility
  - unnoticed until “lump” noted as callus forms
- Sling or sling and swathe
- Pain control
- Ortho follow up 2-3 weeks

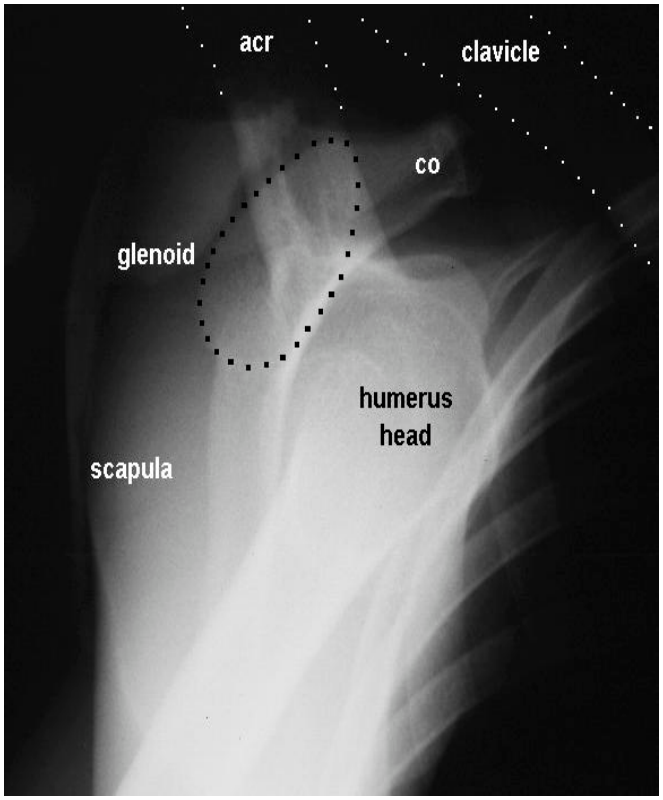


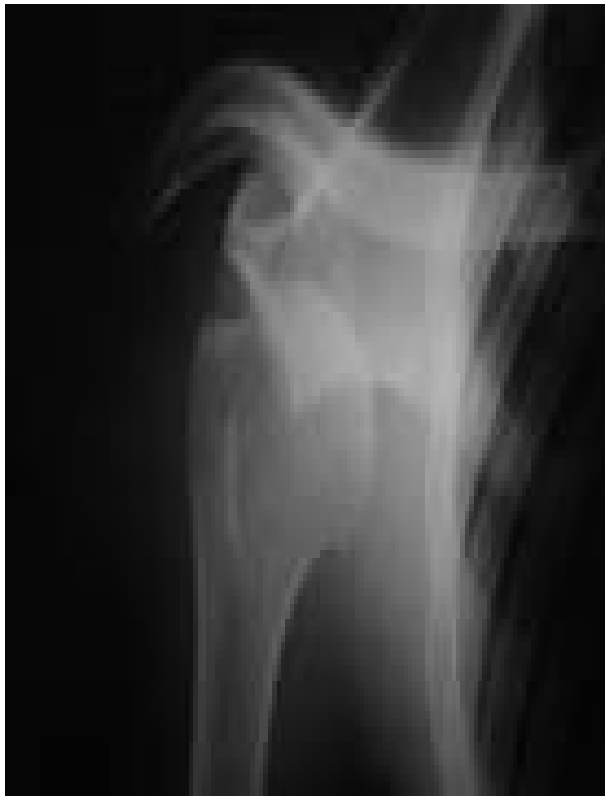




Shoulder Dislocations

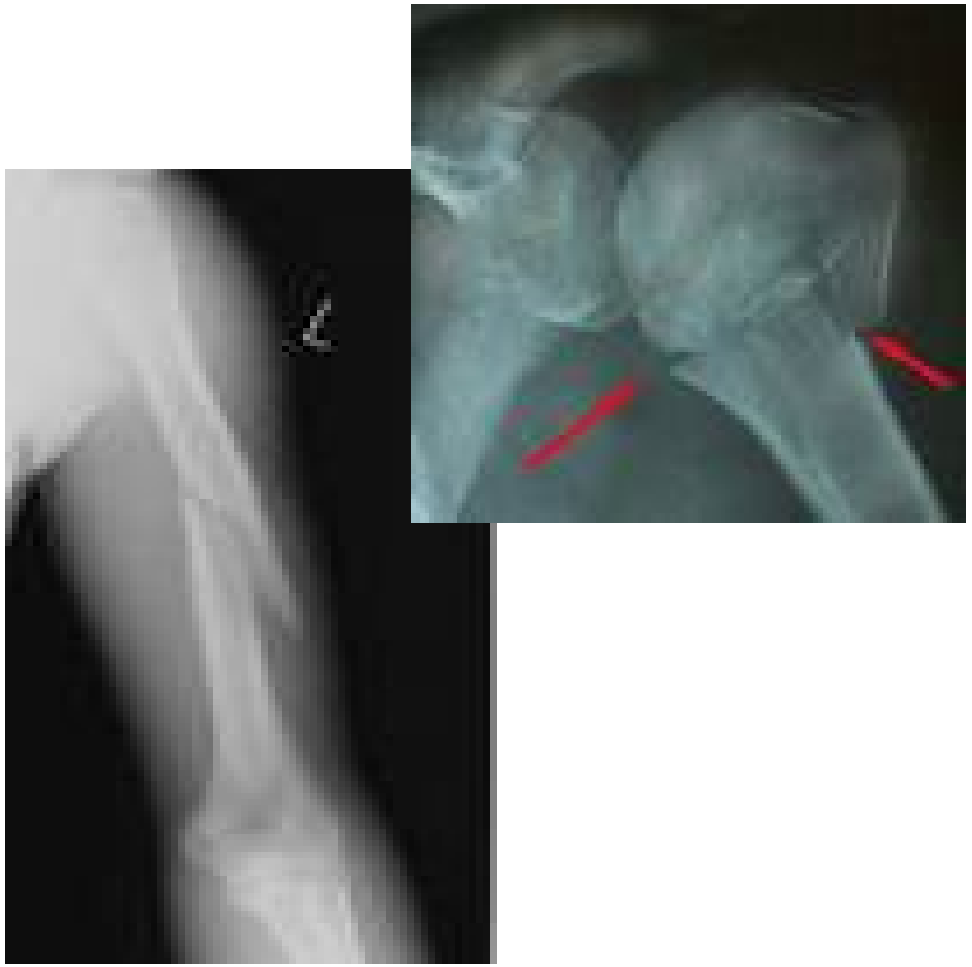






Humerus Fractures

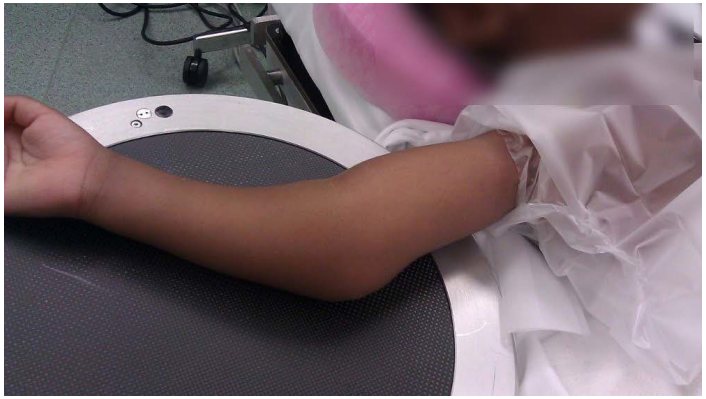
- **Proximal**
  - 80% growth
  - Adolescent
  - nonunion unlikely
  - consult ortho:
    - > 50 degrees angulation
    - NV compromise
  - sling & swathe
  - co-aptation splint

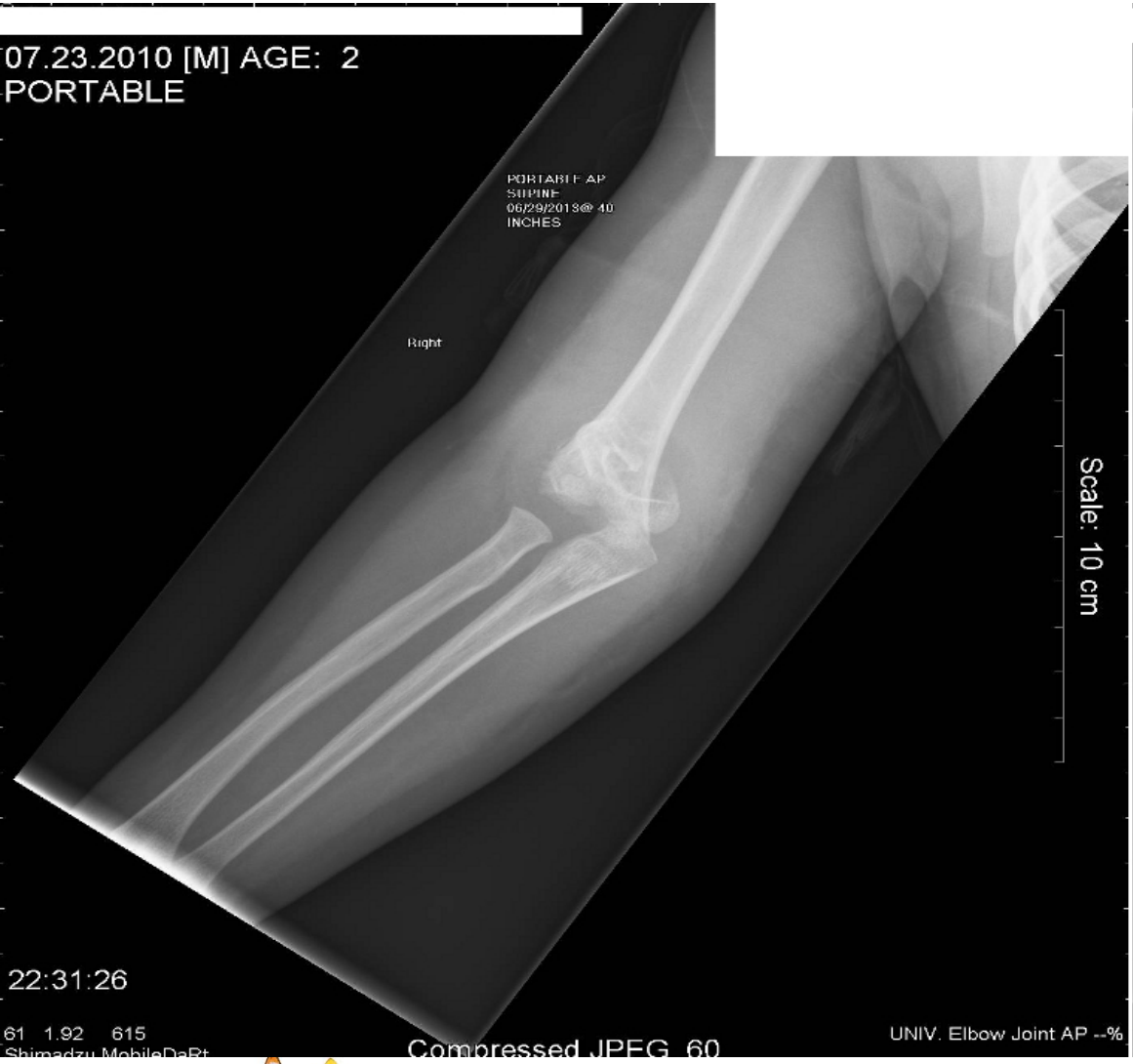


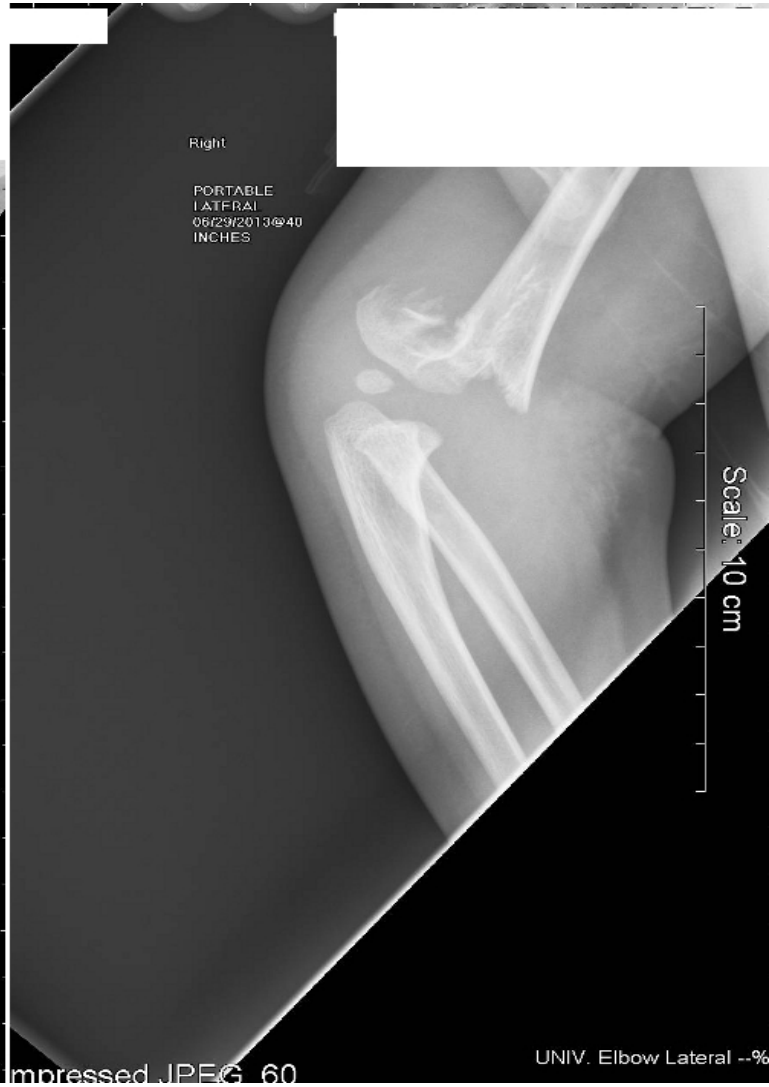
- **Shaft**
  - less common
  - spiral fx < 3 yrs consider **abuse**
  - look for **radial nerve injury**
  - sling & swathe

Trouble?

- 5 yr old boy fell from monkey bars from school
- Landed on R arm
- Isolated injury
- Increased swelling, bruised elbow
- Won't use arm
- Tenting of skin
- What are you concerned about?
- What do I need to know?







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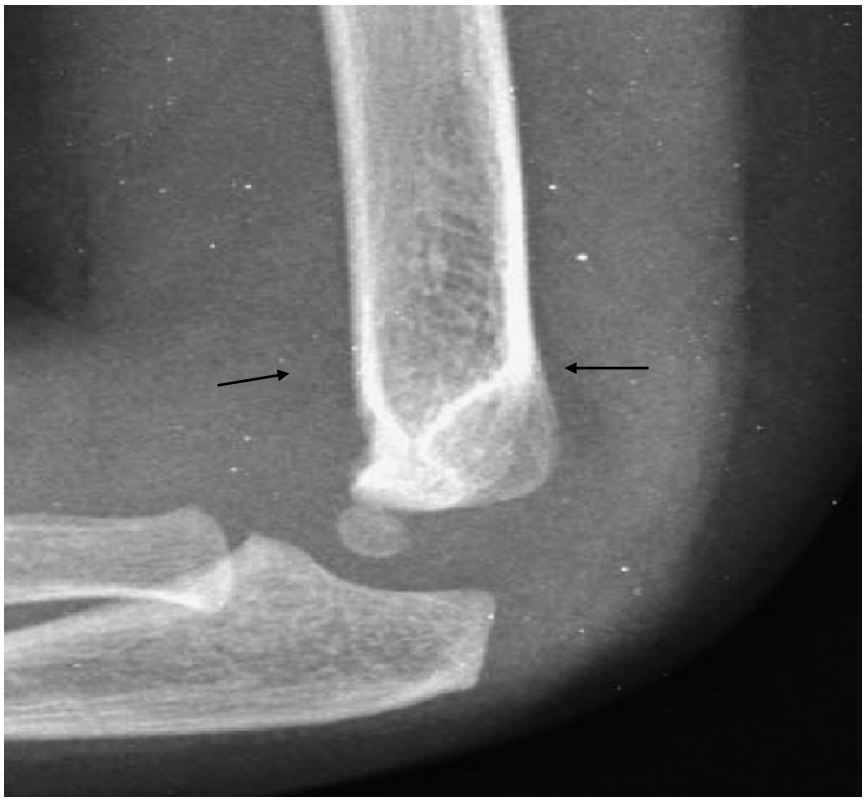
Elbow Anatomy

Ossification Centers

- C - capitellum 1 yr
- R - radial head 3 yr
- I - internal (medial) epicondyle 5 yr
- T - trochlea 7 yr
- O - olecranon 9 yr
- E - external (lateral) epicondyle 11yr

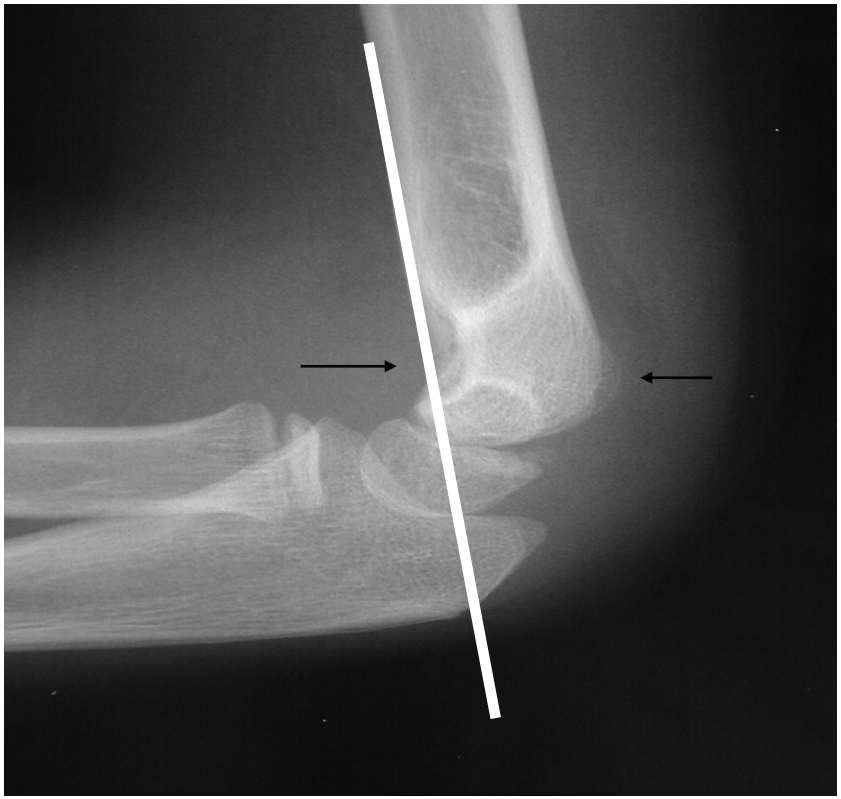
Elbow Fx and Anatomic Landmarks

- **Anterior Fat Pad**
  - May be normal if “adherent” to bone
- **Posterior Fat Pad**
  - Always abnormal if visible
  - Sail sign



