Pediatric Lower Extremity Trauma

Virginia Casey, MD
Pediatric Orthopedics
OrthoCarolina

Many slides contributed by Christian Clark, MD

Children are not just small adults

- Bone less brittle
- Still growing
  - Ability to remodel
  - Growth plate injuries

Children are not just small adults

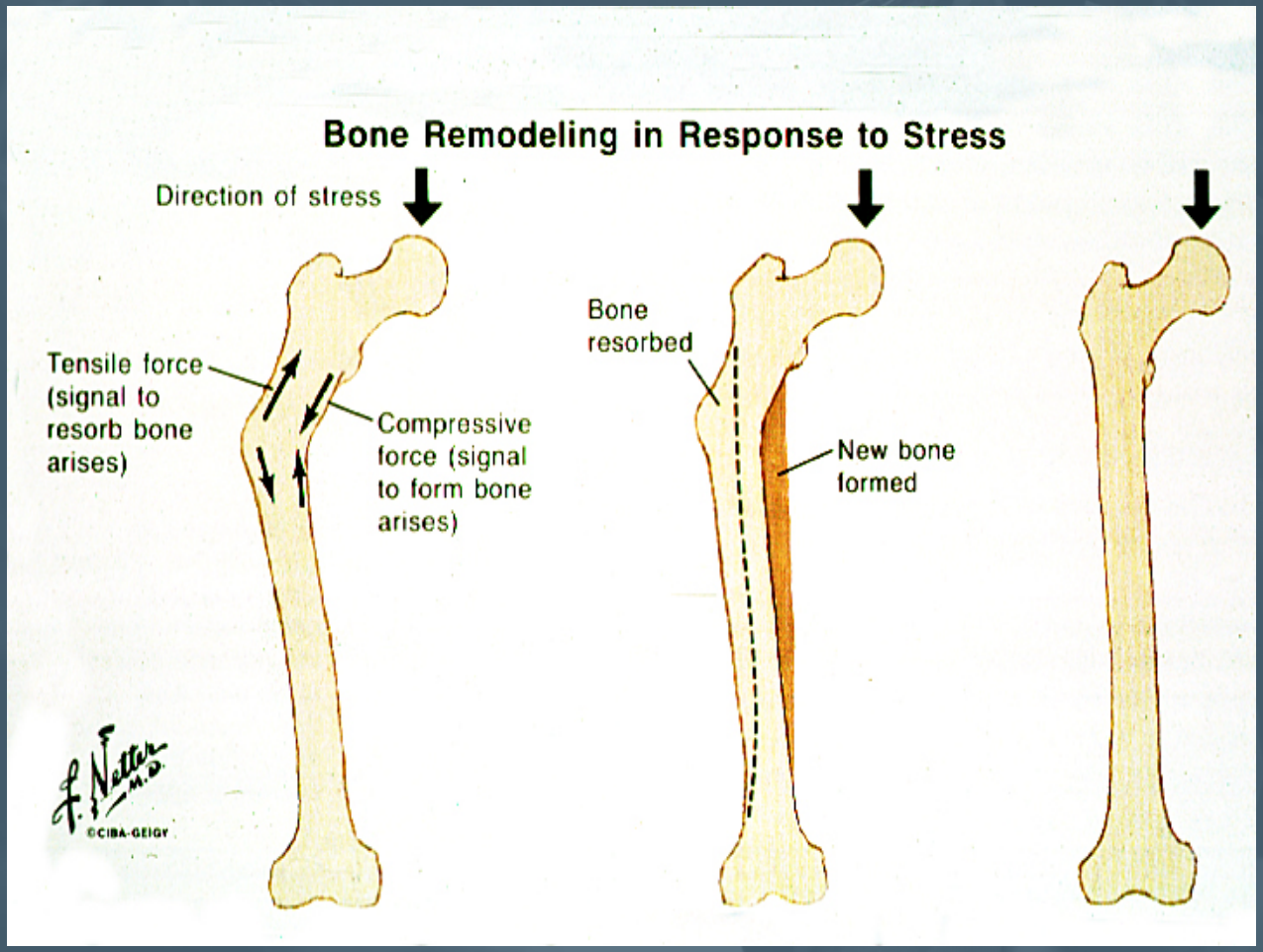
- Growth plate is weaker than ligaments
- Tend to have physeal injuries insteaad of “sprains”

Children are not just small adults

- Many times we will accept more deformity because of the potential to remodel
- Near the end of growth a child will be treated more like an adult

Wolff's Law

- Remodeling of bone occurs in response to physical stresses
  - Bone is deposited in areas of stress and resorbed from sites of little stress


Bone Remodeling in Response to Stress
Direction of stress
Tensile force (signal to resorb bone arises)
Compressive force (signal to form bone arises)
Bone resorbed
New bone formed
F. Netter M.D.
©CIBA-GEIGY

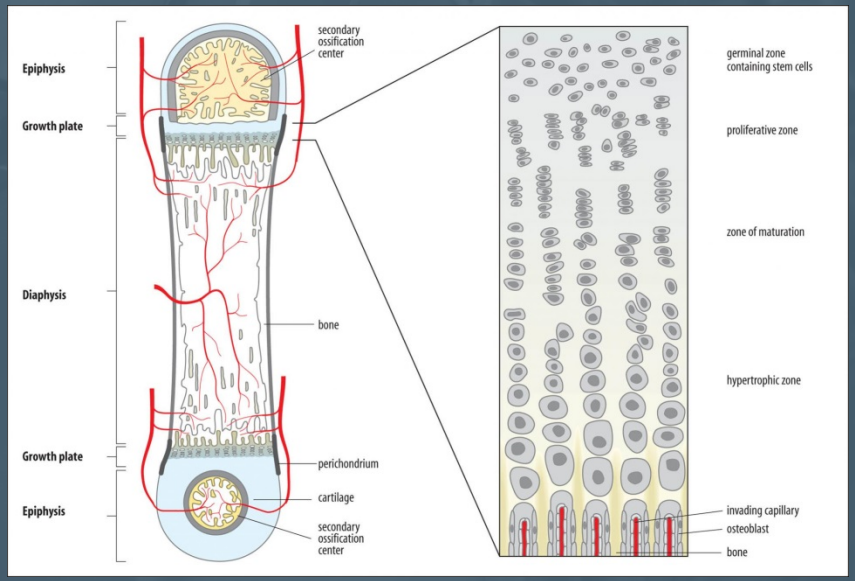
Remodeling

- Amount of growth
  - Patient age
  - Bone / physis involved
  - Location in bone – ie: proximity to physis
- Deformity in plane of motion

Remodeling

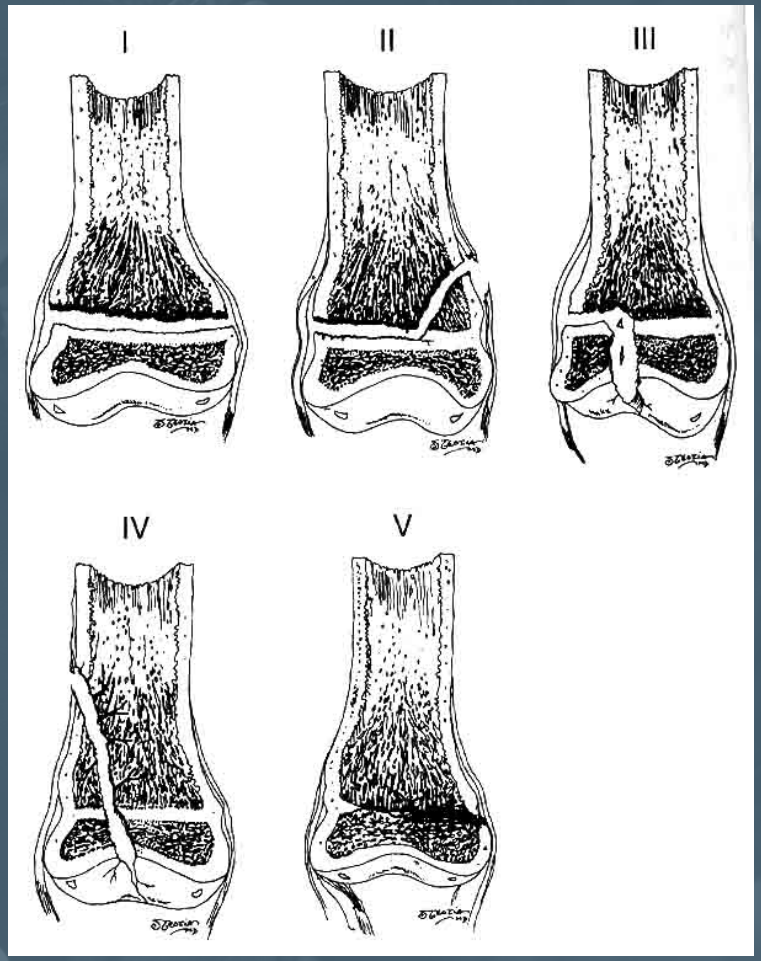
Growth Plate

- Physis is located at the metaphysis-epiphysis junction
- The physis “pushes” the epiphysis away from the metaphysis
- Proliferative zone is on the epiphyseal side



