

Pediatric Lower Extremity Fractures

- Principles
- Specific Fractures



Children are not just small adults

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



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

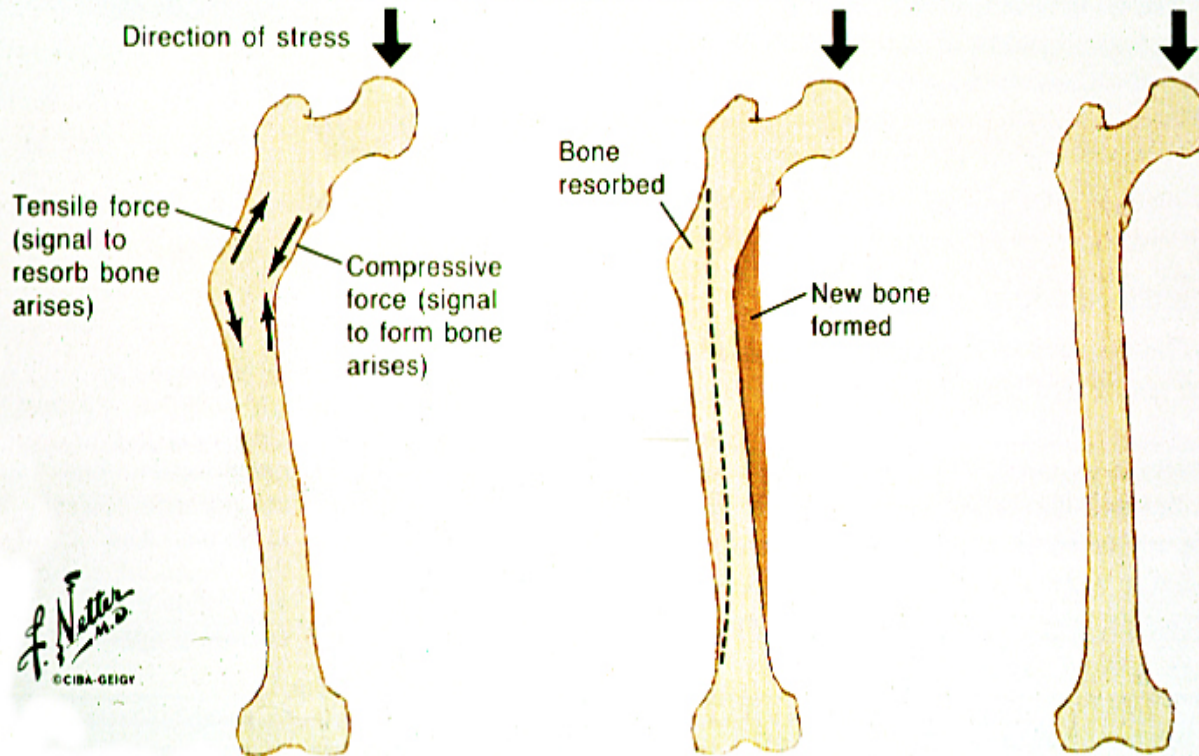


Wolff's Law

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

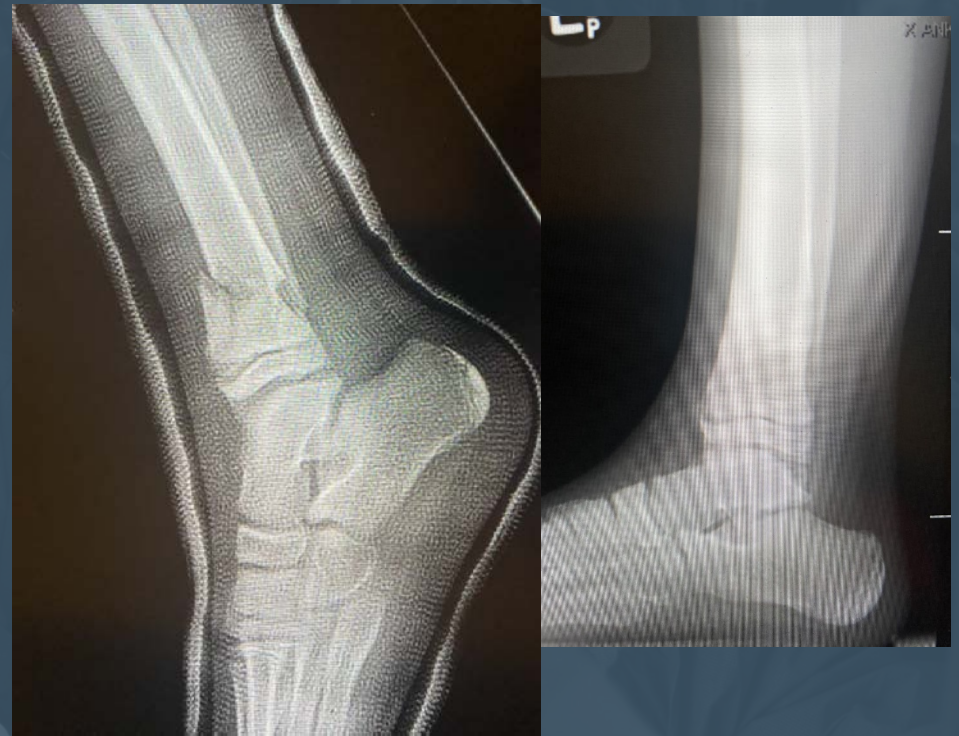


Bone Remodeling in Response to Stress

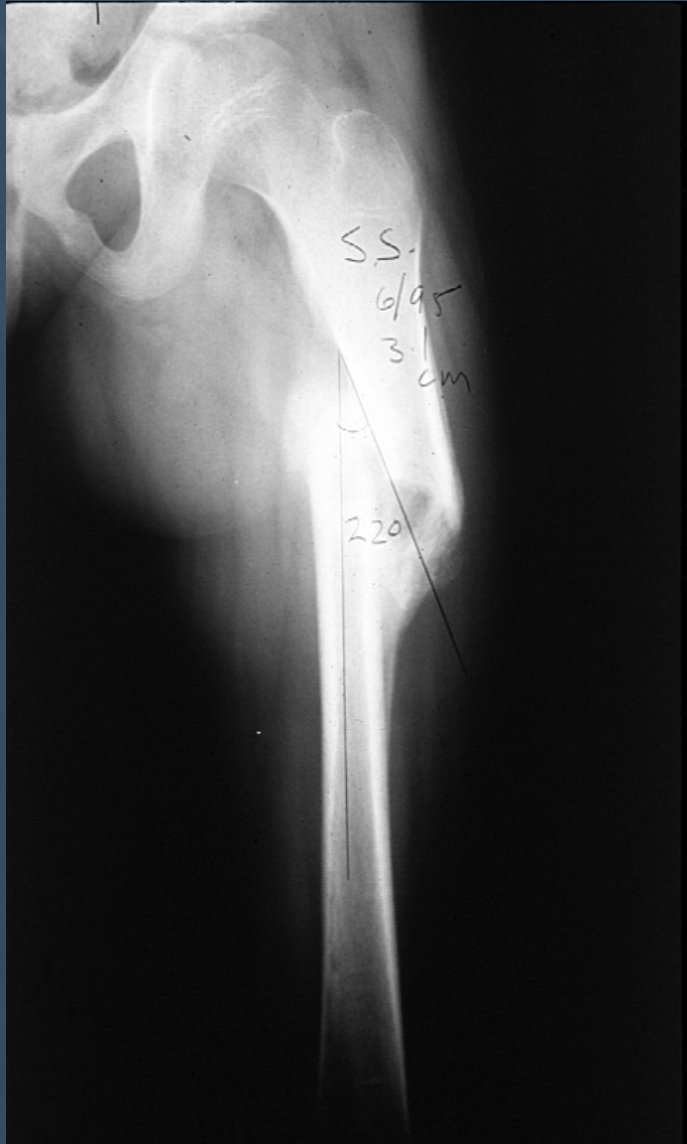


Remodeling