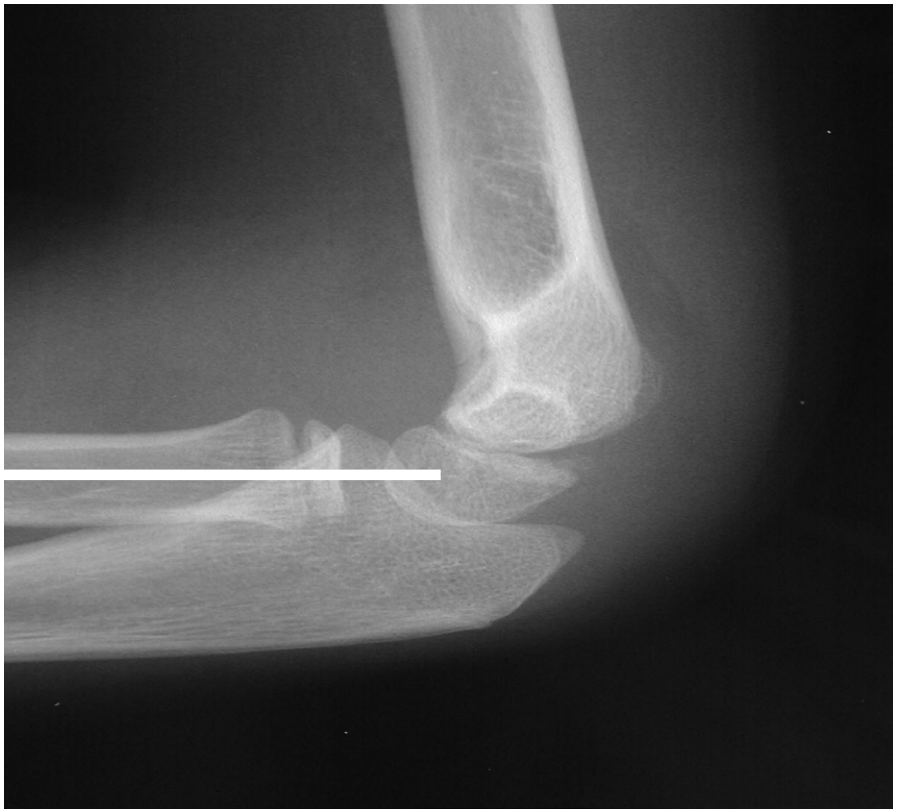
Radiographic Anatomy and Landmarks

- Anterior Humeral Line
  - Drawn along anterior humeral cortex
  - Should pass through middle 1/3 of capitellum



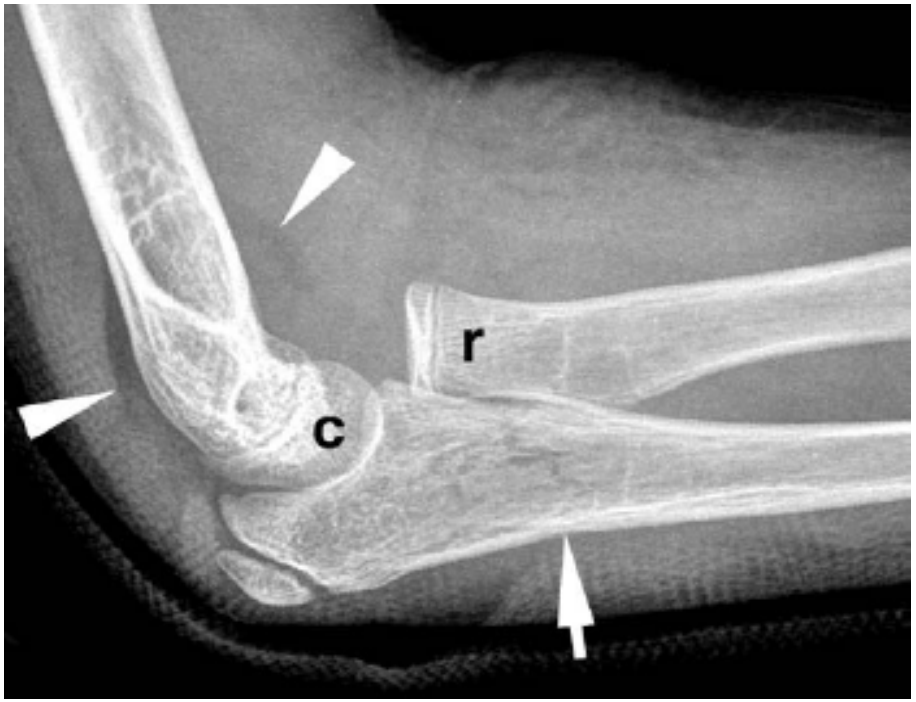
Radiographic Anatomy and Landmarks

- Radiocapitellar line
  - Should intersect middle 1/3 of capitellum
  - Radial head dislocation
- Make a habit to evaluate this line on every pediatric elbow



Radiocapitellar Line

- What kind of Fx is this?
- Monteggia
  - Ulnar fracture + Radial Head dislocation

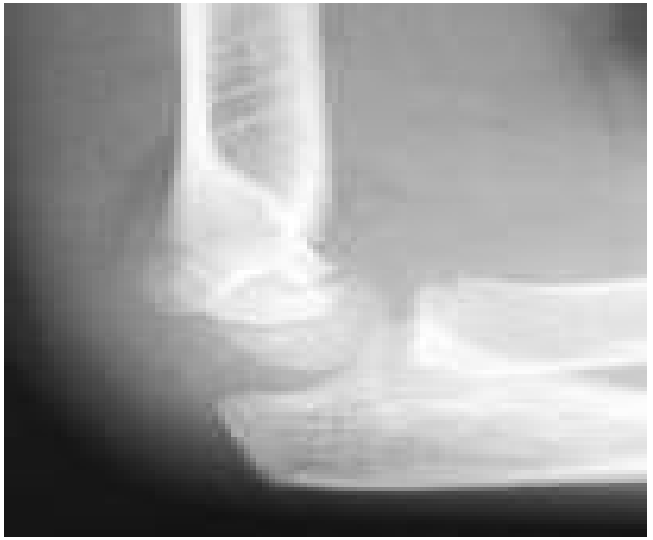


Elbow Fractures in Children

- Very common
- Radiographic assessment difficult
- Requires thorough exam and reassessment
- Neurovascular injuries can occur before and after reduction
- Kids will not move elbow if fracture present
- Swelling about the elbow is constant feature
  - may be minimal if non displaced fx
  - may not develop for 12-24 hrs after injury
- 60% are supracondylar fractures
- May be accompanied by distal radius or forearm fx

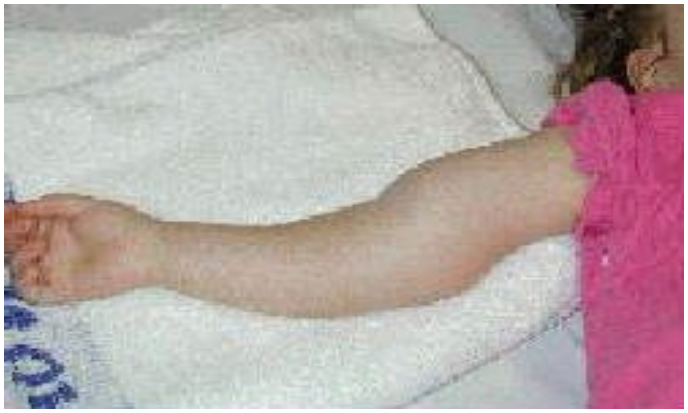
Supracondylar Fracture

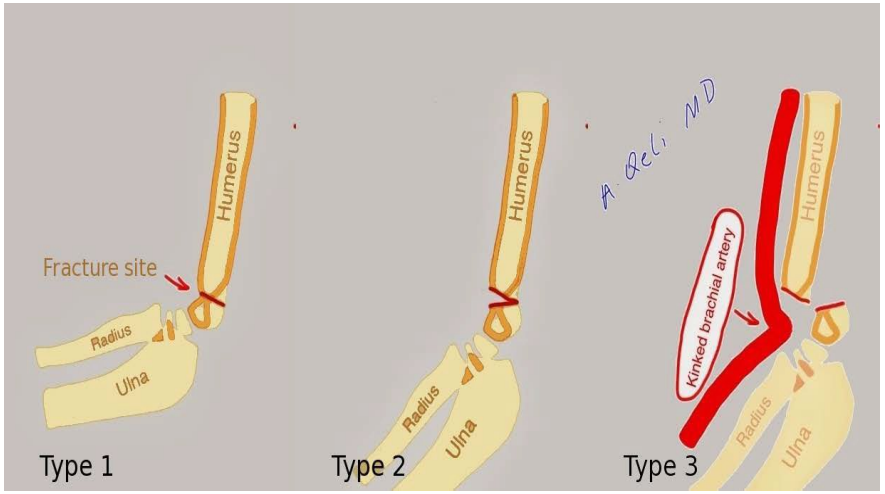
- Fall on outstretched arm
- Hyperextension
- Common elbow fracture
- Complications:
  - NV compromise
  - compartment syndrome
- Graded 1- 3
- Management dependent upon type of injury
  - (splint or OR)
- Ortho needs to see all elbow fractures



Supracondylar Fracture

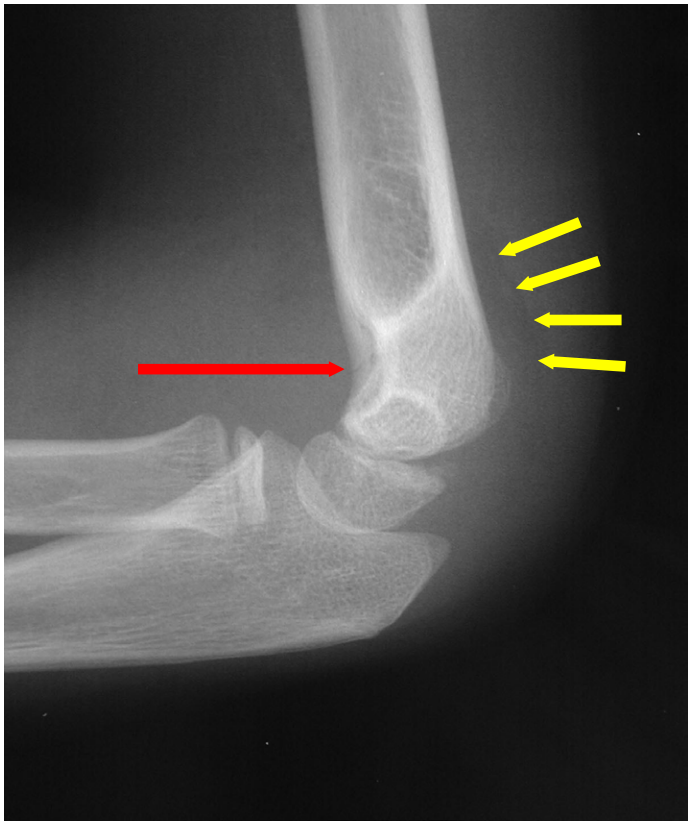
- Type 1: non-displaced
- Type 2: Angulated/displaced with intact posterior cortex
  - Hinged
- Type 3: Complete displacement with no contact between fragments