Growth plate injuries

- Growth plate fractures are common at the distal forearm
- Described using the Salter Harris classification
- Low risk of growth plate disturbance with SH I and II
- Moderate risk with SH III and IV



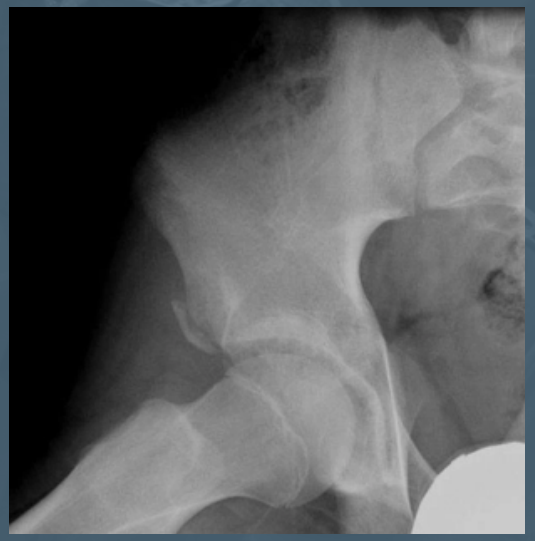
Pelvic Avulsion Fractures

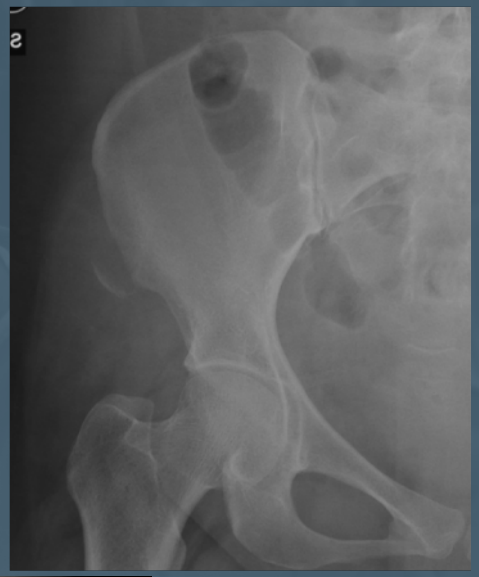
- Most commonly occur in adolescent athletes
- Occur with a violent contracture of the muscle during sports
- Results in an avulsion of the apophysis/ bone at the insertion of muscle

Pelvic Avulsion Fractures

- Commonly occur at four locations:
- AIIS – Quadriceps
- ASIS – Sartorius
- Inf Rami – Hamstrings
- Lesser trochanter- psoas

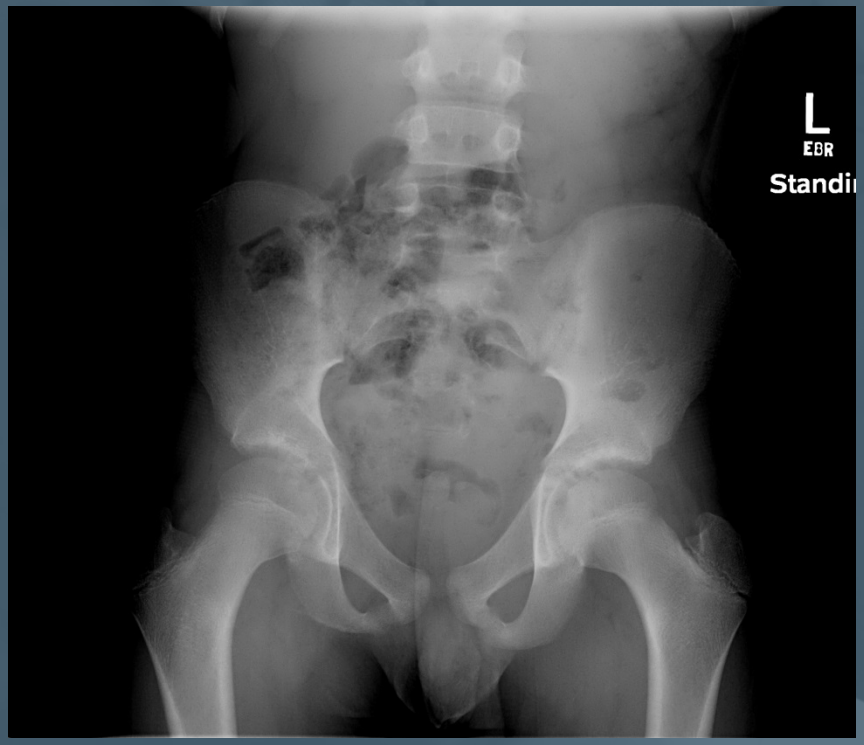
- Can often be seen on radiographs, rarely need advanced imaging



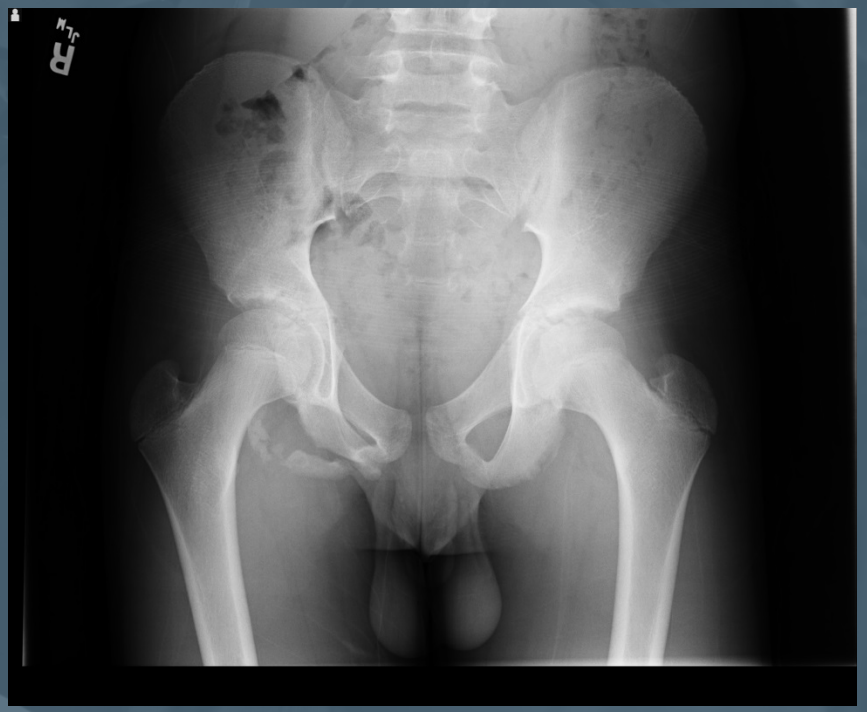


Pelvic Avulsion Fractures

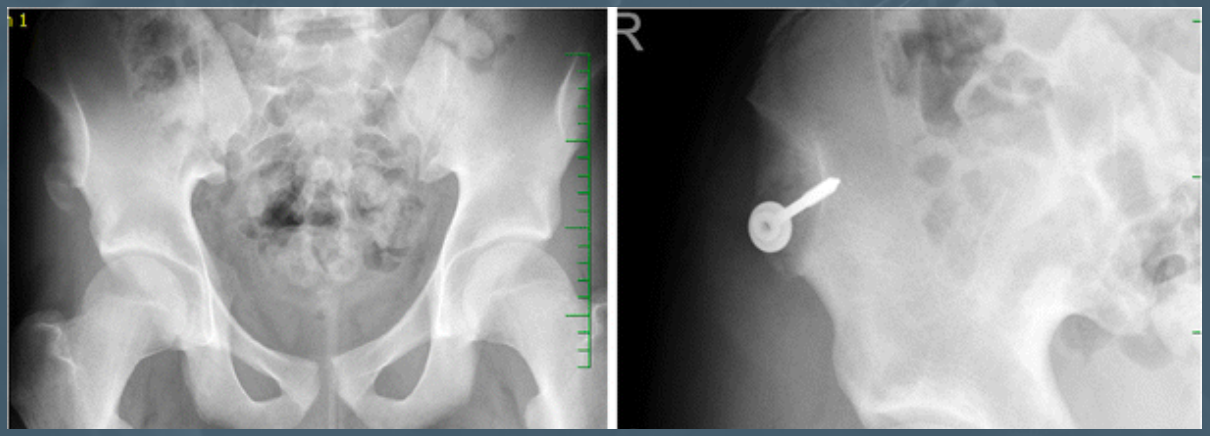
Acute



Chronic



Pelvic Avulsion Fractures



- Most avulsion injuries can be treated conservatively
- Consider surgical intervention with >1.5-3 cm of displacement, chronic pain/ weakness
- Can repair with suture anchors or screws with good results

Pediatric Hip Fractures

14 yo male - MVC

Pediatric Hip Fractures

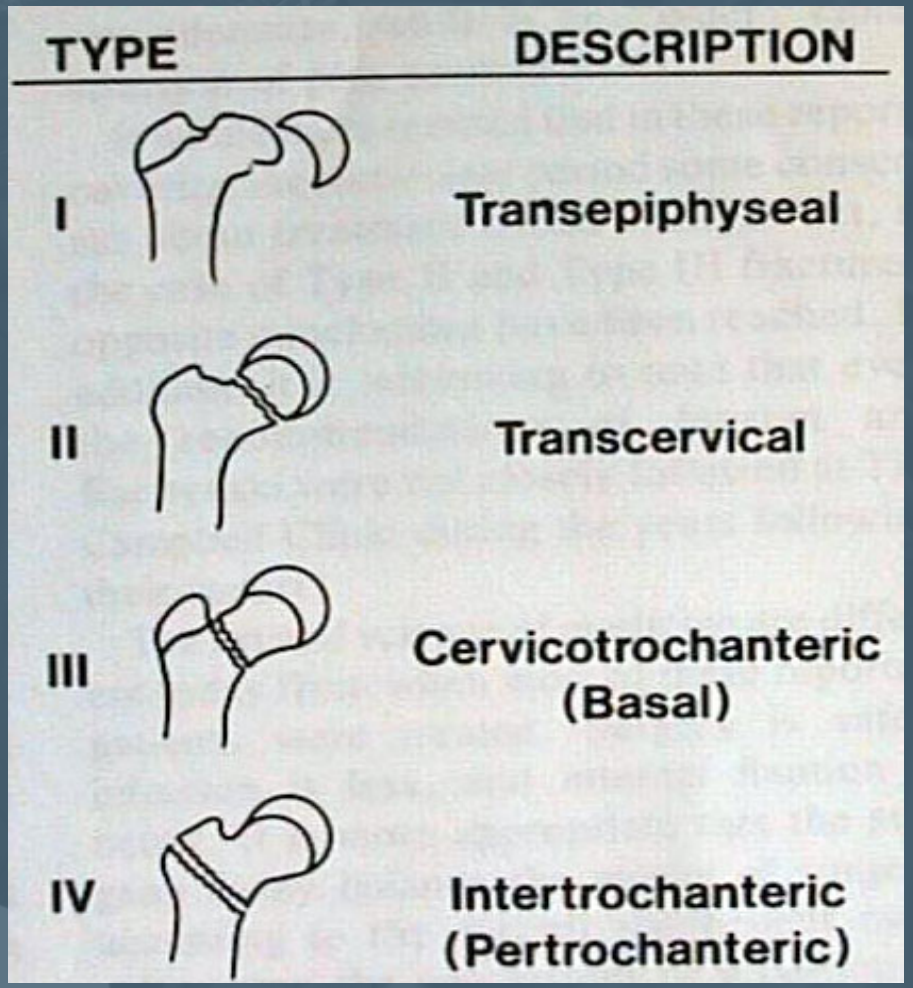
- Now 15 yrs old -15 months after injury

Pediatric Hip Fractures

- "Hip fractures in children are of interest because of the frequency of complications rather than the frequency of fractures."
  - *Canale*

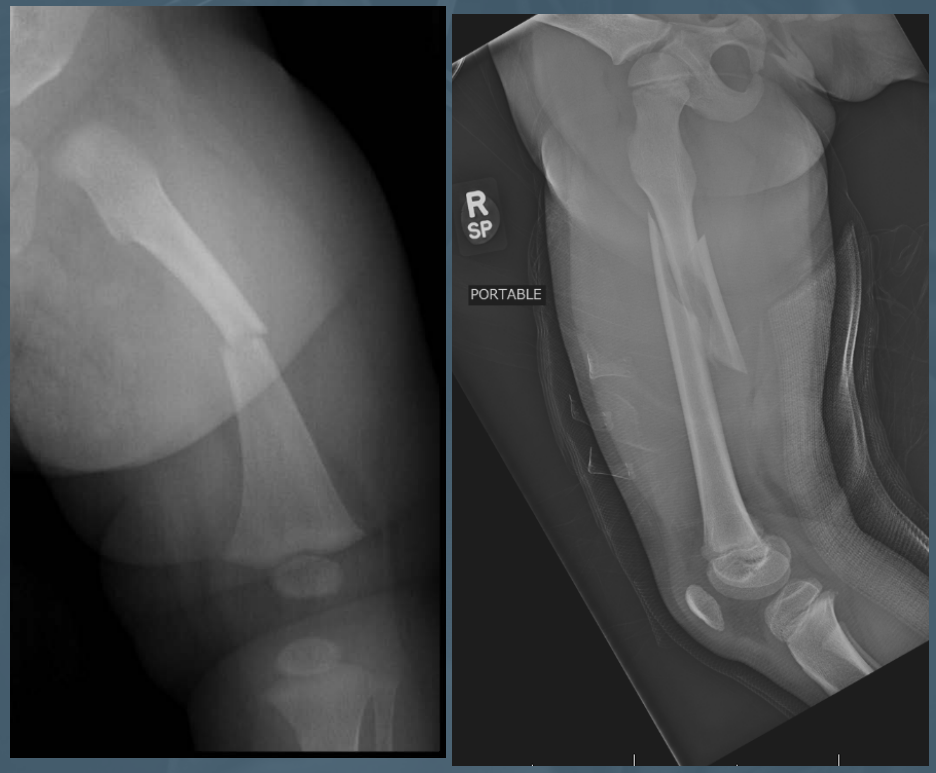
Pediatric Hip Fractures

- Appropriate transfer to Level 1 Center



Femoral Shaft Fractures

- Age and fracture type will guide treatment options for pediatrics
- Ability of the fracture to remodel guides treatment
- Energy for injury is much less in younger patients



Femoral Shaft Fractures

- Initial treatment
  - Evaluate for other injuries
  - NV status
  - Splint? From Back to foot – place leg on pillows
  - Float heel!!!
  - Buck's traction for older kids for comfort