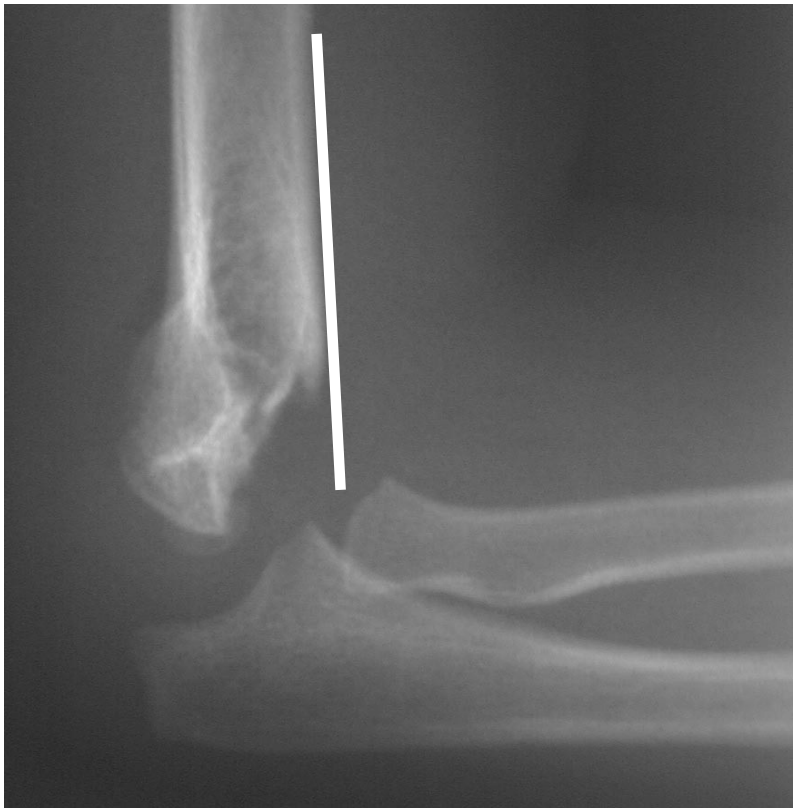


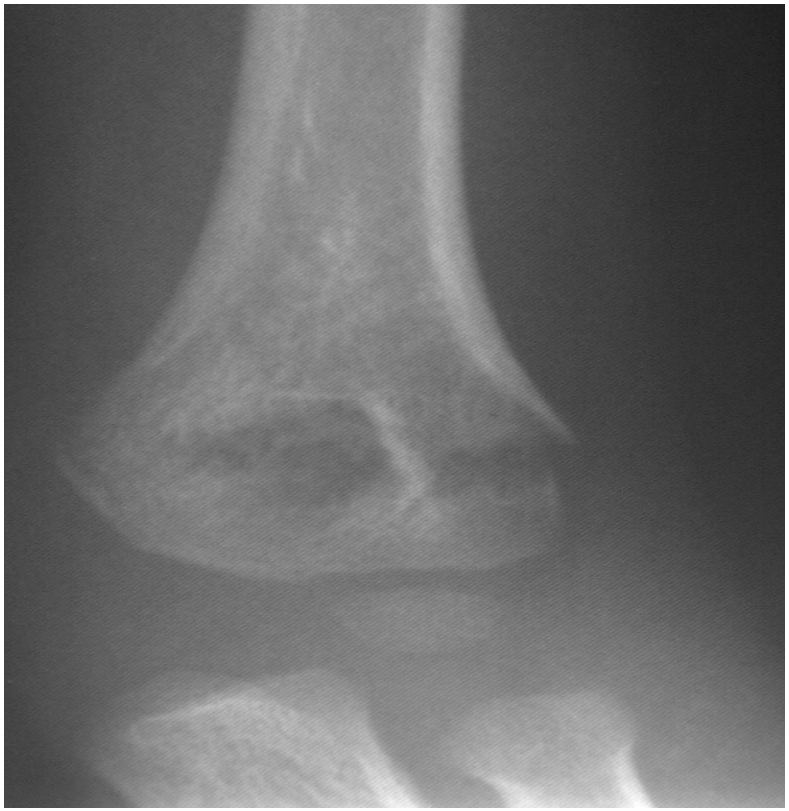
Type 1 - Nondisplaced

- Fracture line (red arrow)
- Posterior Fat Pad



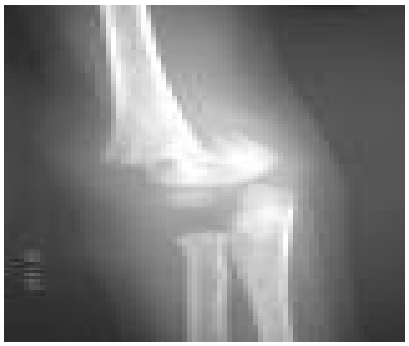
Type 2 – Angulated and Displaced

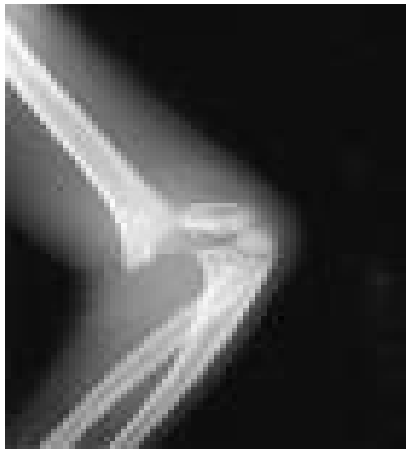


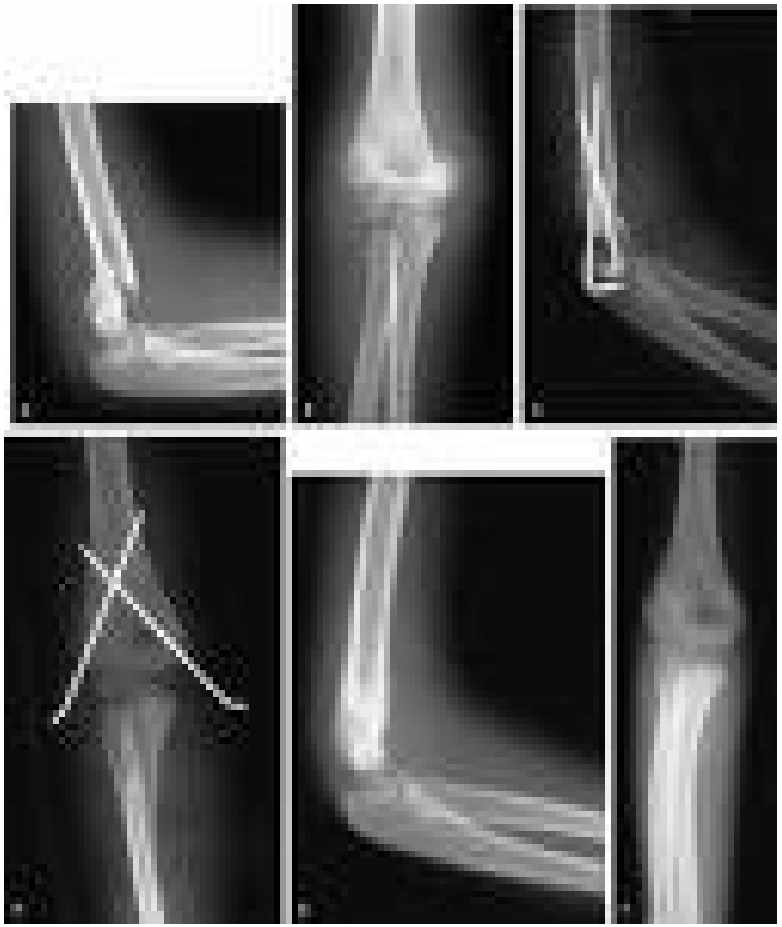


Type 3 – Complete Displacement

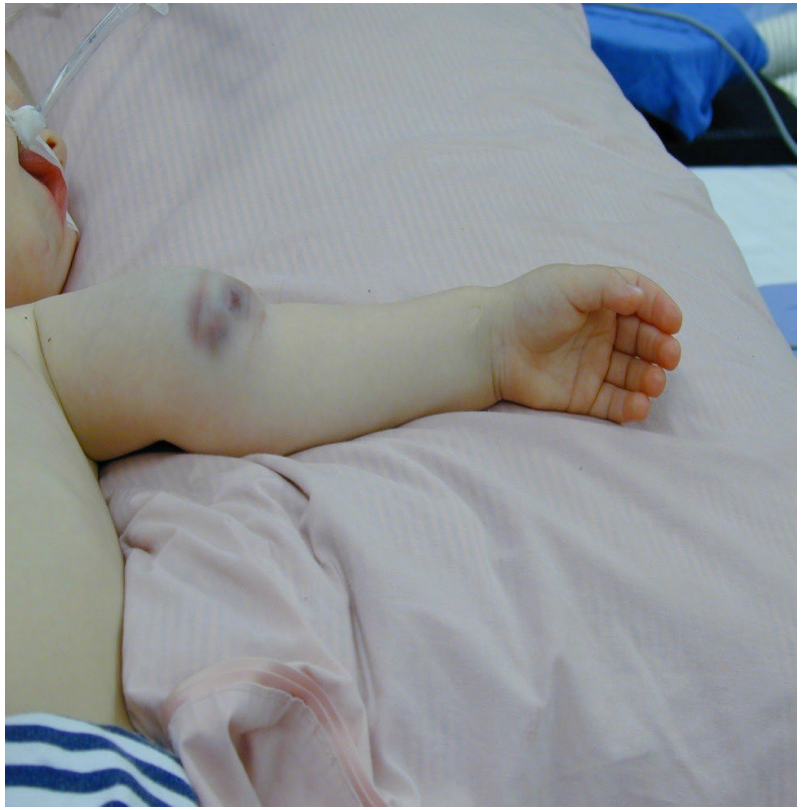
- High risk for NV compromise
- Significant associated swelling
- Ortho consult
- OR for percutaneous pin fixation
- Open reduction may be necessary

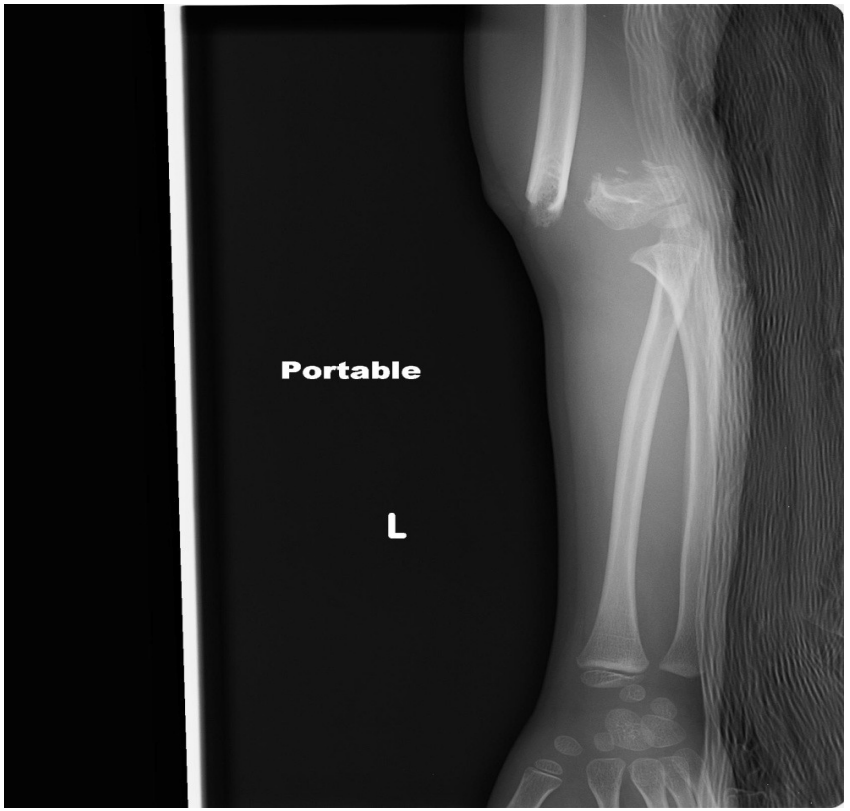






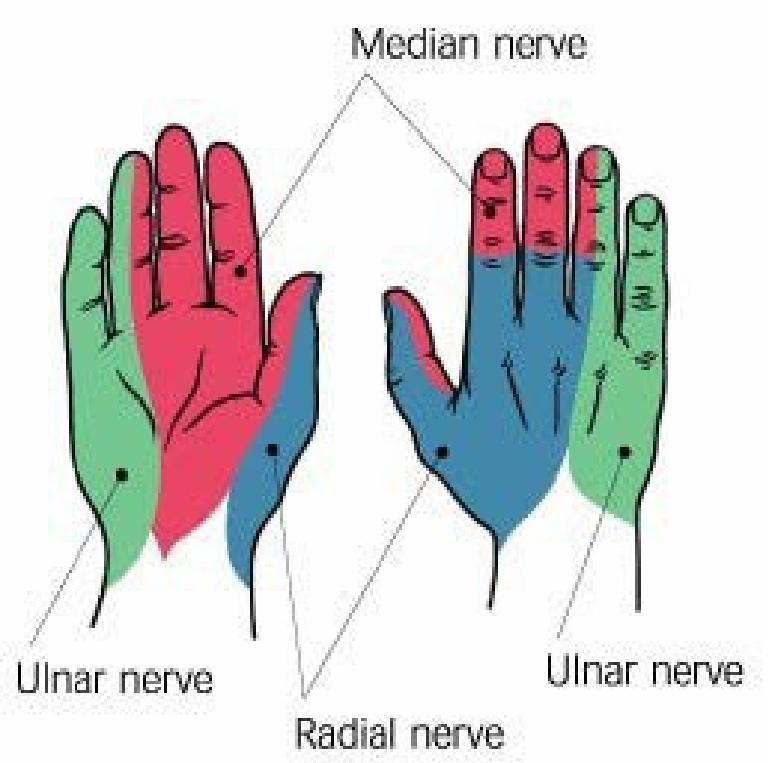
Type 3 – Complete Displacement





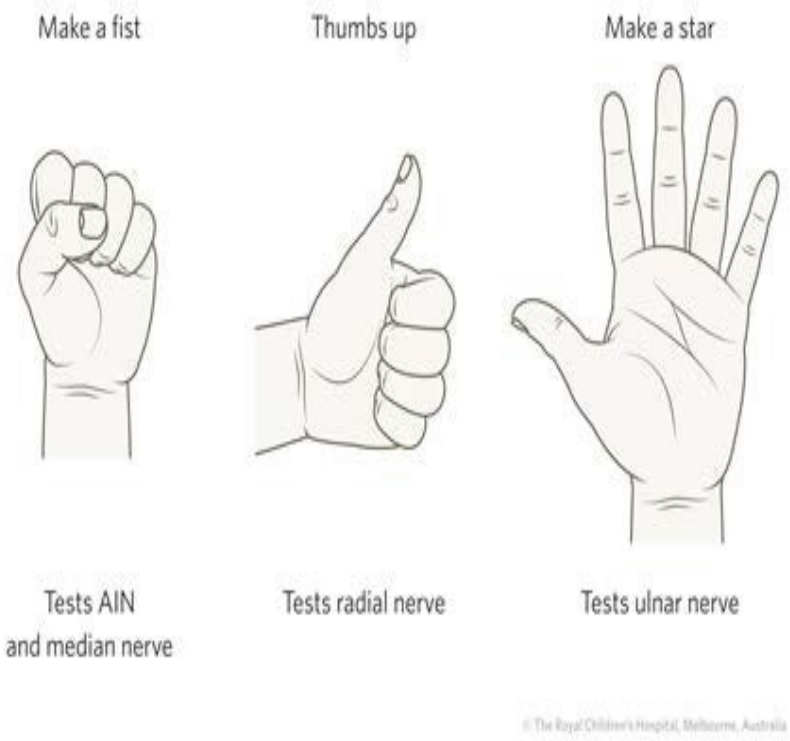
Sensory Exam

- Median: Tip of index finger
- Ulnar: Tip of small finger
- Radial: Dorsal thumb web space



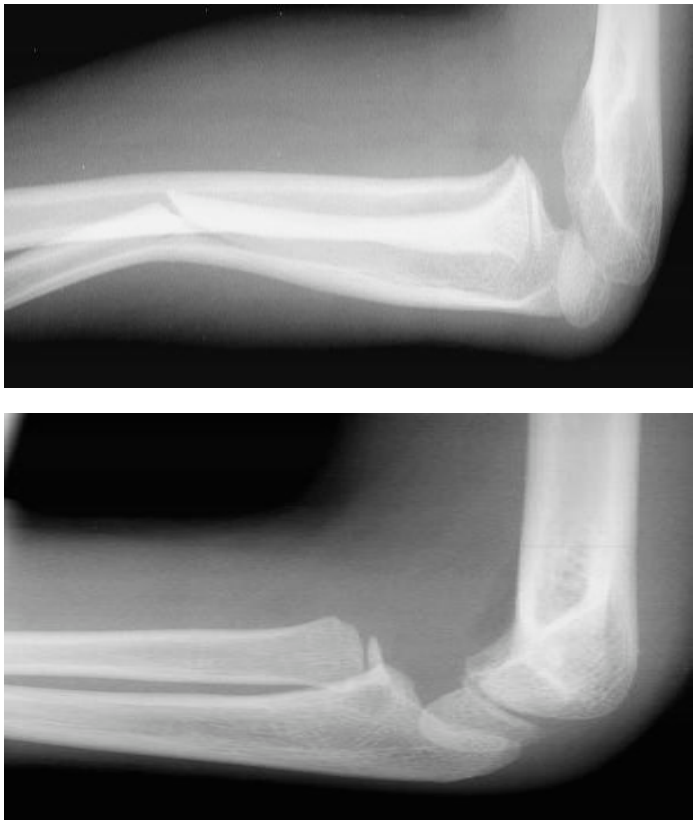
Motor Exam

- Radial: Thumbs up
- Median: Flex thumb or index finger
- Ulnar: Flex tip of 5th finger



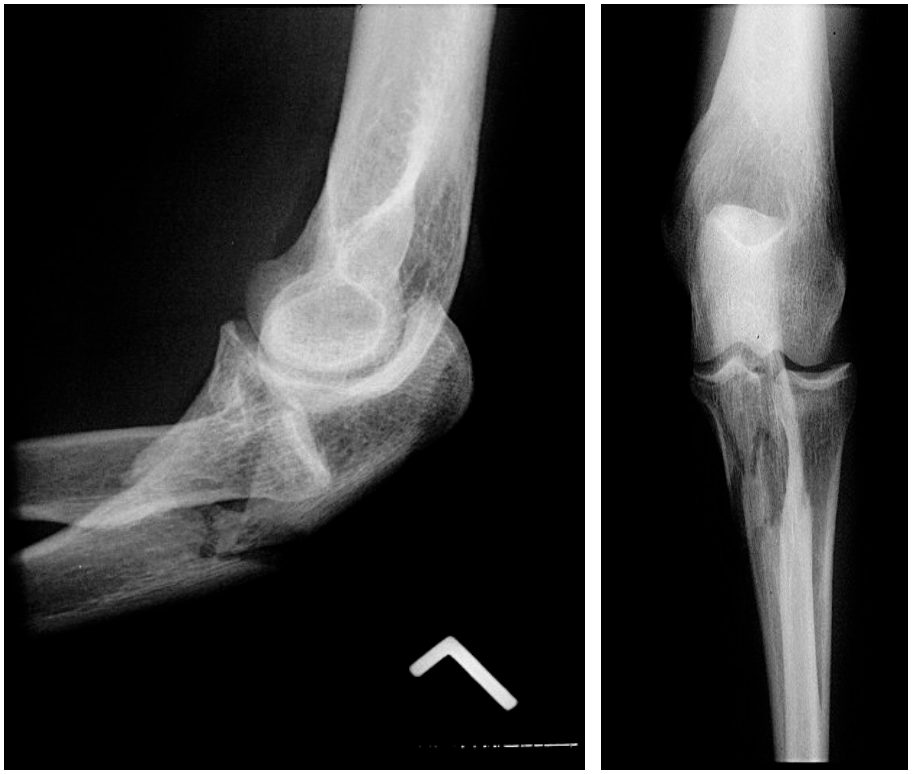
Case 2

- 9 yo falls off slide, landing on outstretched L arm
- Presents to ED due to pain in forearm and elbow
- No hx LOC/ CHI
- Benign medical hx
- Tender over proximal L forearm
- Decreased ROM forearm and elbow due to pain, swelling, guarding
- NV intact, good radial pulse, can wiggle fingers
- Cap refill < 2 sec
- What do films show? What do you want to do?



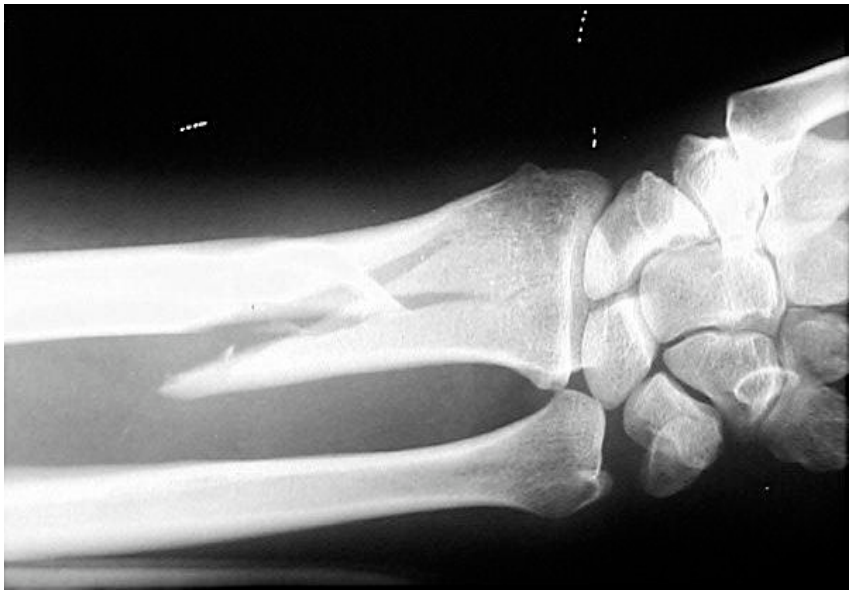
Monteggia Fractuer

- Ulnar fracture + radial head dislocation
- Uncommon in kids
  - 2% all elbow fx's
- Can be easily missed-must have films of both elbow and forearm
- Isolated ulna fractures rare
- If unrecognized and not reduced, can lead to permanent disability
- Pain control, ortho consult, OR for repair



Galeazzi Fracture

- Classic:
  - Fx distal 1/3 radius
  - dislocation of distal ulna
- Disruption of radioulnar joint
- More common teenagers and adults
- Rare fracture
- Suspect in angulated distal radius fractures
- Difficult to recognize
- Requires ortho consult in ED and reduction

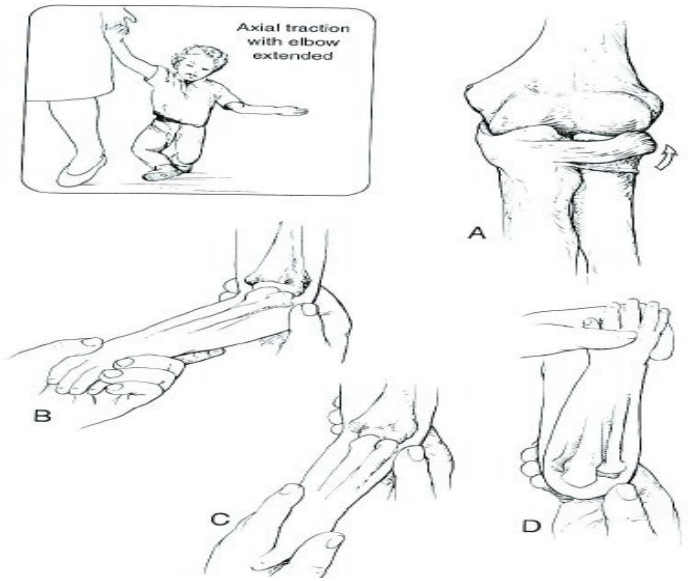


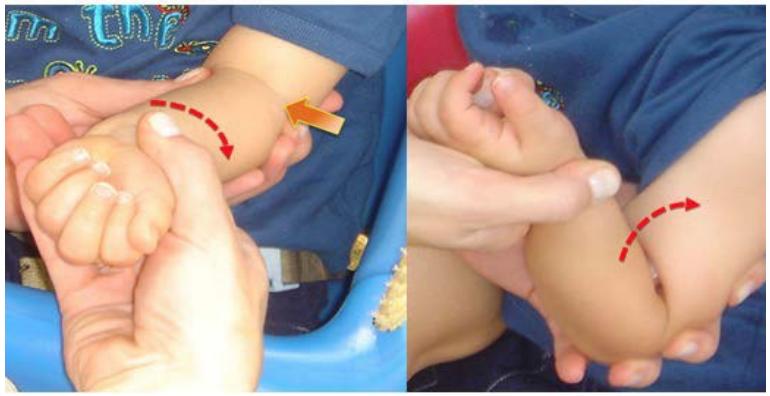
What's going on?

- Mom brings in her 18 mth old because she won't use right arm
- Was trying to put on her shirt, heard baby cry, now hold arm slightly flexed at side
- No fever/ recent illness
- No fall , other trauma
- Do you need an xray?

Radial Head Subluxation

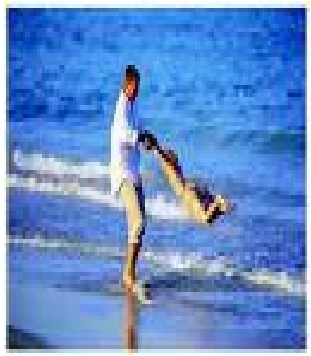
- Nursemaid's Elbow
- Traction Mechanism
- Unusual in >5 yo
- Holds arm pronated, slightly flexed at elbow and at side
- No swelling/ecchymosis
- XR not needed

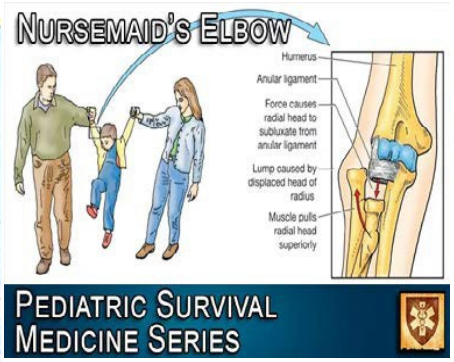




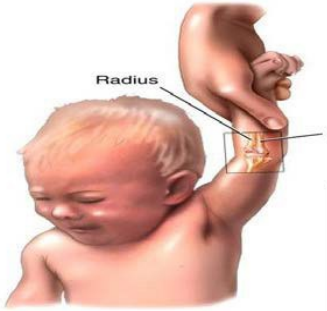
Nursemaid's Elbow

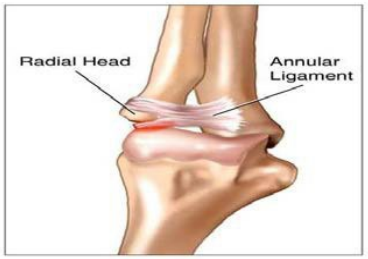
- Radial head subluxation due to annular ligament tear
- Typically "pull" on pronated forearm
- Typical presentation:
  - do not appear in pain
  - refuse to use arm
  - held in pronation and slightly flexed
  - no swelling/ bruising
  - may hold wrist to support extremity
- Reduction techniques:
  - pressure over radial head
  - supination w/ flexion
  - pronation w/ flexion
  - extension/ hyperpronation
- Films only if hx/exam not consistent





Nursemaid's Elbow





NATIONWIDE CHILDREN'S
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Pediatric Forearm Fractures

- Approximately 4% of children's fractures
- Most due from fall onto outstretched hand
- ¾ fractures distal
- Rare to see isolated ulna fracture
- Neurovascular compromise rare
- Remodels well
- Ortho consult
  - Angulation: > 10' midshaft or > 15' distal
- will require procedural sedation for reduction
- Tx - sugar-tong or volar splint

- Approximately 4%
- Most due from fa
- ¾ fractures dista
- Rare to see isola
- Neurovascular co
- Remodels well
- Ortho consult :
  angulation > 1
  > 1
  will require pr
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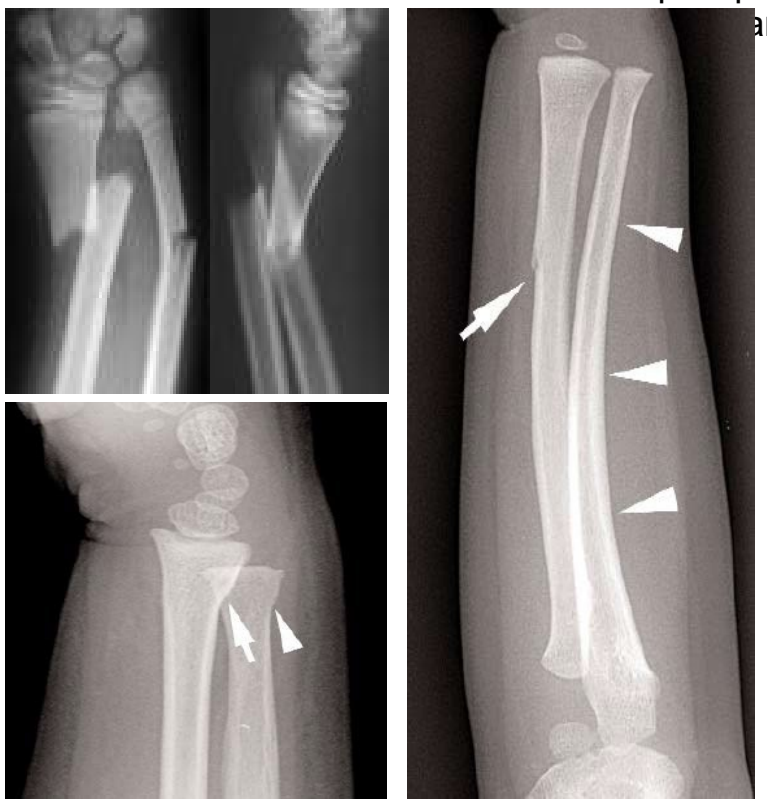
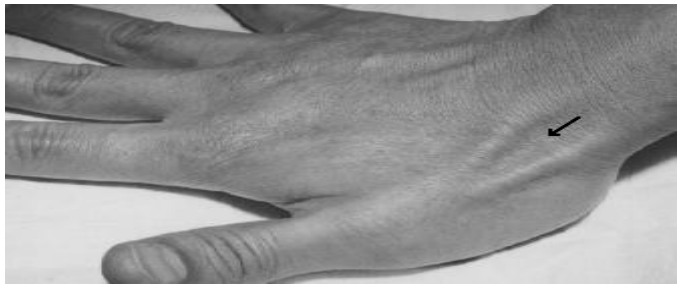
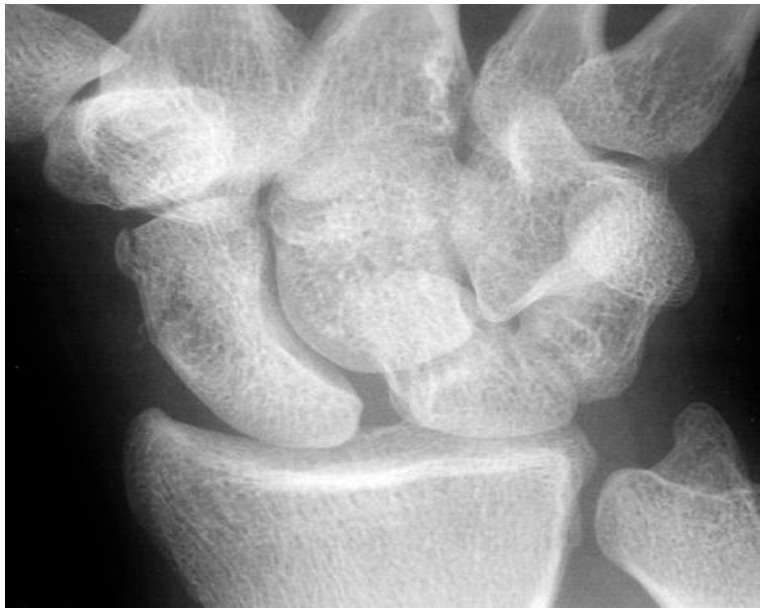


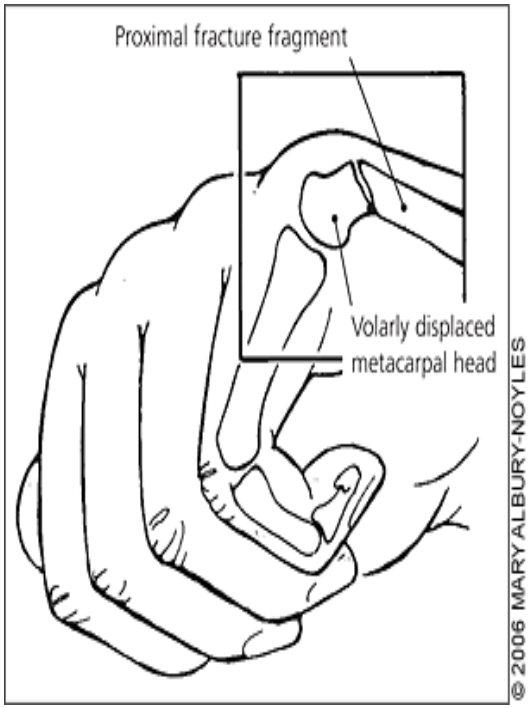
Carpal Bone Fractures - Scaphoid

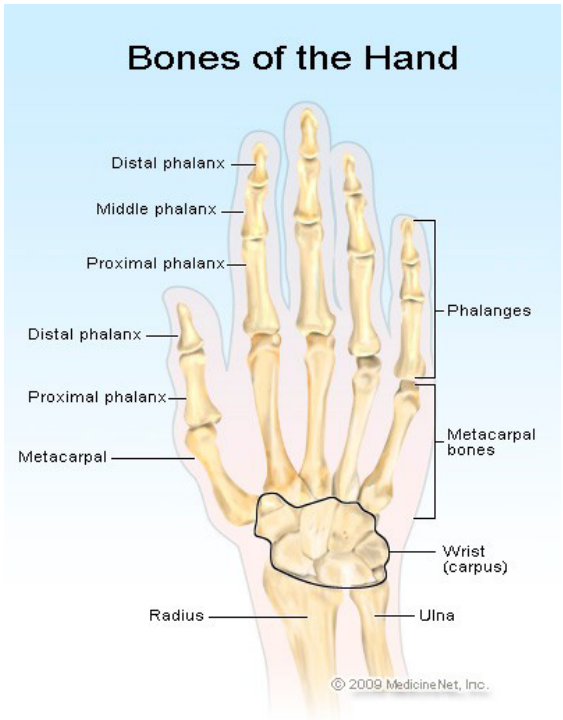
- Rare fx
- Teenager or adolescent
- Hard to diagnose- not easily seen on film
- Heals poorly
- Concern avascular necrosis
- Typical mechanism: fall hyperextended wrist
- Snuffbox pain
- Treat: thumb spica splint

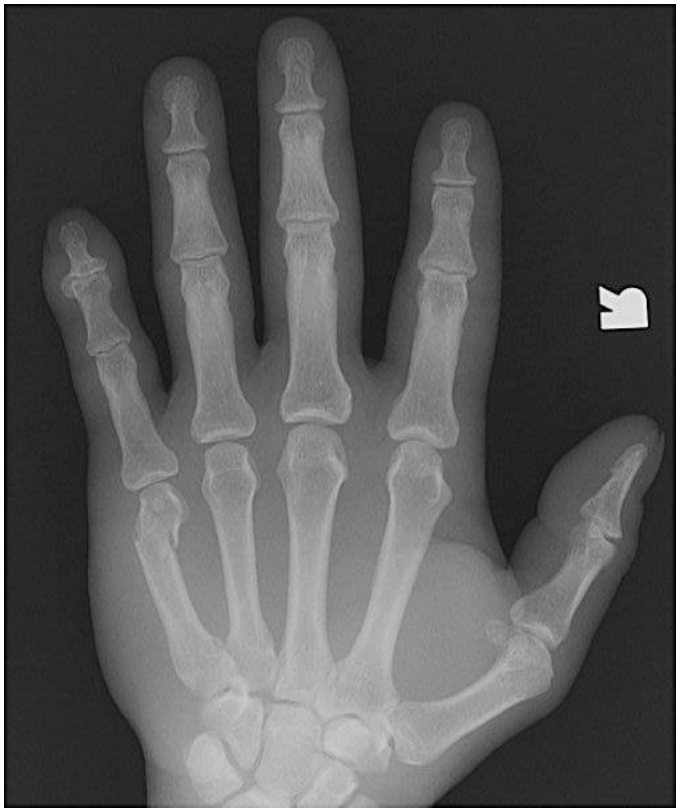




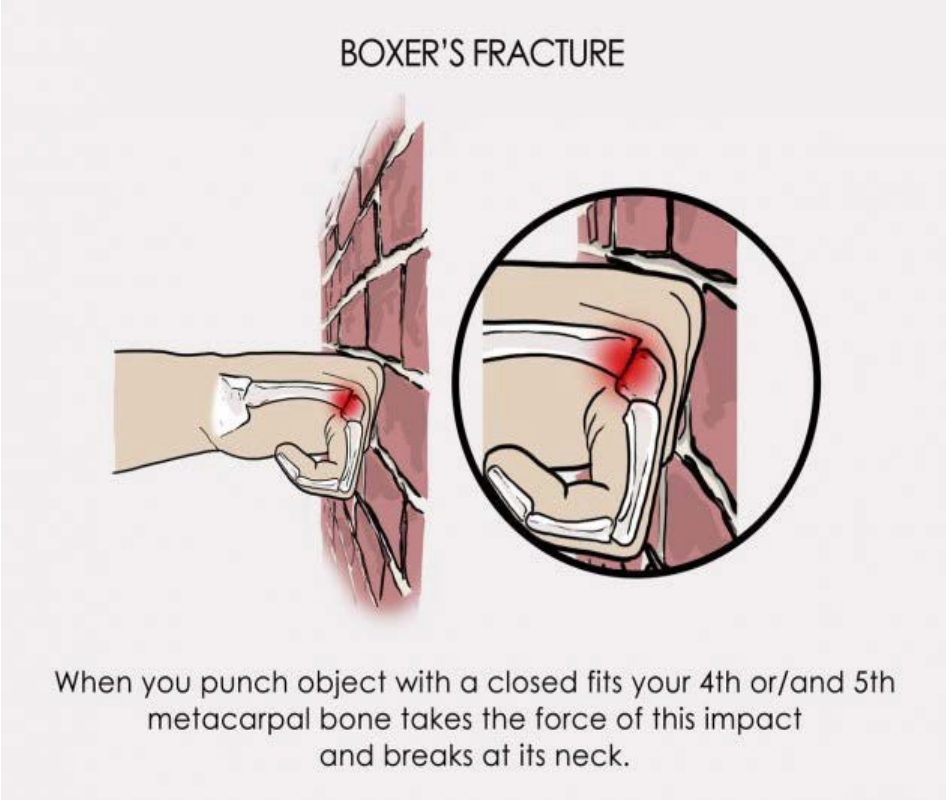
Boxer's Fx

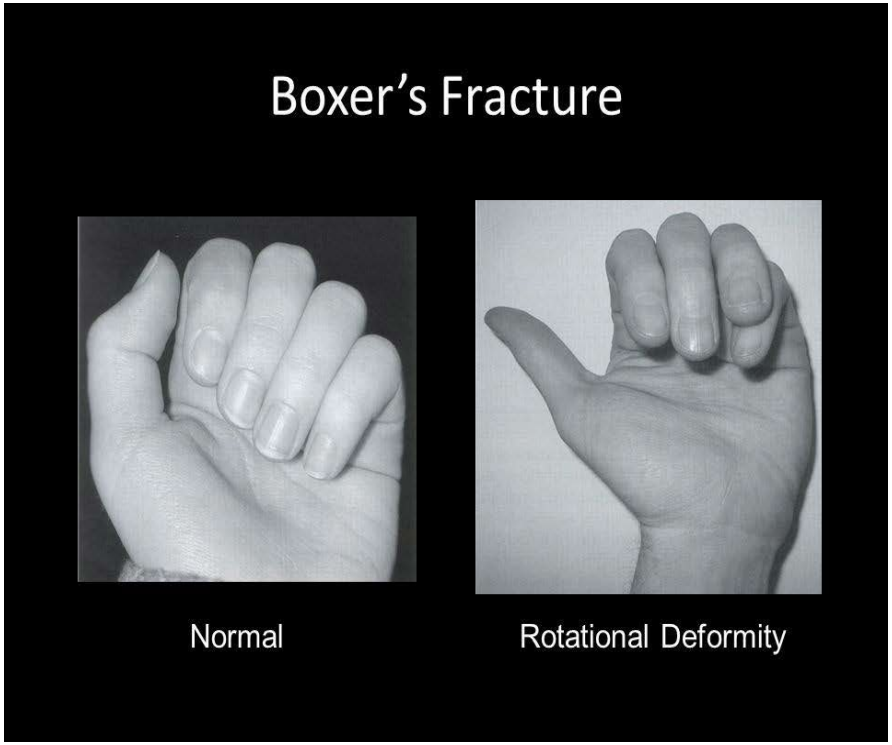






Boxer's Fx





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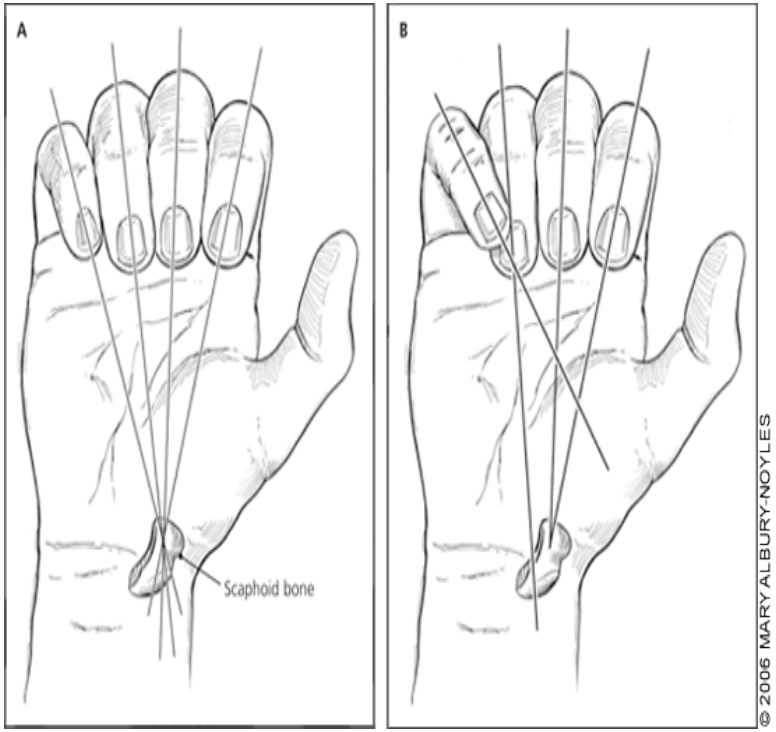
Boxer's Fx