Femoral Shaft Fractures

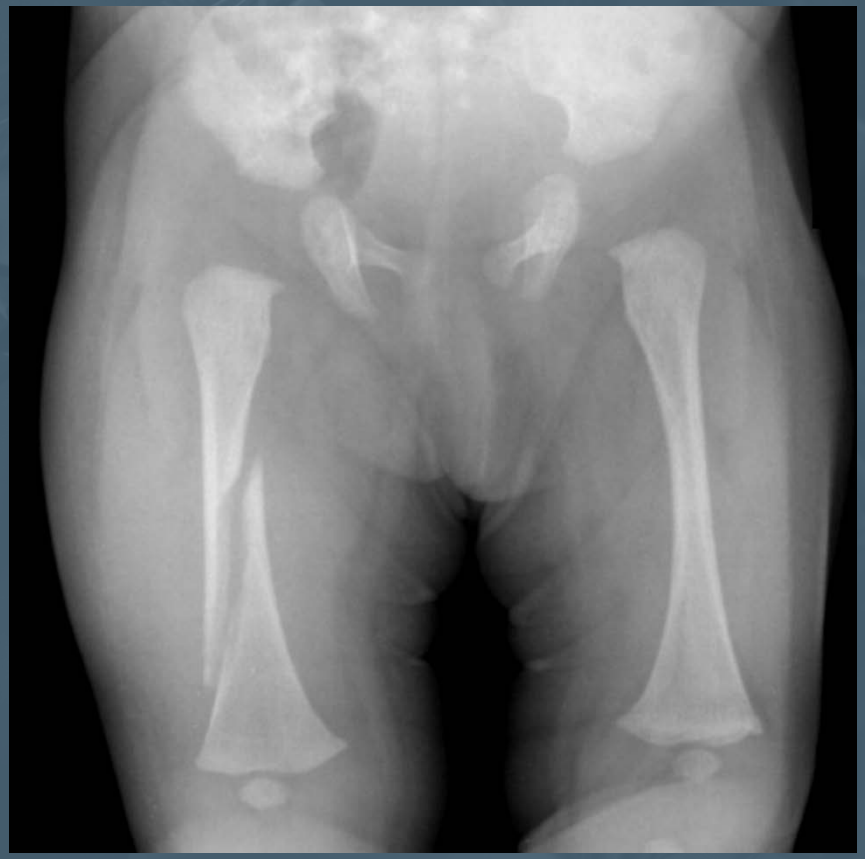
- 0 to 1yo - Pavlik harness/splint
- 1 to 3-5 yo - Hip Spica
- 3-5- 10 yo (100#) – Flexible nails
- > 10 yo – trochanteric entry nail
  - Avoid piriformis fossa even in those close to skeletal maturity
  - If you can see physeal scar avoid piriformis nail

Femoral Shaft Fractures

- Newborns can sustain femoral shaft fractures during delivery
- Fairly low energy needed
- Can accept significant angulation and shortening
- Treat with Pavlik harness or posterior splint

Femoral Shaft Fractures

- Can see in infants due to trauma or NAT
- Consider NAT if the patient is <2-3 years old
- Heals very quickly with abundant callus, often palpable
- Very good at remodeling



Femoral Shaft Fractures

- In older children, usually <5 years old, consider spica casting
- Allows stabilization and reduction of the fracture
- Difficult for heavier kids
- Risk of complications from the cast
- <10 deg coronal, <20 deg sagittal, <2 cm short

Hip Spica

- Avoid 90/90 position
  - Reports of compartment syndome
- Gortex liner
- Place cylinder cast first
- Pad behind popliteal fossa
- Place knee at 45 degrees

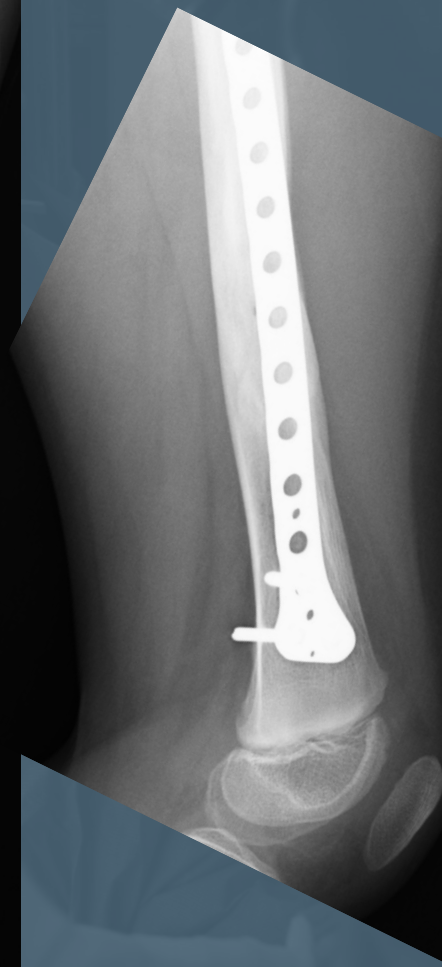
Femoral Shaft Fractures

- Over 5 years of age, can start to consider IM nail
- Usually will consider Flexible nails if under 8-9 years of age to protect proximal blood supply
- Better if patient is less than 100 lbs
- Not rotationally stable
- Remove at 6-12 months

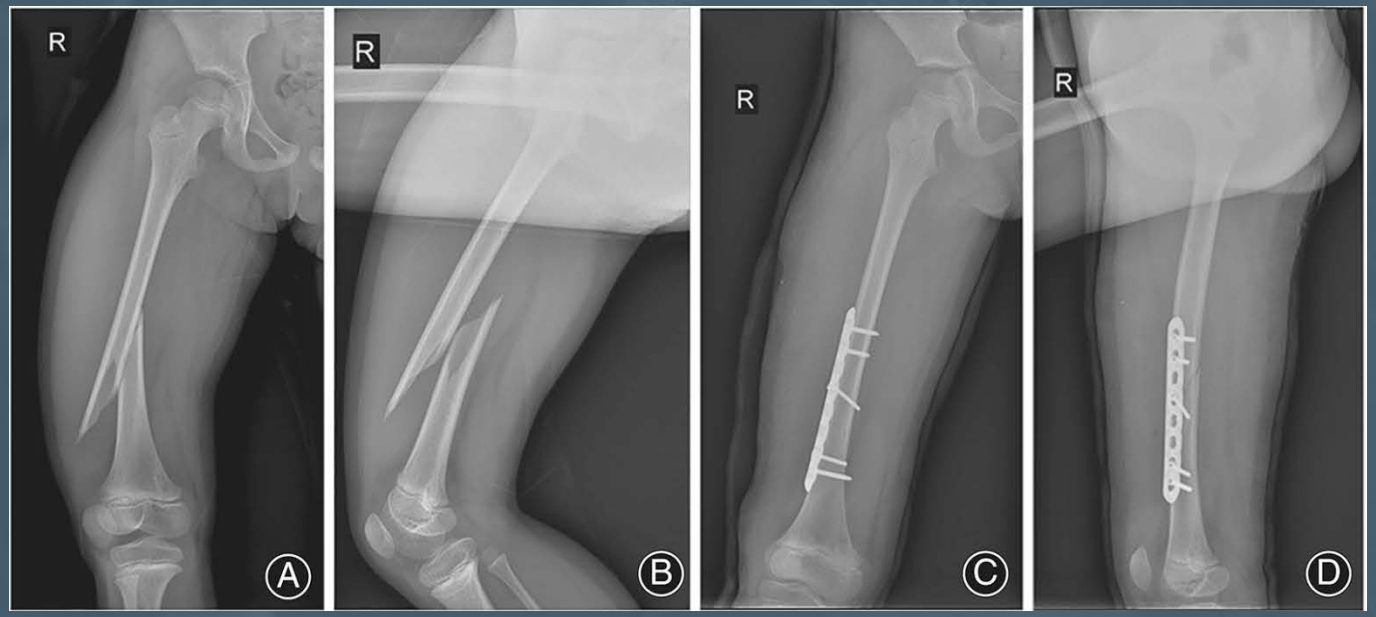
Femur Fractures Flexible Nails

- Usually distal entry
- 1 Medial 1 Lateral
- Same size nails with combined 80% canal fill
- Works well even in oblique fractures
- Possible contraindiactions
  - Wt > 100#
  - Comminution
  - Distal Fracture