- Uncommon injury
- Adolescent boy
- Mechanism of injury= direct blow/ strike object w/ closed fist
- Fracture 4th or 5th metacarpal
- Be wary of **infection**
- Look for rotational defects
- Never acceptable in fx of mcp or phalanges
- Reduce if angulation > 30'
- Ulnar gutter splint

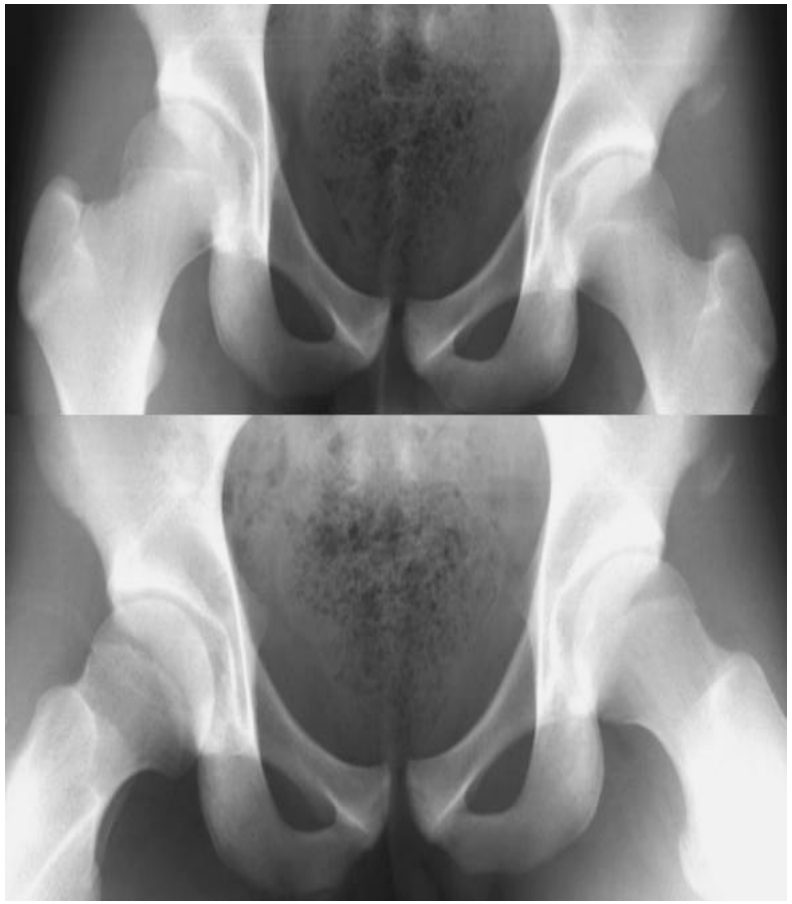


Diagnosis?

15 year old baseball player
Rounding 3rd base, acute pain in hip while running Pain is sharp, felt " pop"
Finished game but has pain walking
Exam benign except pinpoint tenderness at AIIS, worse w/ abduction of hip

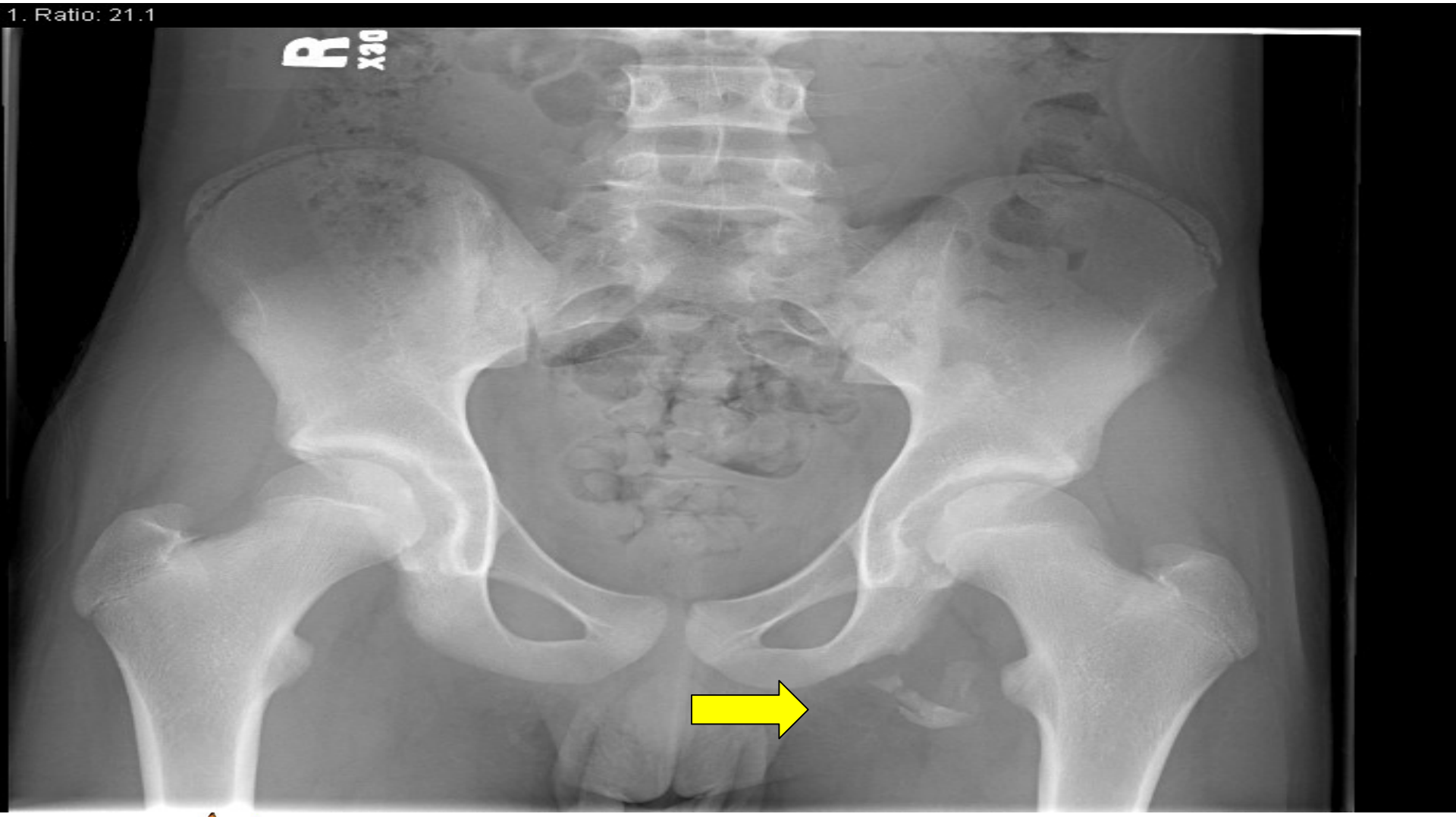
Pelvic Avulsion Fx

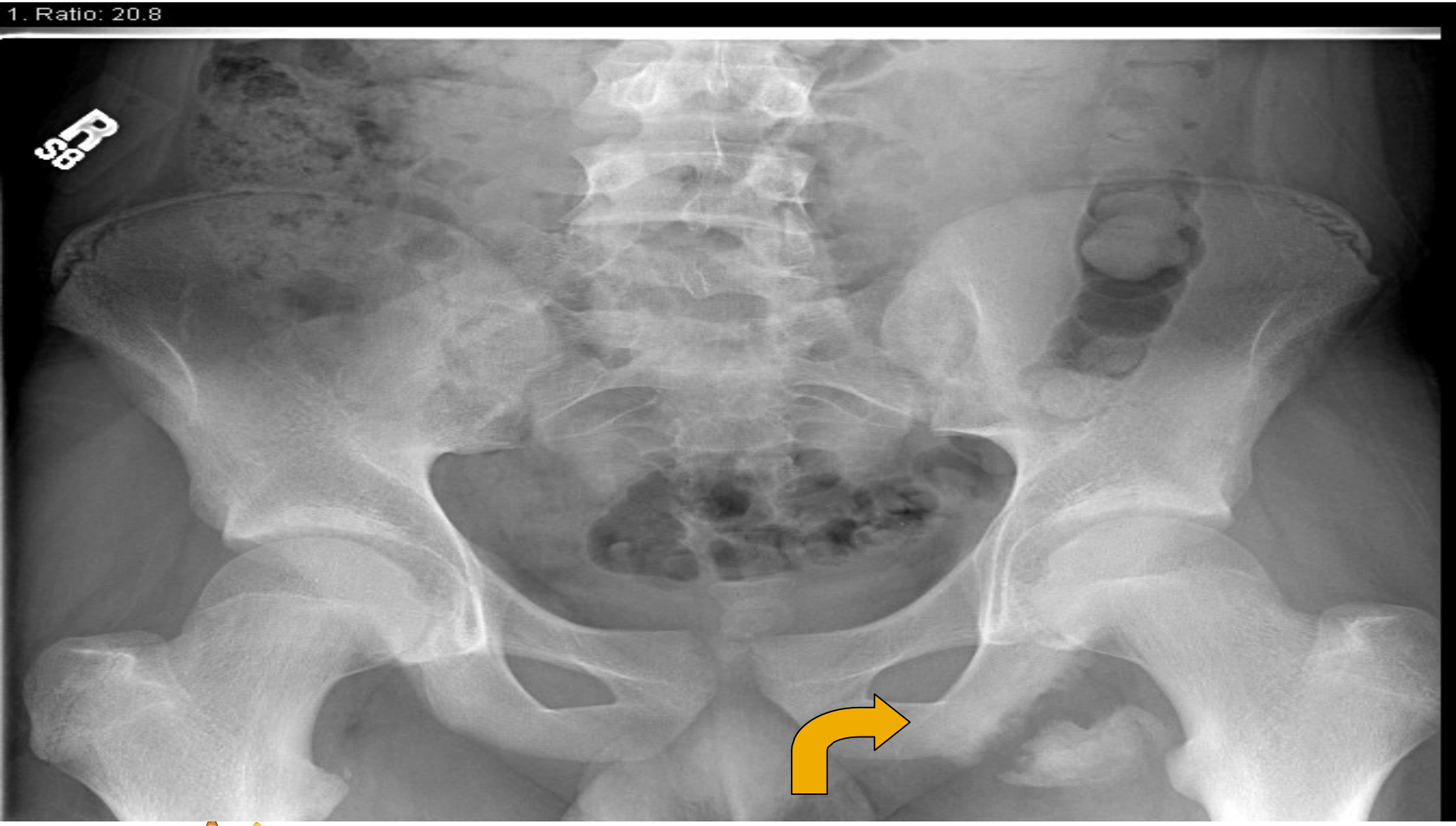
- Intense muscular contraction
- Subsequent shearing of secondary ossification center
- Pelvis, tibia tubercle, phalanges
- Require conservative care
- Adolescent -14-18 yrs
- 90% Male
- 80% sports related



Pelvic Avulsion Fx

- Localized tenderness
- Pain with ROM and stretch
- Pain worse with activity
- Antalgic gait
- Limp
- Pelvis XR



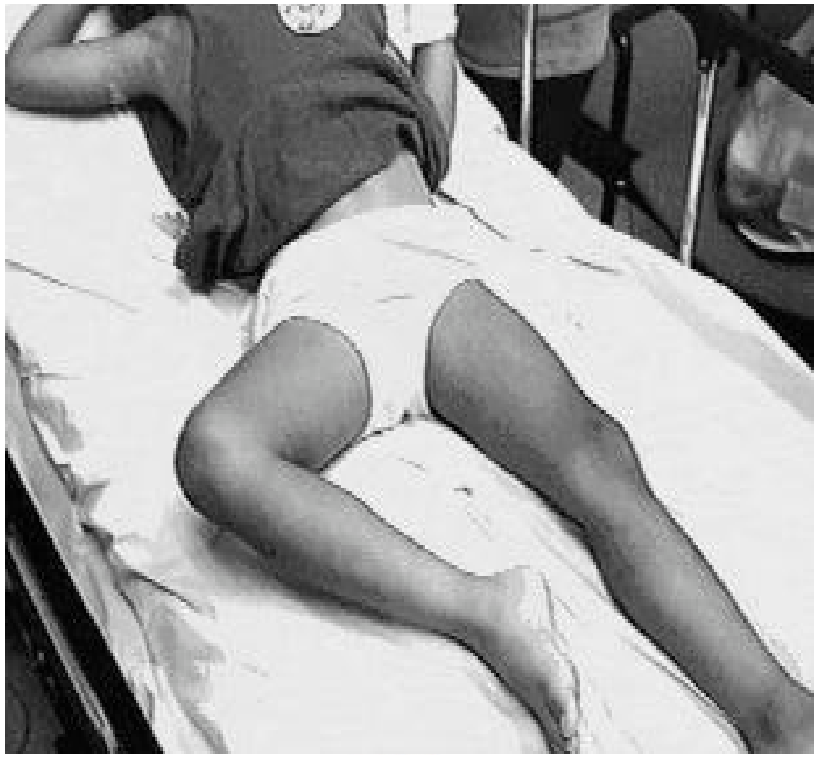


Pelvic Avulsion Fx: Treatment

- Conservative treatment:
  - rest from sport/activity crutches
  - NSAID's
- Symptoms usually decrease in 2-4 weeks
- Often 2-3 months of activity modification needed
- Physical Therapy program: often helpful

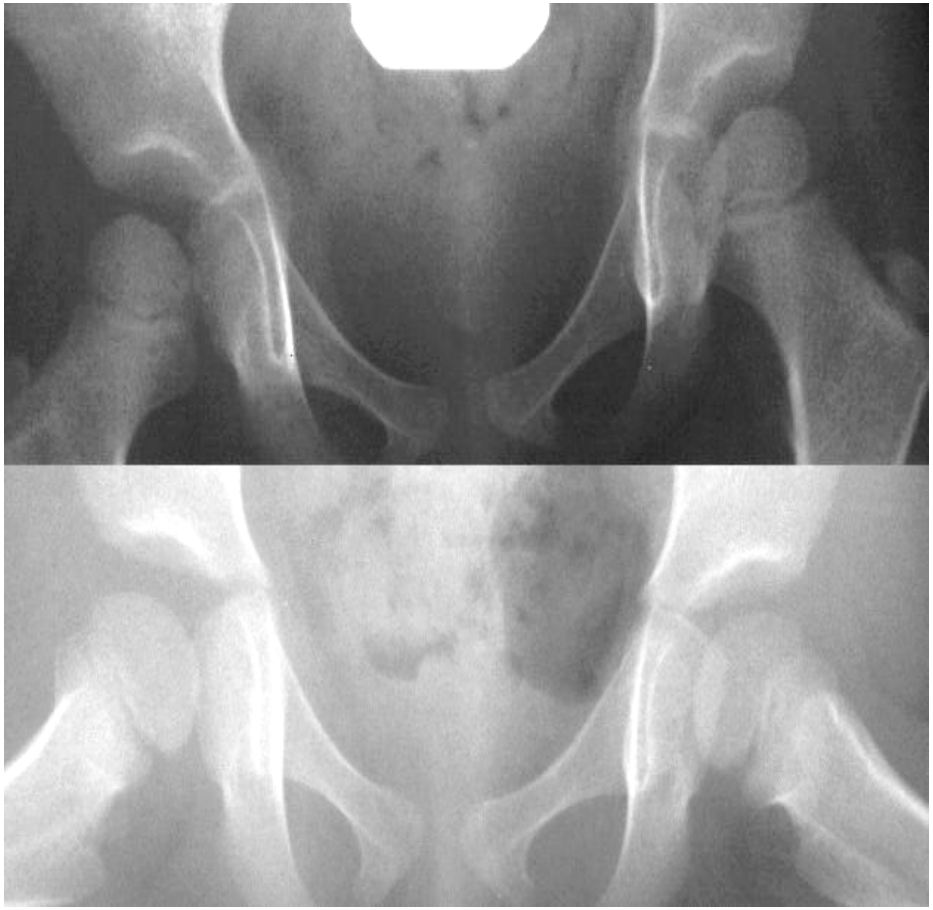
Bad?

- 4 yr old, previously healthy
- Febrile, R leg pain x 1 night
- Slipped and fell earlier but able to walk immediately
- Temp 40.7, HR 160
- Uncomfortable, non toxic
- Refuses to wt bear at all
- R leg held externally rotated and abducted
- ROM severely limited due to pain
- What is going on ?
- What do you want to do?



What now?

- WBC 21.7, 85 seg, 4 bands
- CRP 8.2
- ESR 48
- What do films show?