Femoral Shaft Fractures

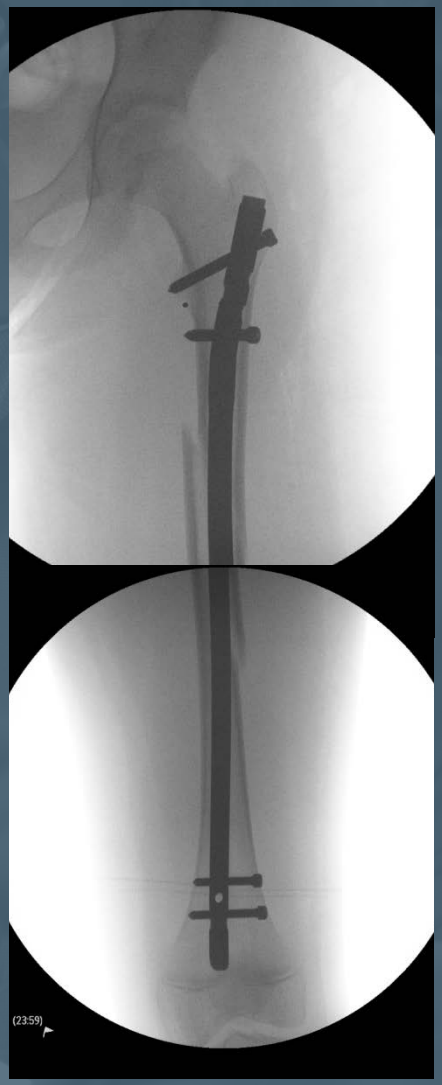


- Can consider submuscular plating for unstable fractures or heavier children
- Helps with comminuted, length unstable fractures
- Consider for very proximal or distal fractures

Femoral Shaft Fractures

- As patient gets older, less concern for proximal blood supply
- Can perform Trochanteric IM nailing
- Allows stabilization for length and rotation

- Consider removal after healing



Femoral Shaft Fracture > 10 yo

- Trochanteric Entry Nail
- AVN reported with piriformis nail

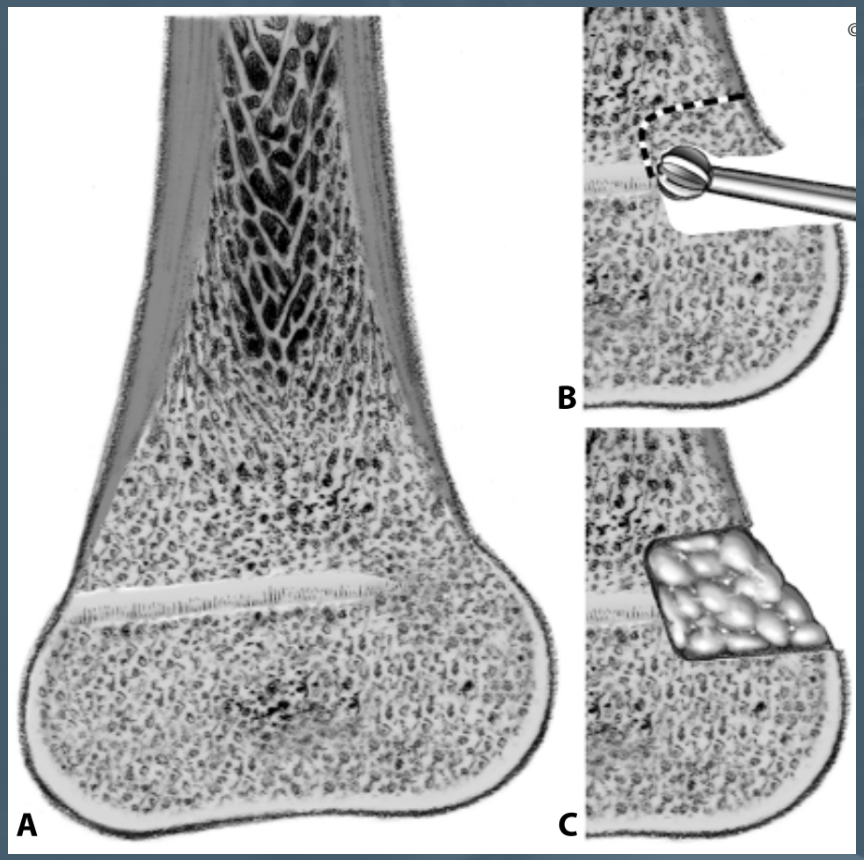
Distal Femur Fractures

- Can occur thru the physis prior to skeletal maturity
- Often is a Type II SH Fracture
- Can often see with radiographs
- May need stress views or MRI if non-displaced

Distal Femur Fractures

- If truly non-displaced, can treat with casting
- With displacement, can treat with closed vs open reduction and internal fixation
- Consider k-wires for SH Type I
- Screw fixation with SH Type II

Distal Femur Fractures



- Distal femur physis is complex design
- Can lead to physeal bar, LLD, angular deformity
- 30-50% chance of growth plate disturbance
- Small chance of popliteal artery injury, compartment syndrome

Patella Fractures

- Sinding-Larsen – apophysitis at connection of patellar tendon
- Avulsion fracture – small fragment of patellar tendon avulsed off
- Sleeve fracture – small fragment of bone with chondral fragment

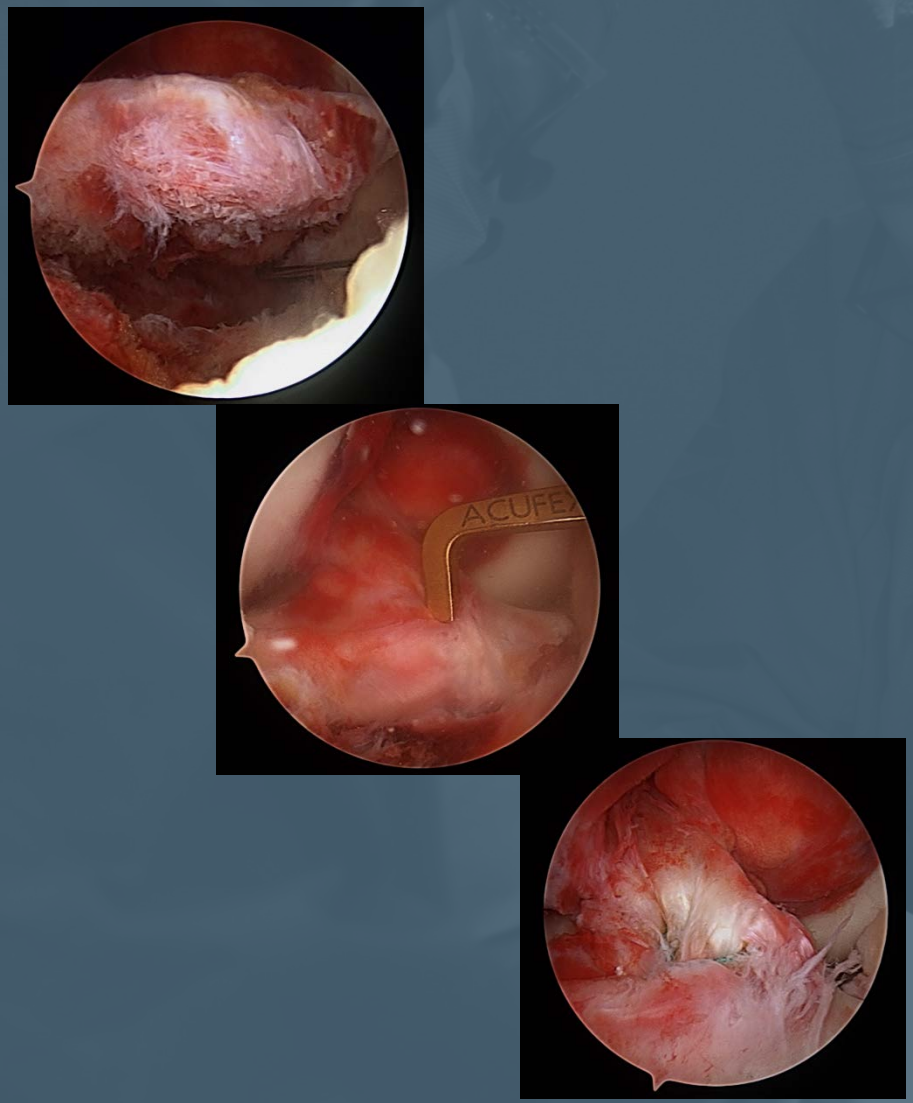
Patellar Sleeve Fracture

- Fairly rare occurance
- Most commonly off the inferior pole
- Can see patella alta
- For displacement, need ORIF to repair fragment and cartilage
- Use darts, screws or suture

Tibial Spine Avulsion Fracture

- Classic injury is hyperextension with sports or bike riding
- ACL avulses medial tibial spine bone fragment
- Treatment depends on displacement
- Can try aspiration with closed reduction

Tibial Spine Avulsion Fracture

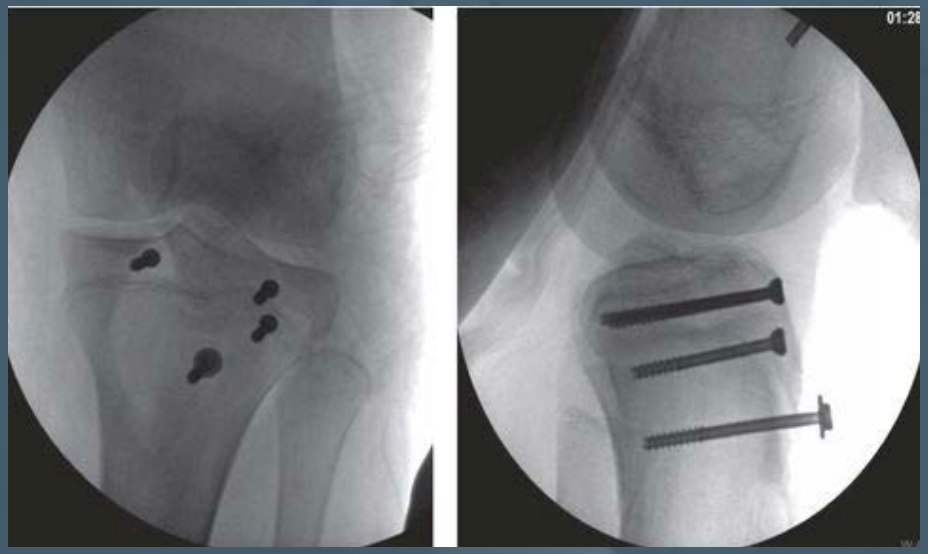


- Reduction can be blocked by intrameniscal ligament
- Fix with suture or screw
- Can develop arthrofibrosis
- Injury to ACL fibers is common

Tibial Tubercle Fractures

- Typically occurs with running, jumping sports
- Often occurs near skeletal maturity
- Consider operative fixation with displacement > 2 mm
- ORIF with small screws in epiphysis, across apophysis

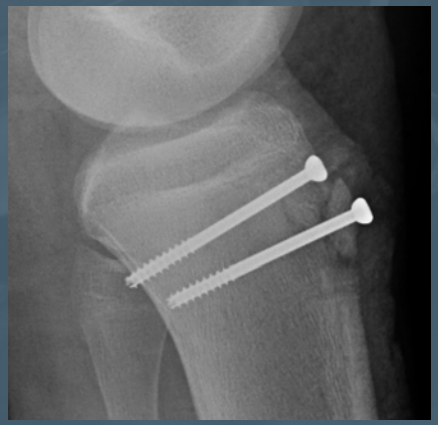
Tibial Tubercle Fractures

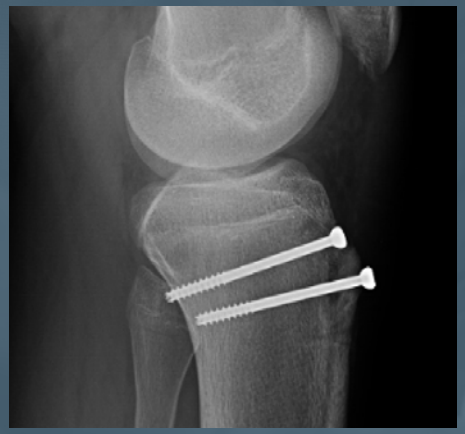


- Periosteal sleeve often blocks reduction
- May need soft tissue repair as well as ORIF
- Consider meniscal injury
- Watch for concurrent patellar tendon injury
- Can use suture anchors for patellar tendon injury off tibia

Tibial Tubercle Fractures

- Can develop recurvatum from premature closure
- May need screw removal
- Need to be aware of possible compartment syndrome due to anterior tibial recurrent artery injury





Tibial Shaft Fractures

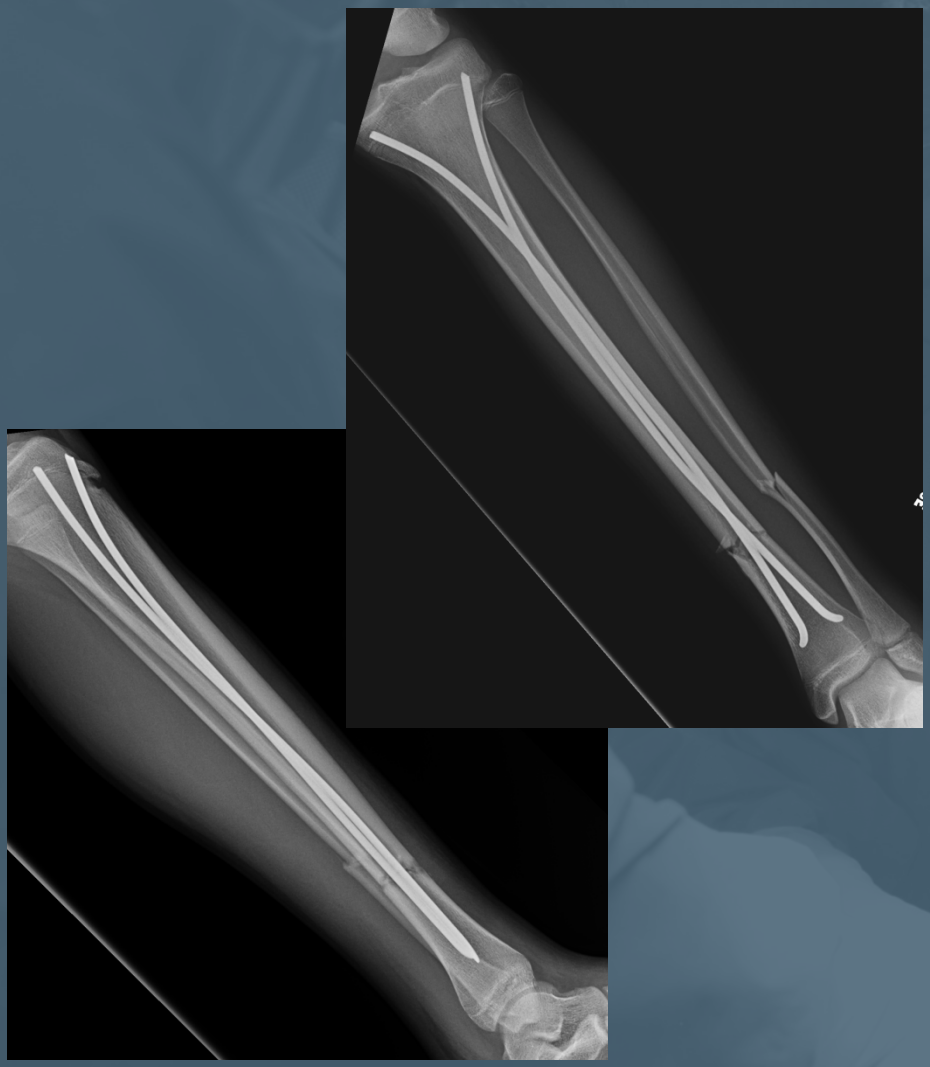
- Bimodal distribution of occurrence
- In younger patients, can be low energy injury
- “Toddler’s Fracture”
- Torsional injury
- Can be occult injury
- Treated with boot or cast