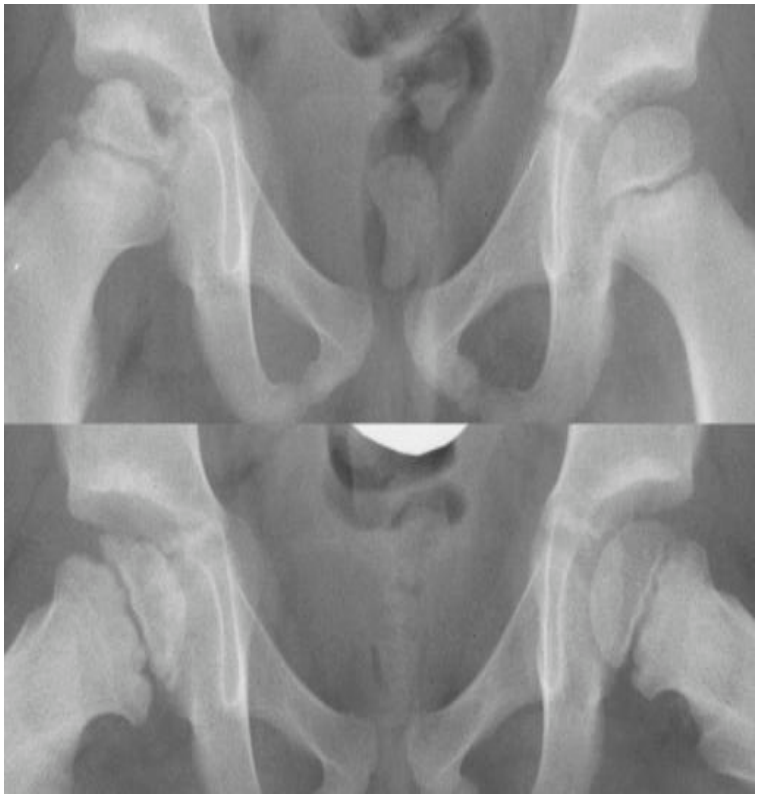


Septic Arthritis

- Peak age < 3 yrs
- Usually single joint
- Most common: hip, knee, shoulder, elbow
- Hematogenous seeding bacteria to joint
- Direct spread from adjacent osteomyelitis or trauma
- Staph Aureus most common pathogen
- Neonate:
  - Staph aureus, Group B Strep, Gram negative bacilli
- Toddler:
  - Staph aureus, Group A Strep, S pneumonia
- Sexually active teen: Neisseria gonorrhoeae

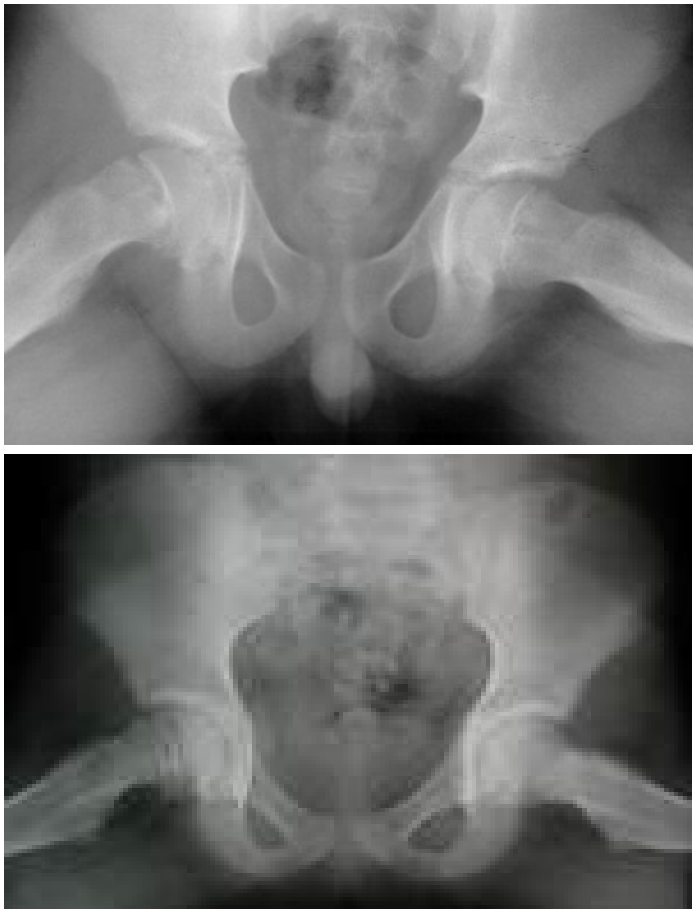
Septic Arthritis

- Non specific findings in neonates
- Older kids more localized pain, fever, decreased ROM
- Septic hip - classically
  - **leg externally rotated ,flexed, abducted**
- Delay in diagnosis/ tx results rapid cartilage destruction, ischemia, avascular necrosis
- Film frequently normal w/ acute septic arthritis
- U/S- highly sensitive for detection effusion
- Lack of effusion does not exclude infection
- Labs include : elevated ESR and CRP
- WBC may be normal or elevated
- Blood cx + < 50% cases
- Caird, et al (J Bone Joint Surg, 2006)
  - Fever, elevated ESR and CRP best predictor septic joint
- **True orthopedic emergency**
- Arthrocentesis for diagnosis, OR, antibiotics 4-6 wks



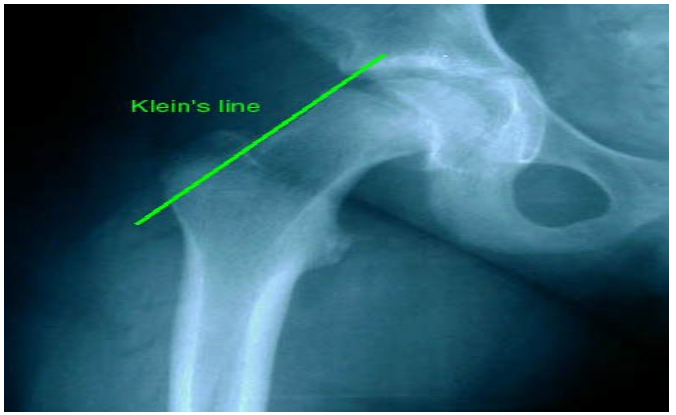
Case 4

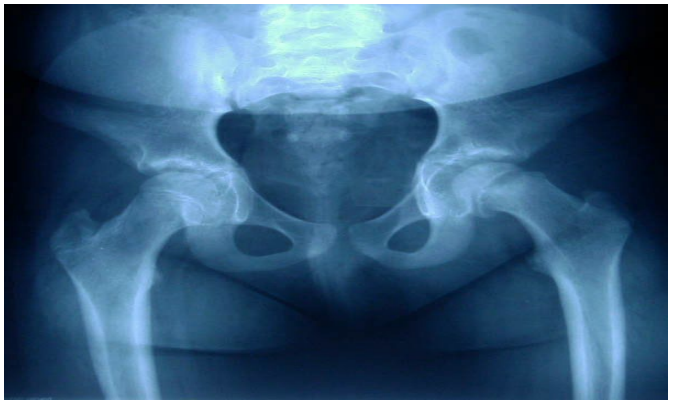
- 14 yo M with 3 month hx limp and R knee pain
- Wt 100 kg
- Limps, has pain with ROM R hip
- Internal rotation and flexion of hip most limited
- No warmth, redness, afebrile
- What is going on?
- What do you want to do?



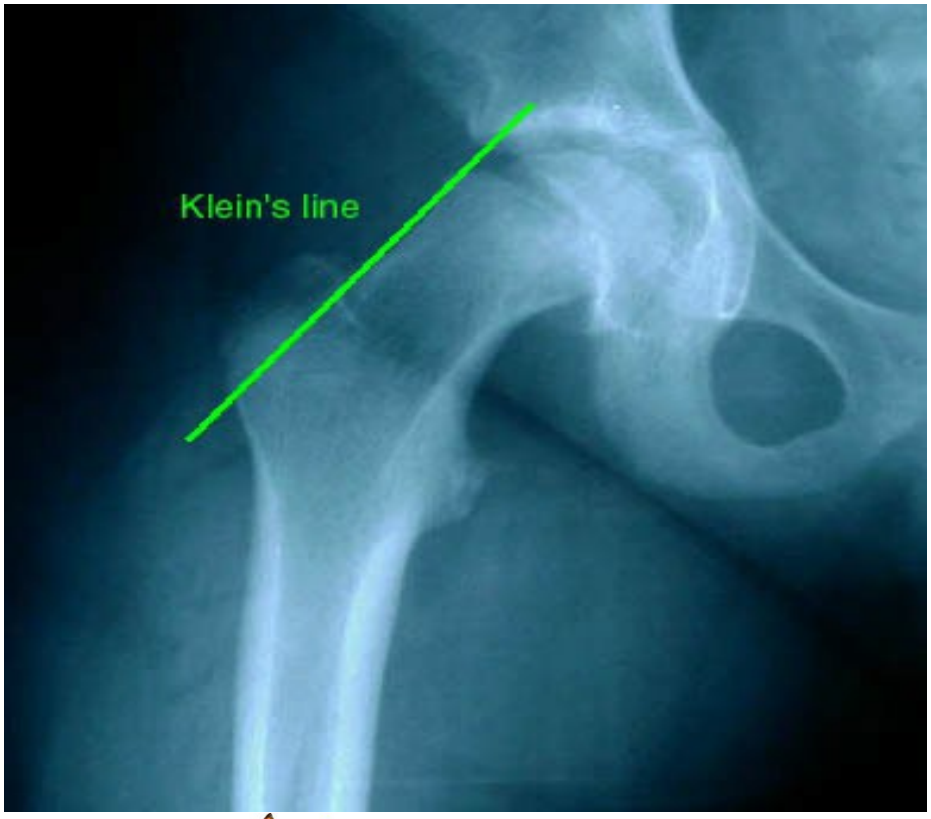
Slipped Capital Femoral Epiphysis

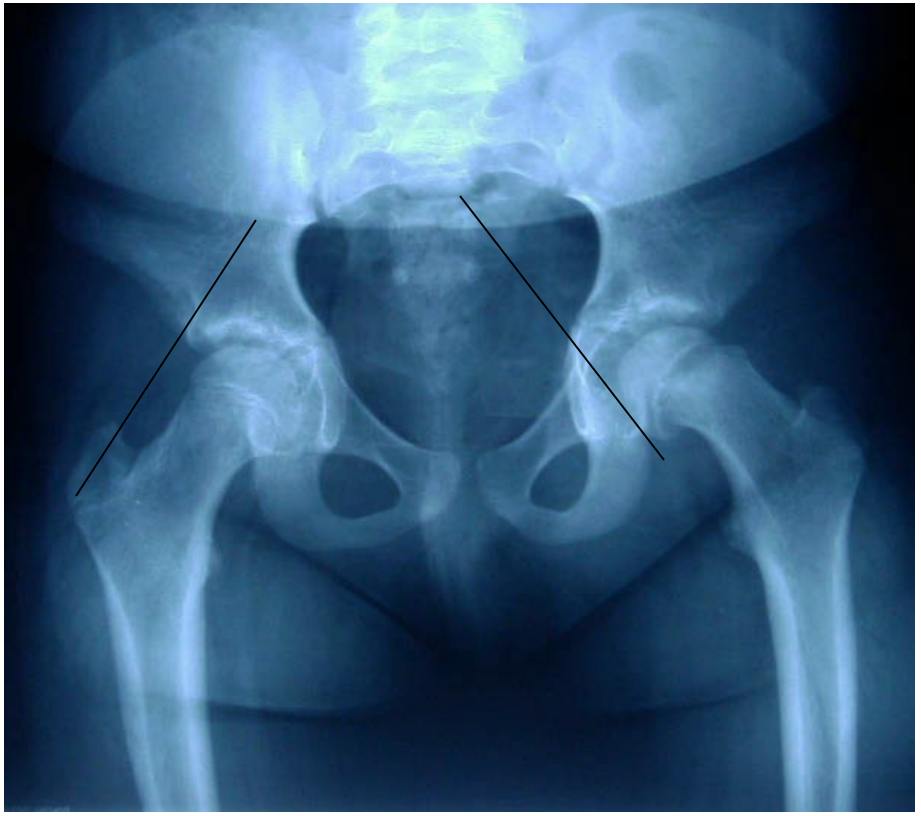
- Etiology unknown
- M > F (2:1)
- Obese
- Black/African American, 8-15 yrs of age (time of growth spurt)
- Almost all cases present w/ chronic hip or knee pain
- Limited: internal rotation, abduction, flexion
- Must consider in any preadolescent or adolescent with knee pain
- Must get AP, frog leg views pelvis, both hips need comparison – slip may be subtle
- 10-25 % cases bilateral





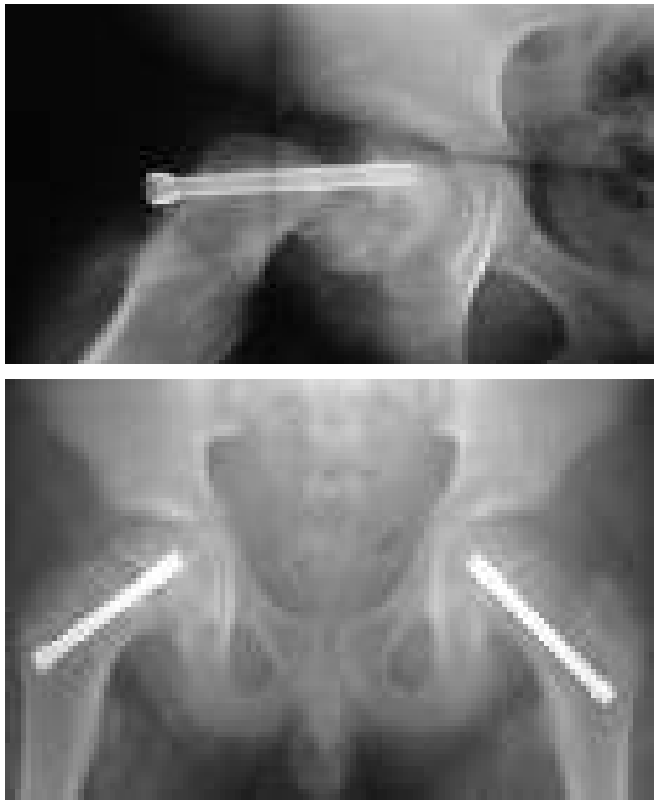
SCFE





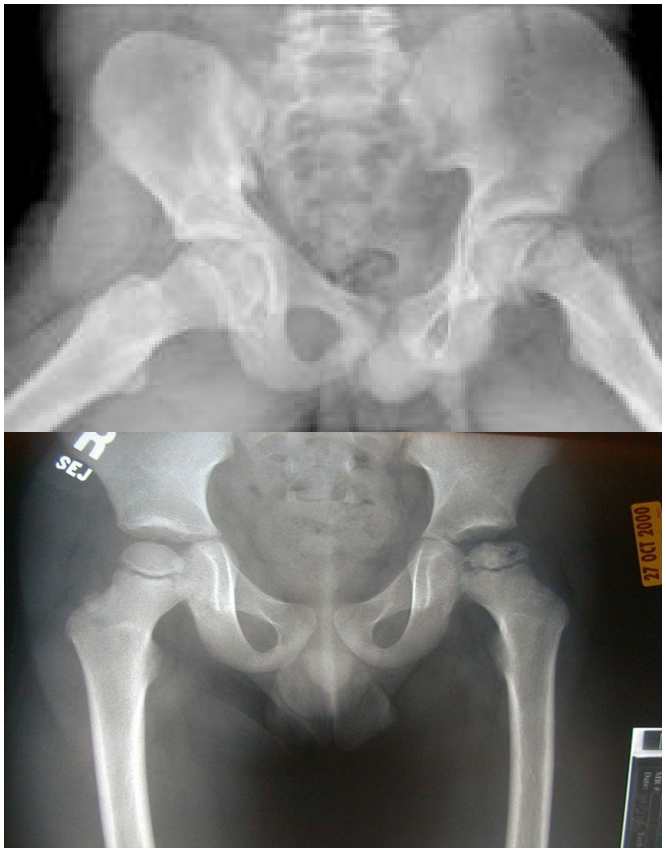
SCFE Tx

- Strict non wt bearing
- Goal: prevent further slippage
- Ortho evaluation urgently
- Screw placement/ pinning
- Complications
  - Contralateral SCFE
  - AVN
  - Degenerative changes



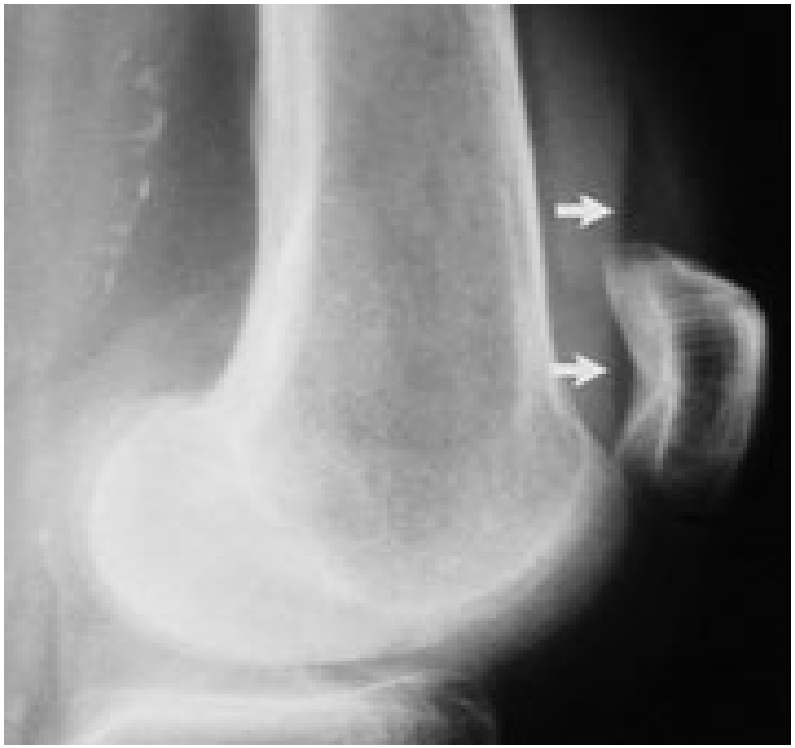
Avoiding Pitfalls

- Hip pain often referred to the knee in children
- Always examine hip in any child with knee pain
- Misdiagnosis common:
  - Legg-Calve-Perthes, SCFE, malignancy, JIA
- Red Flags
  - prolonged fever
  - pain awakens from sleep
  - swollen red joints
  - unexplained wt loss
  - unexplained bruising
  - ill appearance



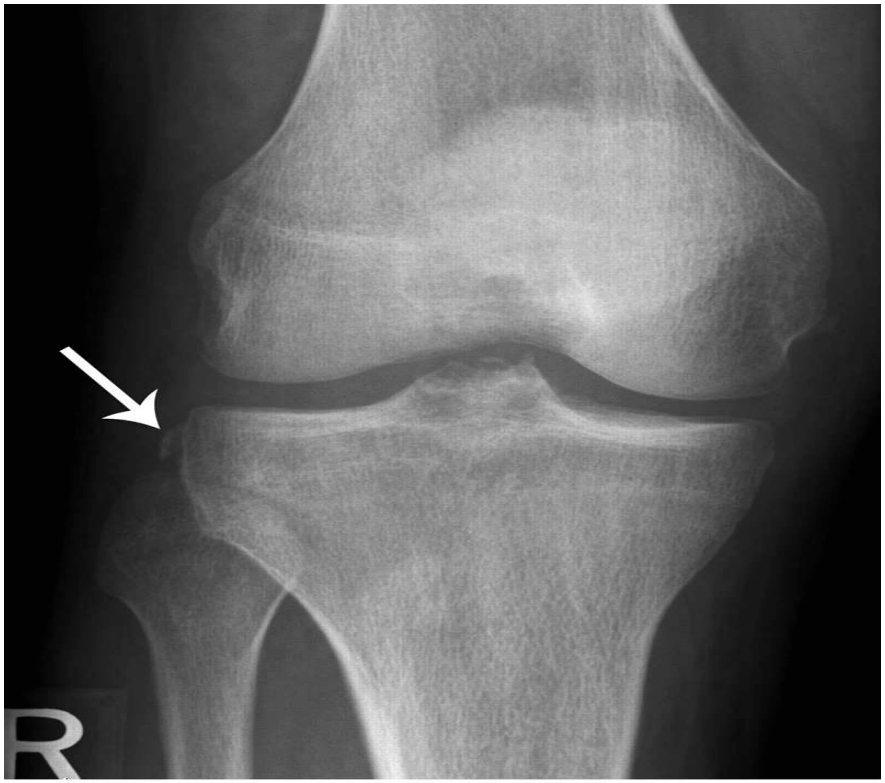
Case 5

- 16 yr old female soccer player
- Planted leg, felt “pop”
- Immediate pain
- Quite swollen
- Hard to weight bear
- What does film show?