Tibial Shaft Fractures

- Can occur with higher energy in older patients

- Limited displacement acceptable
- 5-10 deg angulation, <1 cm shortening, <50% translation

Tibial Shaft Fractures

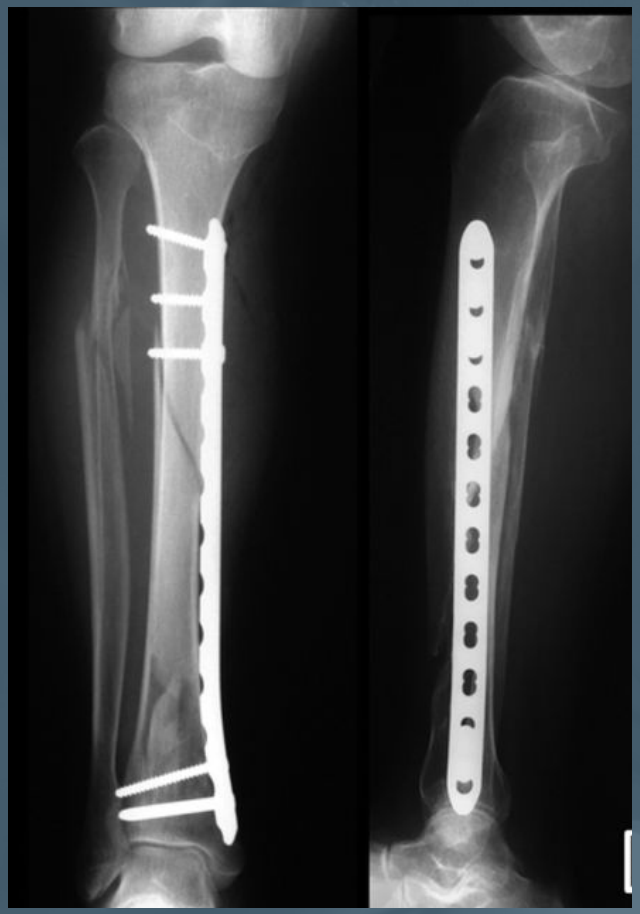


- Flexible nailing for skeletally immature
- Solid nail after physeal closure
- Plating for comminuted, length unstable fractures
- Consider external fixator for significant soft tissue injury

Tibial Shaft Fractures

- Flexible nailing for skeletally immature
- Solid nail after physeal closure
- Plating for comminuted, length unstable fractures
- Consider external fixator for significant soft tissue injury

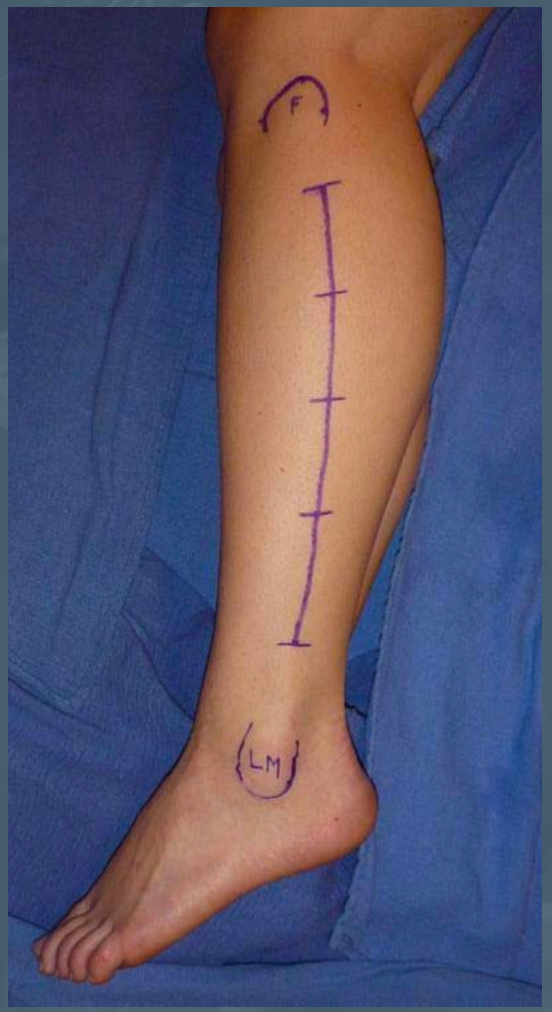
Tibial Shaft Fractures



- Flexible nailing for skeletally immature
- Solid nail after physeal closure
- Plating for comminuted, length unstable fractures
- Consider external fixator for significant soft tissue injury

Tibial Shaft Fractures

- Monitor for compartment syndrome after injury, watch for the three A's
- Can develop LLD or angular deformity
- Delayed union/ non-union in open fractures



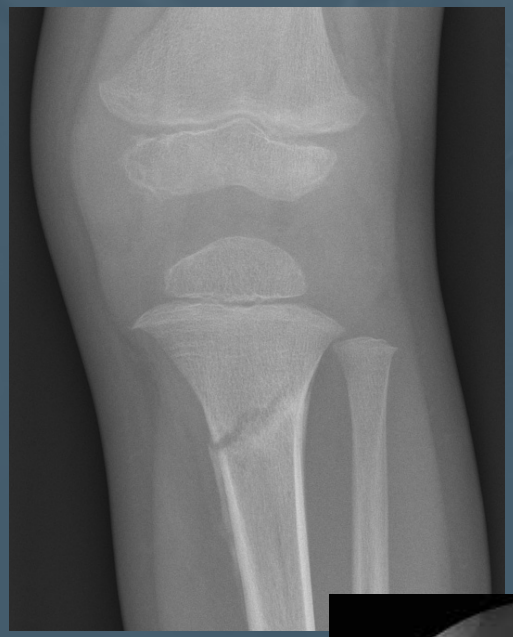
Tibial Shaft Fractures

- Monitor for compartment syndrome after injury, watch for the three A's
- Can develop LLD or angular deformity
- Delayed union/ non-union in open fractures

Tibial Shaft Fractures

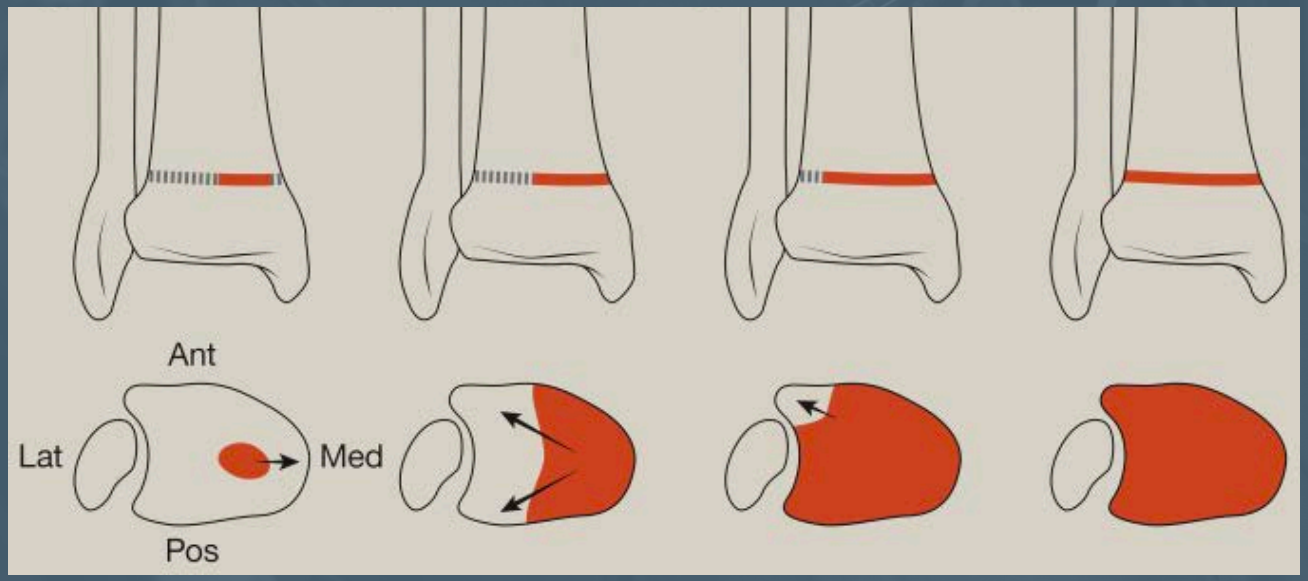
- Monitor for compartment syndrome after injury, watch for the three A's
- Can develop LLD or angular deformity
- Delayed union/ non-union in open fractures