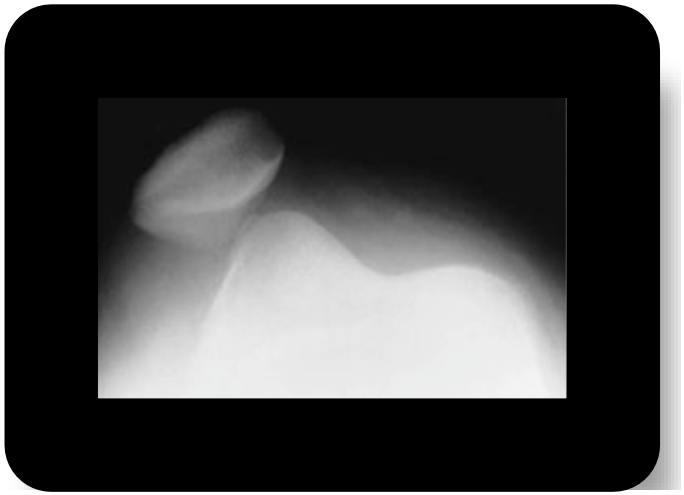
Segond Fracture

- Lateral capsule sign
- Avulsion fx lateral aspect proximal tibia
- Pathognominic for intra-articular injury
- >70% ACL tear



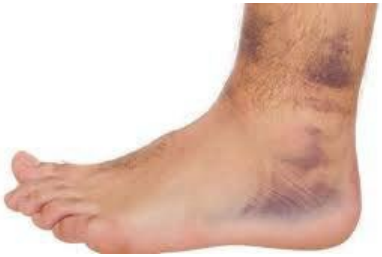
Diagnosis?

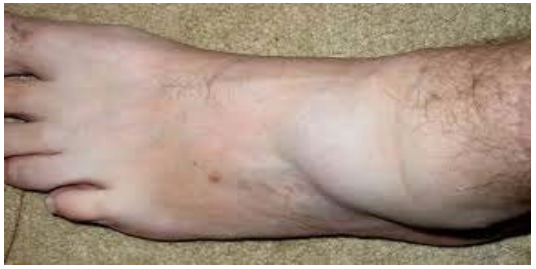
- “pop”
- Large effusion, medial knee pain
- May reduce spontaneously
- May require ER visit
- Adolescents
- F > M



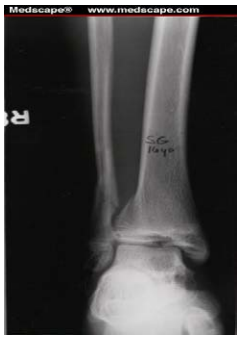
Case 6

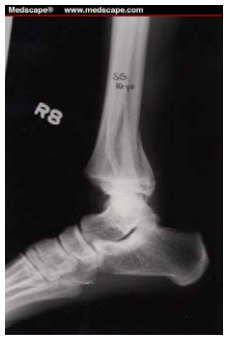
- 16 yo M skakeboarder, landed badly trying to do trick
- Cannot wt bear
- Diffuse swelling to ankle/ foot
- Wiggles toes gingerly
- Good pedal pulse
- Isolated injury
- Bad or really bad?

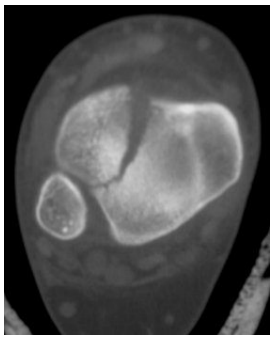


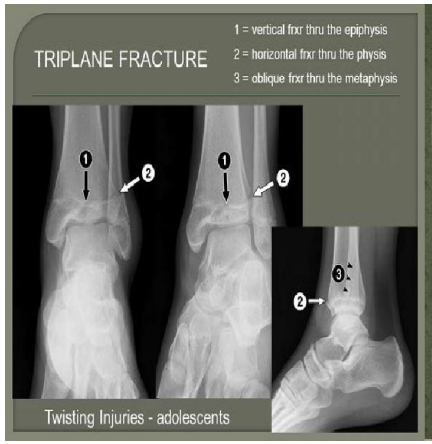


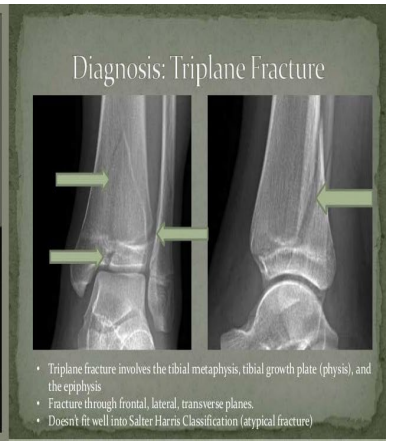
Triplane Fracture







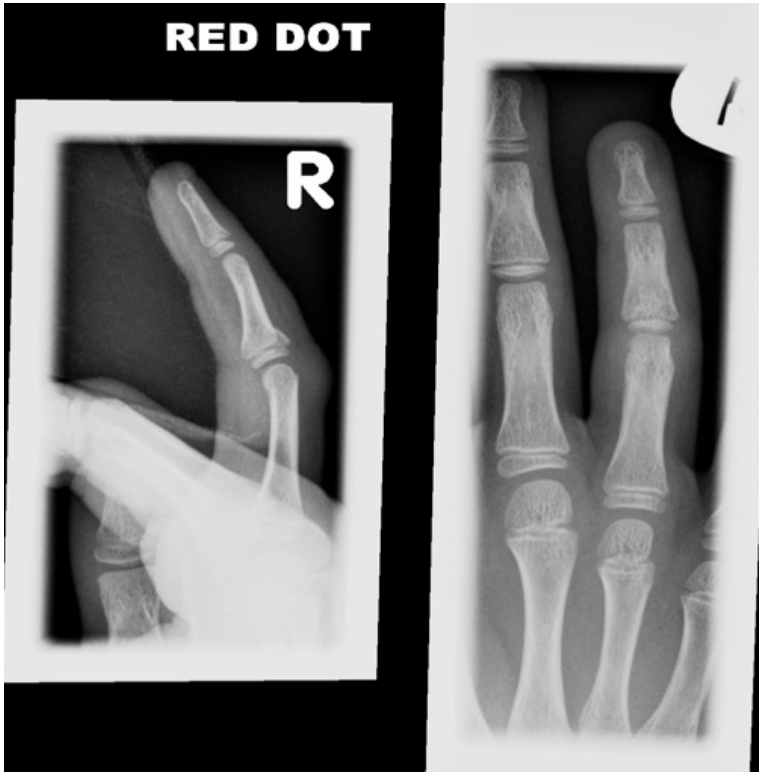




- Unusual fracture
- Combination SH 2 and SH 3 fx of distal tibia
- Associated fibular fx common
- Most common 12-15 yrs of age
- Unstable fracture
- Require Ortho consult
- Growth plate damage potentially significant
- Anatomic reduction essential

Question 1

- 10 yo M presents to ED after hurting R index finger playing basketball
- Swelling/tenderness of PIP joint
- Film shows fx line through the growth plate extending into the metaphysis
- This is what type of SH fracture?



Question 2

14 yo M with R wrist pain after falling while skateboarding. He thinks he landed on his R hand when he tried to brace himself.

Exam: mild swelling in wrist
snuff box pain and pain when pressure applied to thumb pain with supination forearm/ hand

XR negative

What do you want to do:

a. Velcro wrist splint
b. Sugar tong splint
c. Thumb spica
d. Ace wrap
e. Volar splint

Question 3

What nerve is most commonly injured in a child with a supracondylar fracture?

a. Median
b. Ulnar
c. Radial
d. Brachial

Question 4

In children, the most common site of fracture is

- a. Clavicle
- b. Tibia
- c. Femur
- d. Forearm

Question 5

Testing of the motor component of which nerve can be accomplished by having the patient make an “OK” sign with the thumb and forefinger?

- a. Axillary nerve
- b. Radial nerve
- c. Anterior interosseous branch of the median
- nerve
- d. Ulnar nerve

Question 6

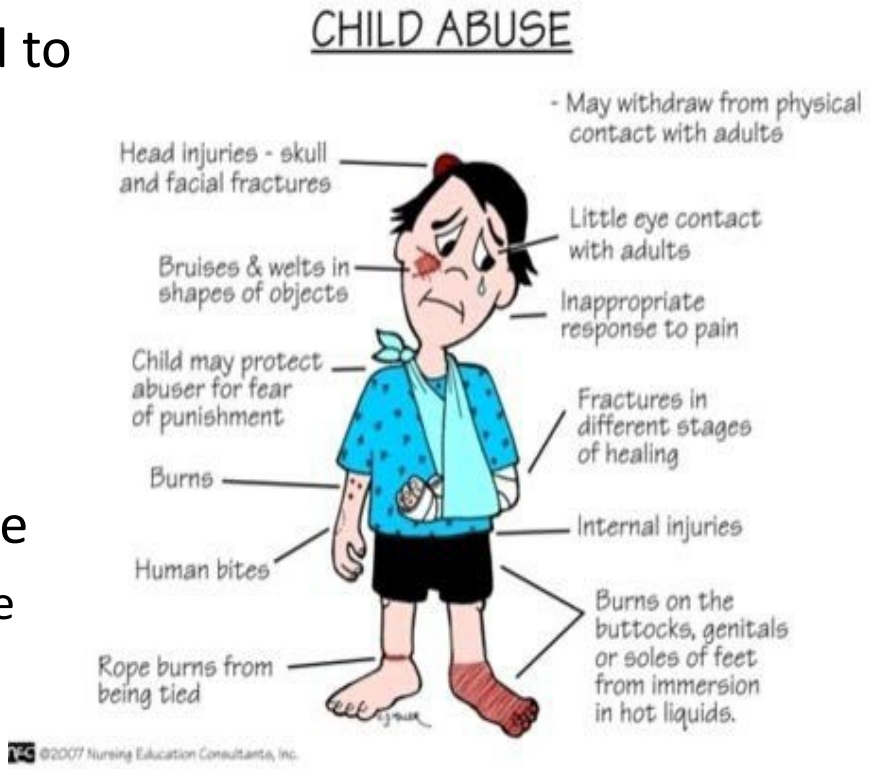
Which of the following findings on a lateral elbow xray is most indicative of a fracture?

- a. Elevated posterior fat pad
- b. Lack of an anterior fat pad
- c. Anterior humeral line intersecting the capitellum
- d. Radiocapitellar line intersecting the capitellum

Questions & Discussion

Non-accidental Injury

- Close to 1% all children victims of abuse
- 1/3 of these kids will be reinjured
- 1-5% of these kids will die if returned to original environment
- Abuse is 2nd leading cause of death infants and children
- Majority < 1 year of age
- Must have high index of suspicion
- Risk factors: parental substance abuse
  - Young parent child < 3 yrs old premature disability



Non-accidental Trauma (NAT)

History

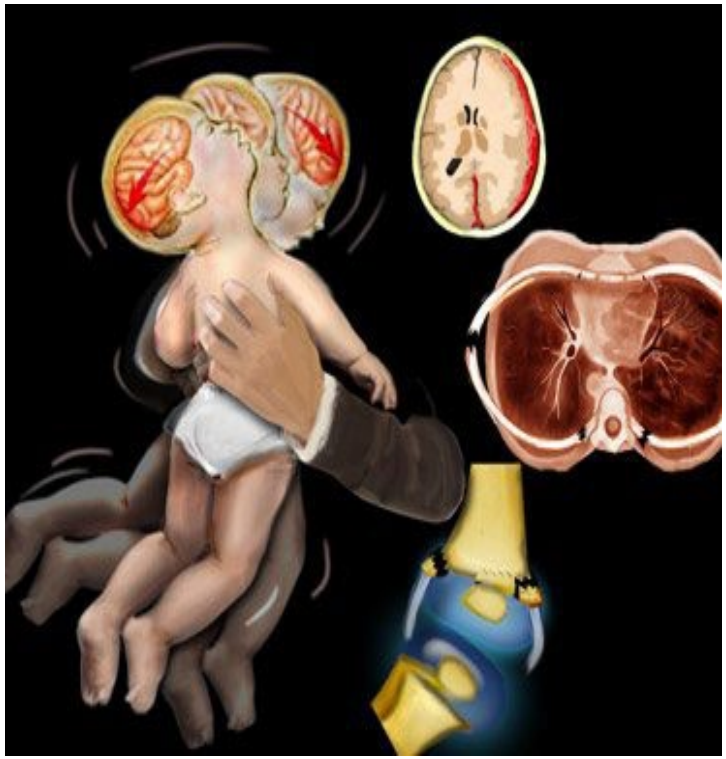
- Mechanism
- Is story plausible
- Who witnessed event
- Time from injury to tx
- Who has access to pt
- Inconsistent stories

Physical Exam

- Serious injury can exist despite no outward signs
- Patterns of bruising/ unexpected areas
- Burns/ scars
- May require ophtho exam/ CT scan (Shaken Baby)

Orthopedic Injuries in NAT

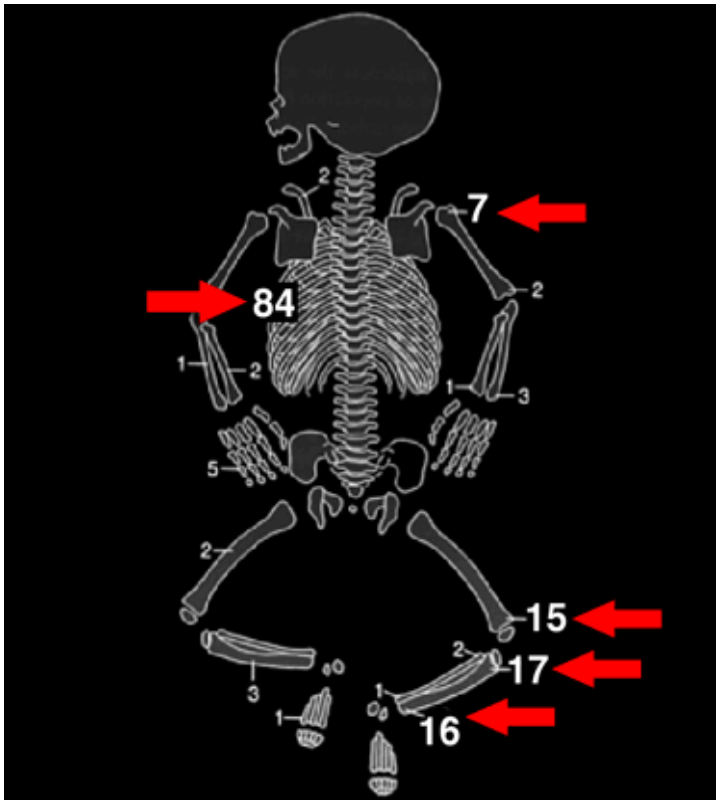
- Seen 30-50% children
- Injuries highly specific for abuse include:
  - Corner or bucket handle fractures
  - Scapular fractures
  - Posterior rib fractures
  - Old fractures
  - Multiple fractures of different ages
  - Spinous process fractures
- Spiral fractures are not pathognomonic for abuse