Cozen's Phenomenon



- In younger patients with isolated metaphyseal tibia fracture
- Increased blood flow to proximal physis (?)
- Typically occurs months after injury
- Usually resolves spontaneously, may need guided growth

Transitional Ankle Fractures



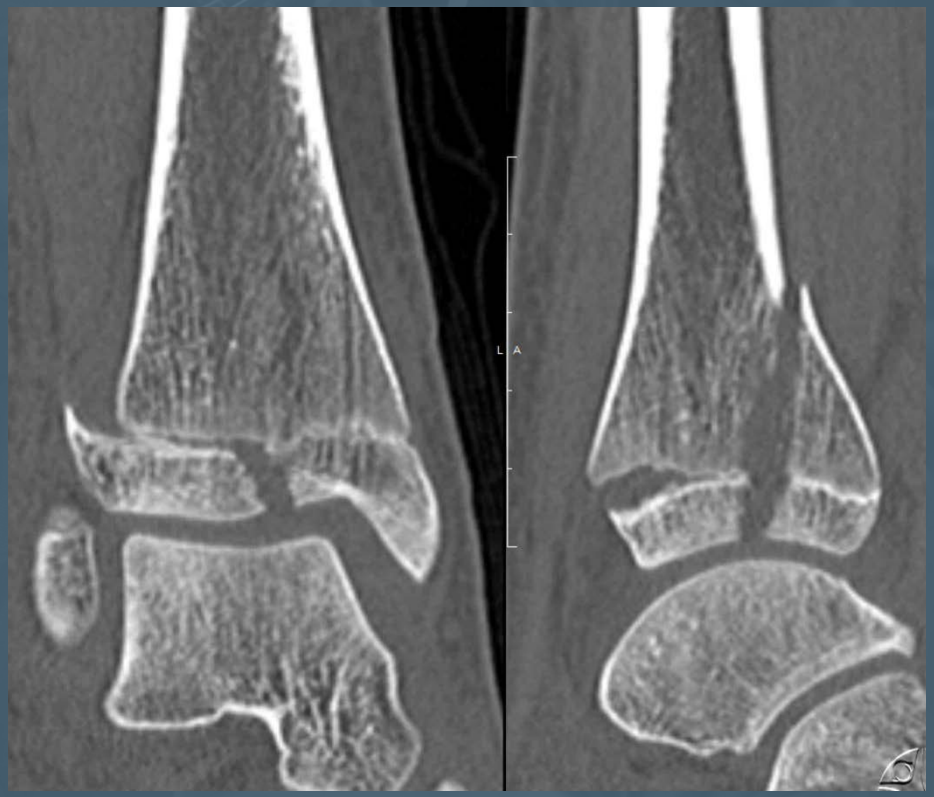
- Typically occur at the time of distal tibial physeal closure
- Distal tibia physis closes in an asymmetric pattern
- Gradually closes from middle to medial to lateral

Triplane Fractures

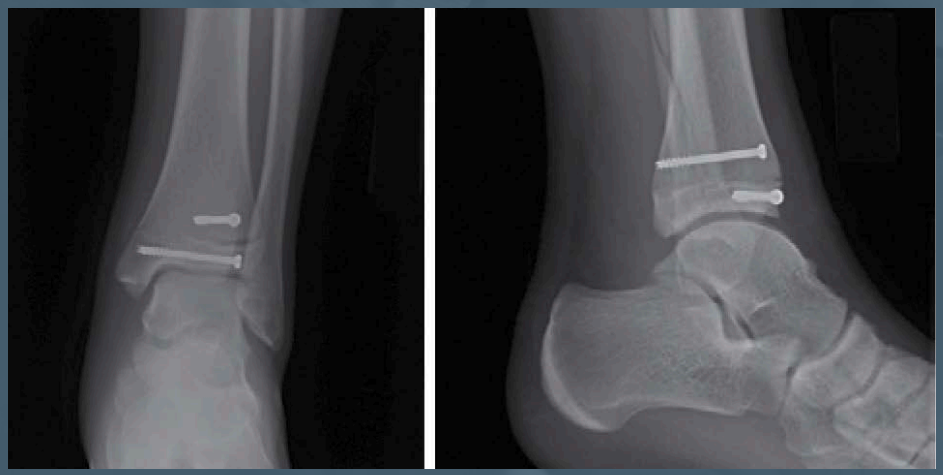
- Status of physis closure will dictate the type of injury
- Early in closure, injury pattern is a triplane fracture
- Results in various multi-planar injuries

Triplane Fractures

- Fracture occurs in the sagittal, coronal and axial planes
- Classic appearance shows a SH type III fracture on the AP view,
- SH type II fracture on the lateral view
- Can use CT to evaluate displacement, fragments

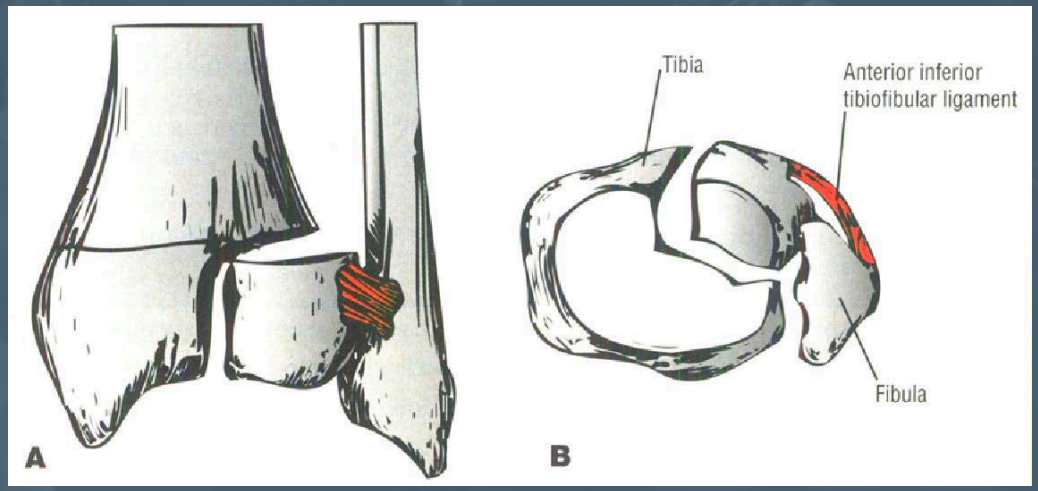


Triplane Fractures



- Displacement >2 mm - consider surgery
- Multiple fracture patterns, with most being two or three parts
- Can have an extra-articular variant
- Closed vs open reduction, with screws in multiple planes

Tillaux Fractures



- Occurs closer to skeletal maturity
- Distal tibial physis is closed with the exception of the lateral anterior portion
- SH type III fracture caused by pull of the anterior inferior tib-fib ligament

Tillaux Fractures

- Consider surgical intervention if displacement is >2 mm
- Reduced with closed vs percutaneous vs open techniques
- Can place screw across fracture site to help reduce the fragment

Transitional Fractures

- Rarely cause significant growth disturbance as the occur during physeal closure
- Can cause premature OA in ankle with >2 mm of displacement
- Controversy about whether to remove epiphyseal screws

Questions?