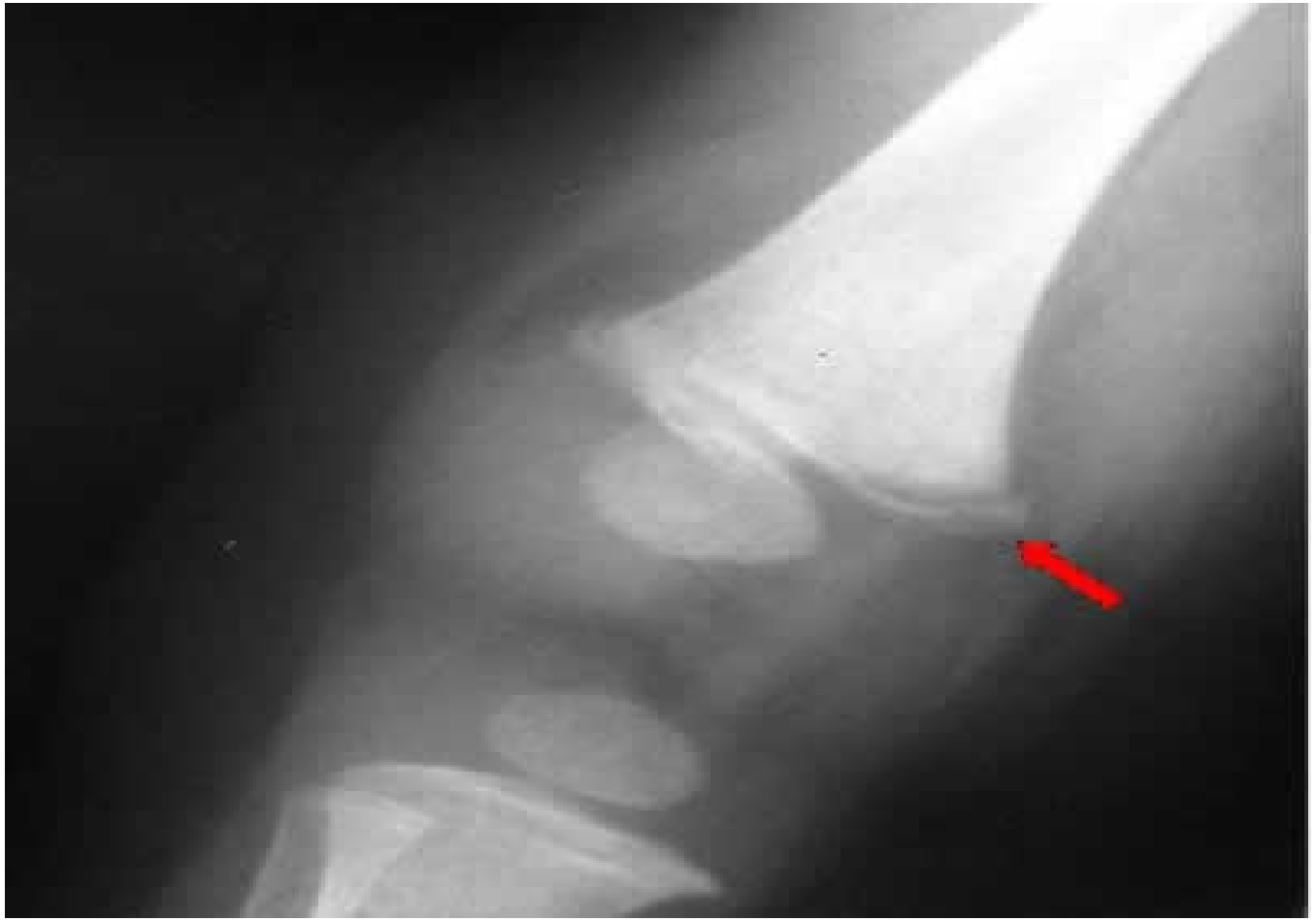
Orthopedic Injuries and Abuse

Fractures *High Specificity for Child Abuse*

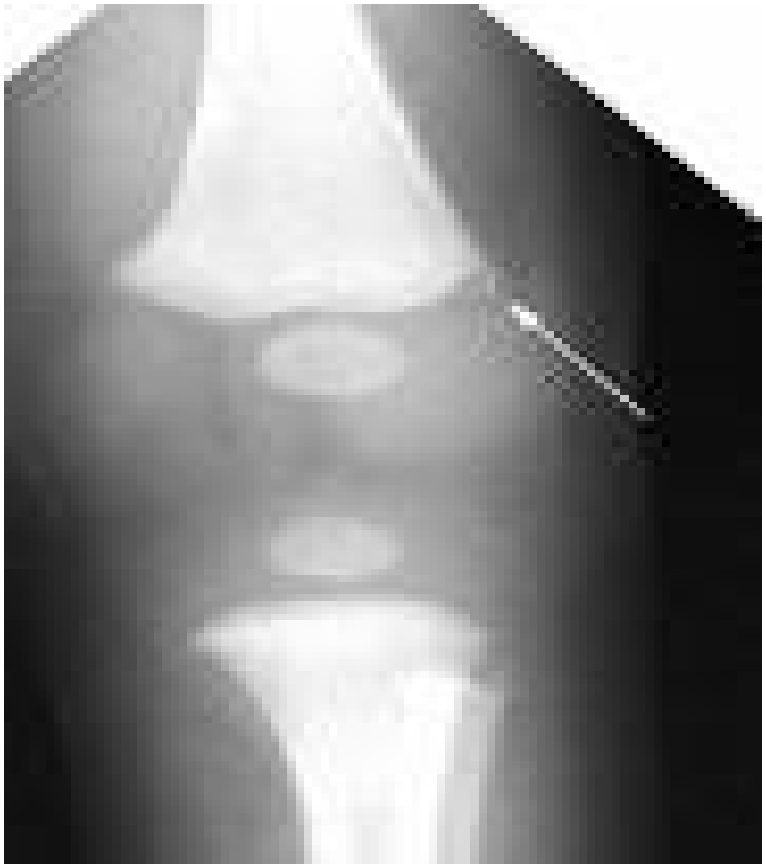
Bucket handle or Corner fractures
Ribs (especially posterior)
Acromion
Spinous processes
Sternum
Occipital impression fractures

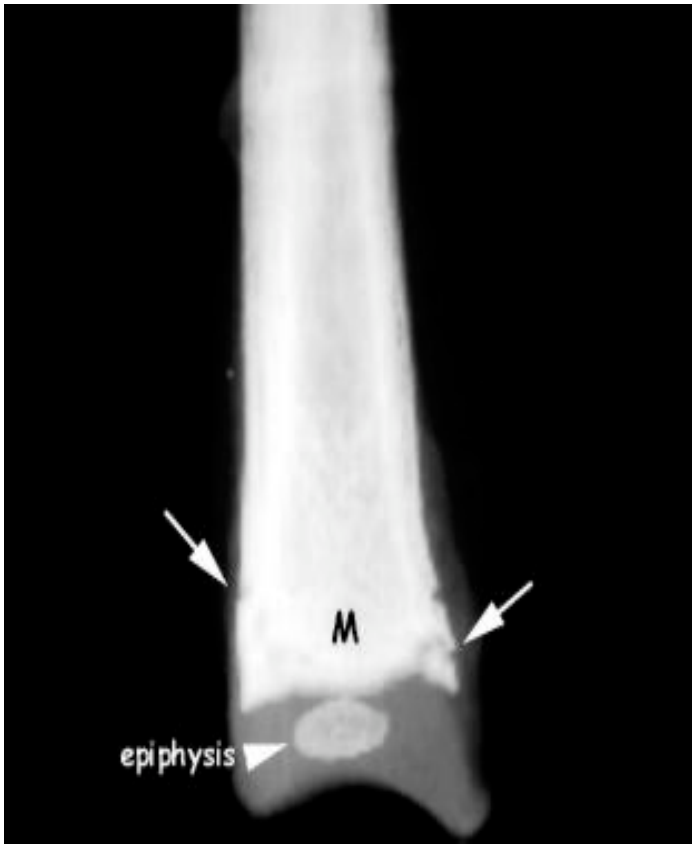


Bucket Handle Fracture

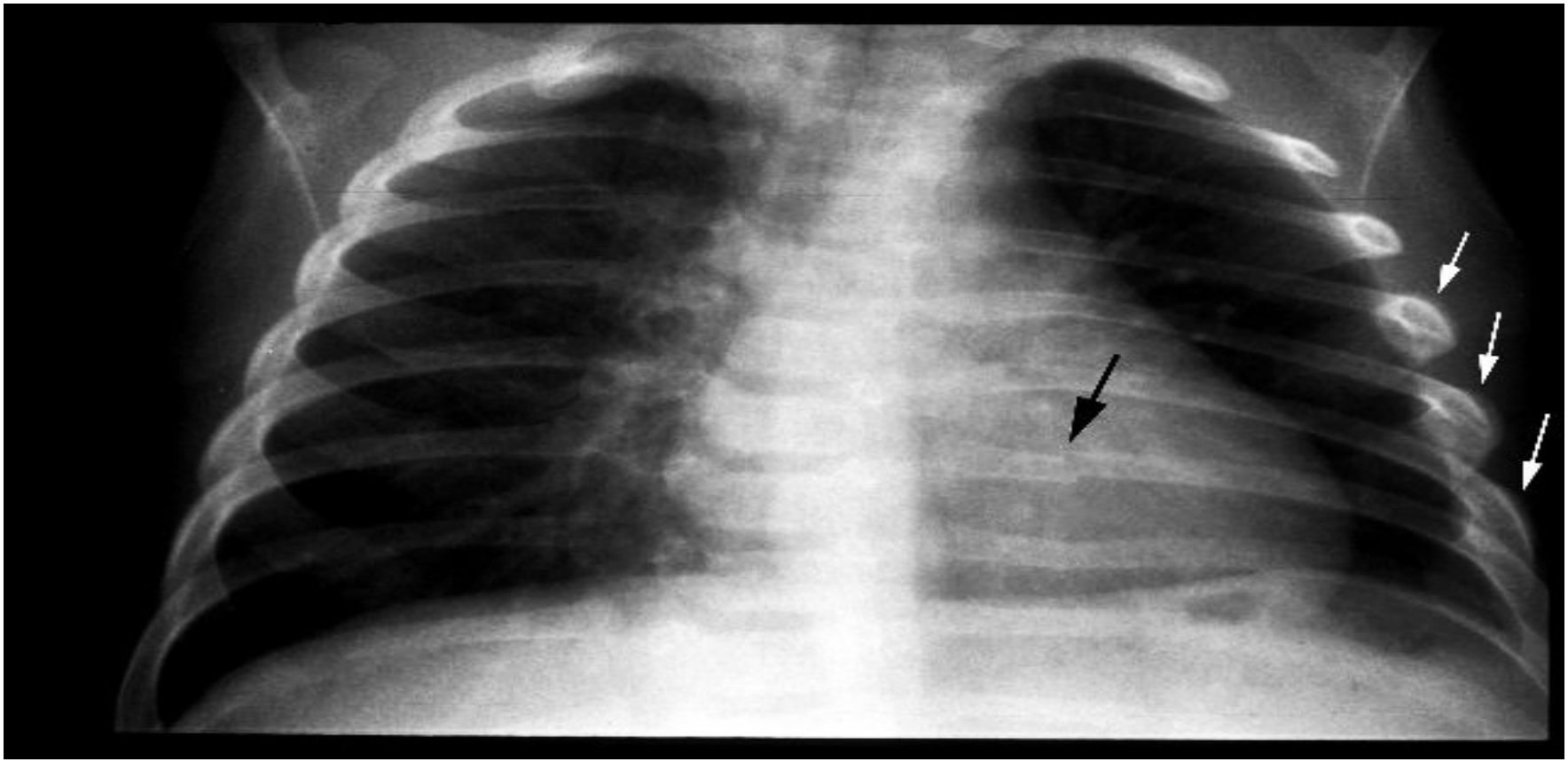


Corner Fracture

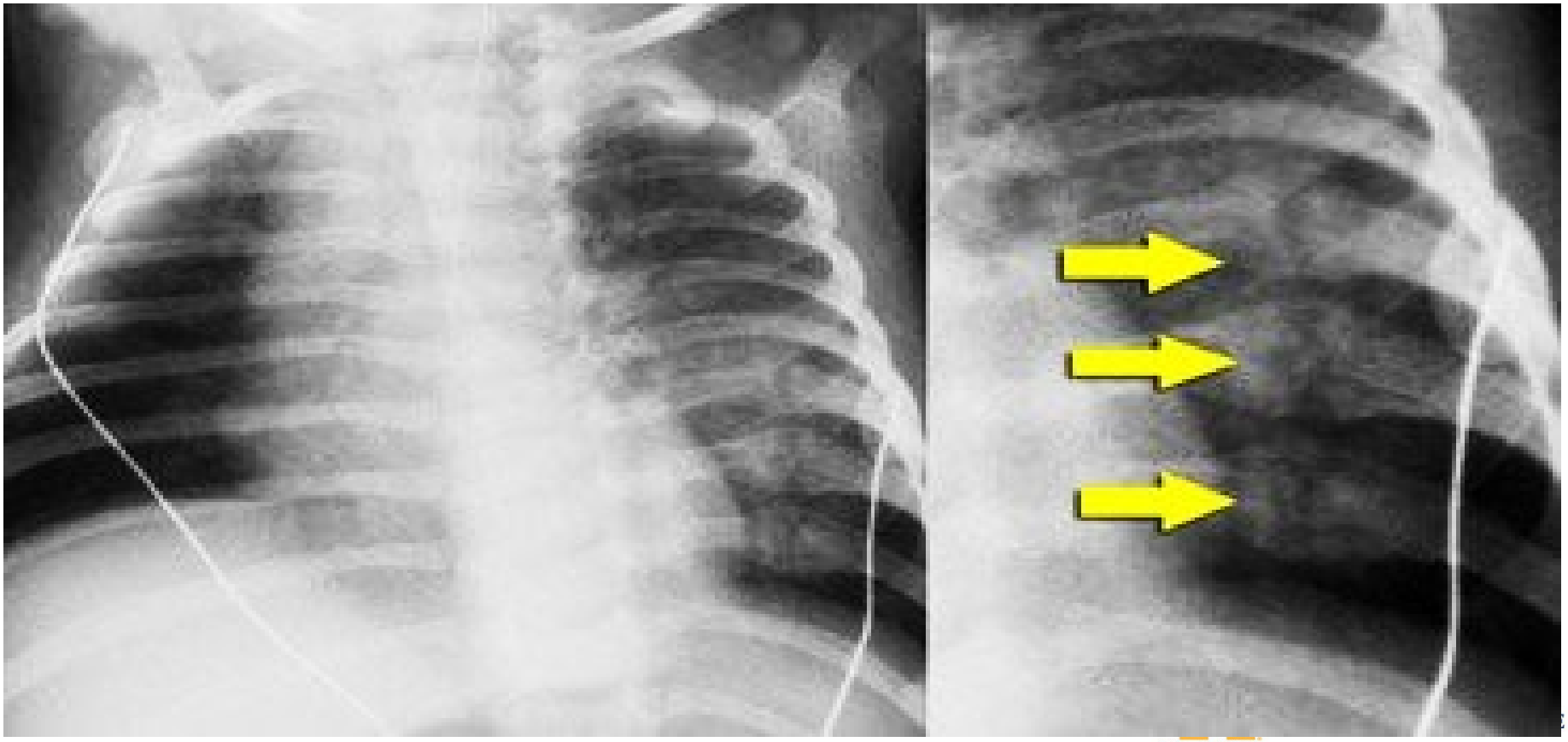




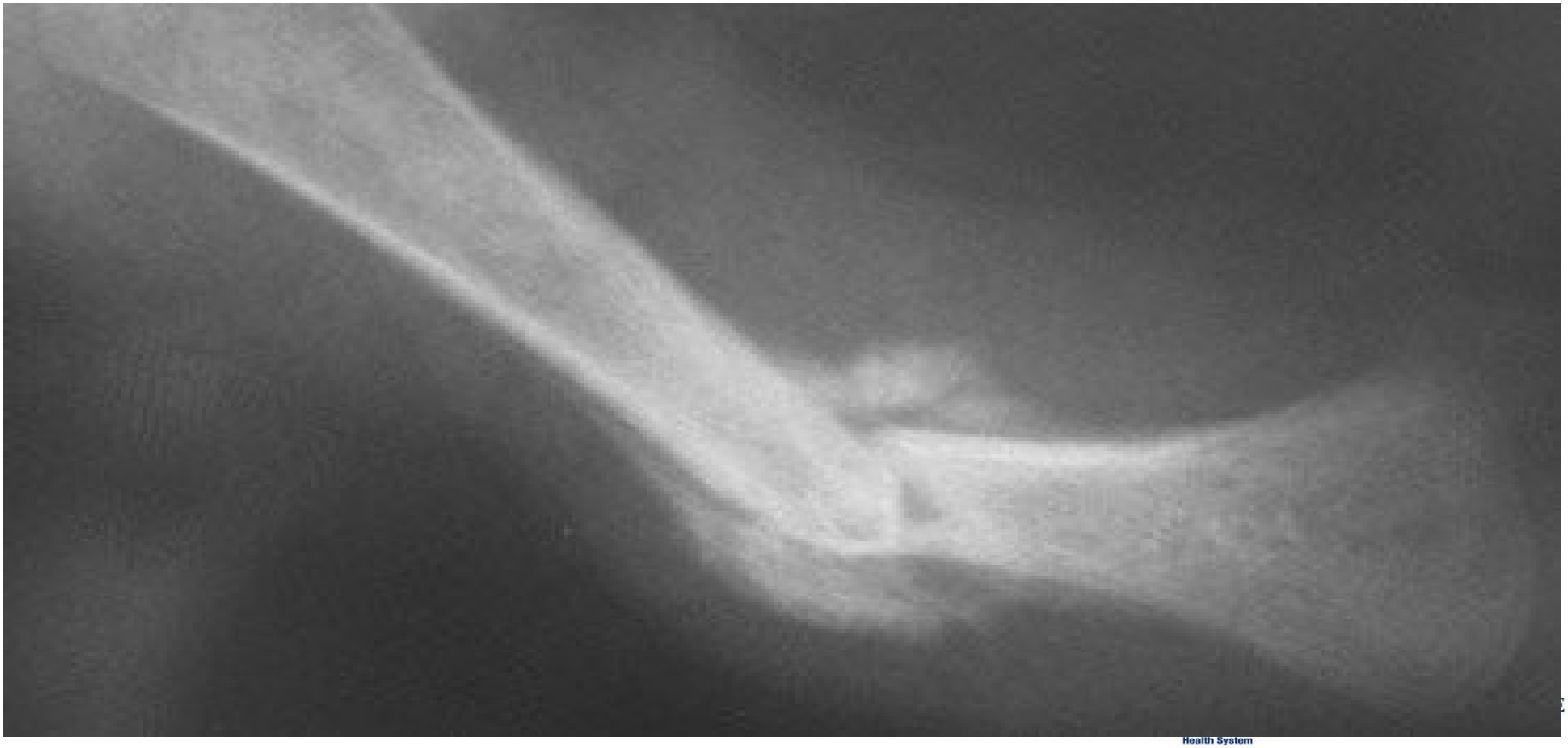
Posterior Rib Fractures



Posterior Rib Fractures



Healing Fracture



Health System

NATIONWIDE CHILDREN'S
When your child needs a hospital, everything matters.℠

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