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



Remodeling

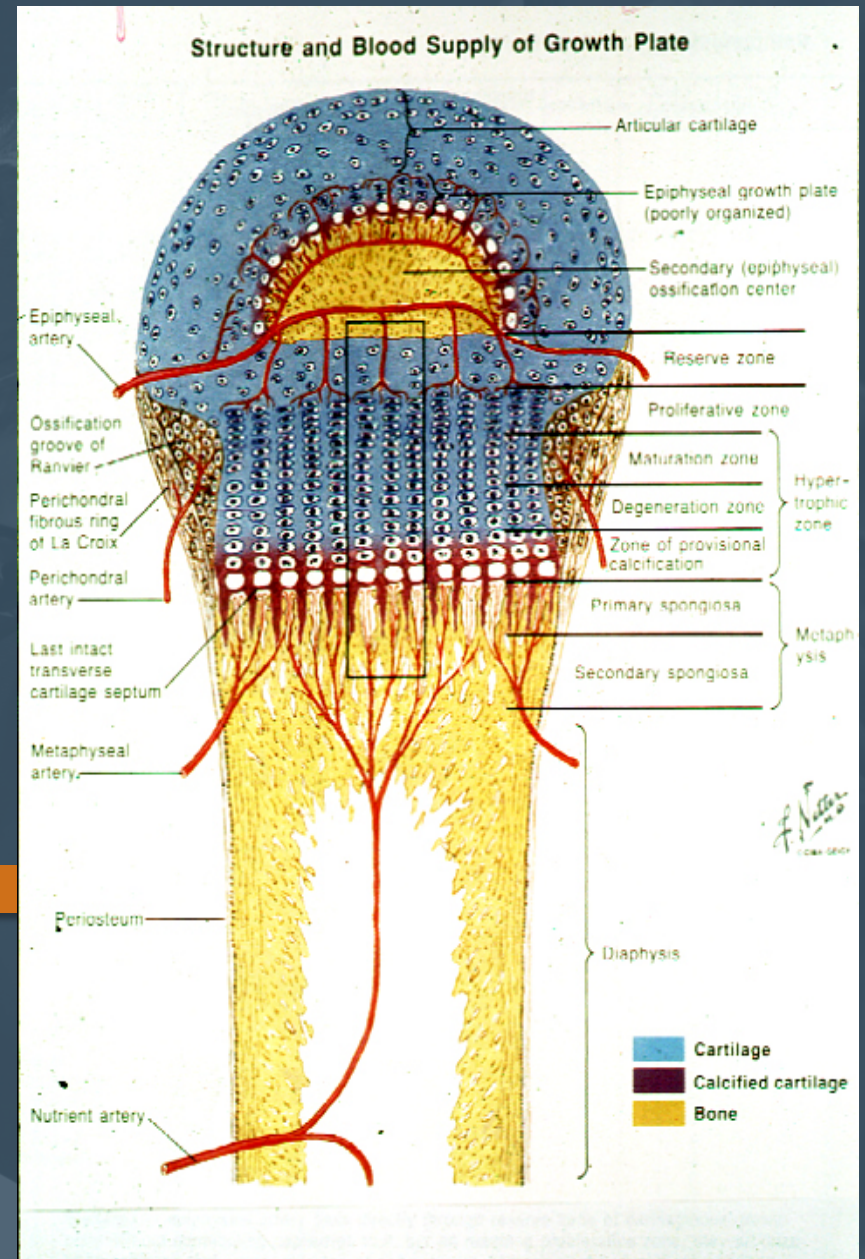


Children are not just small adults

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



Growth Plate/ Physis



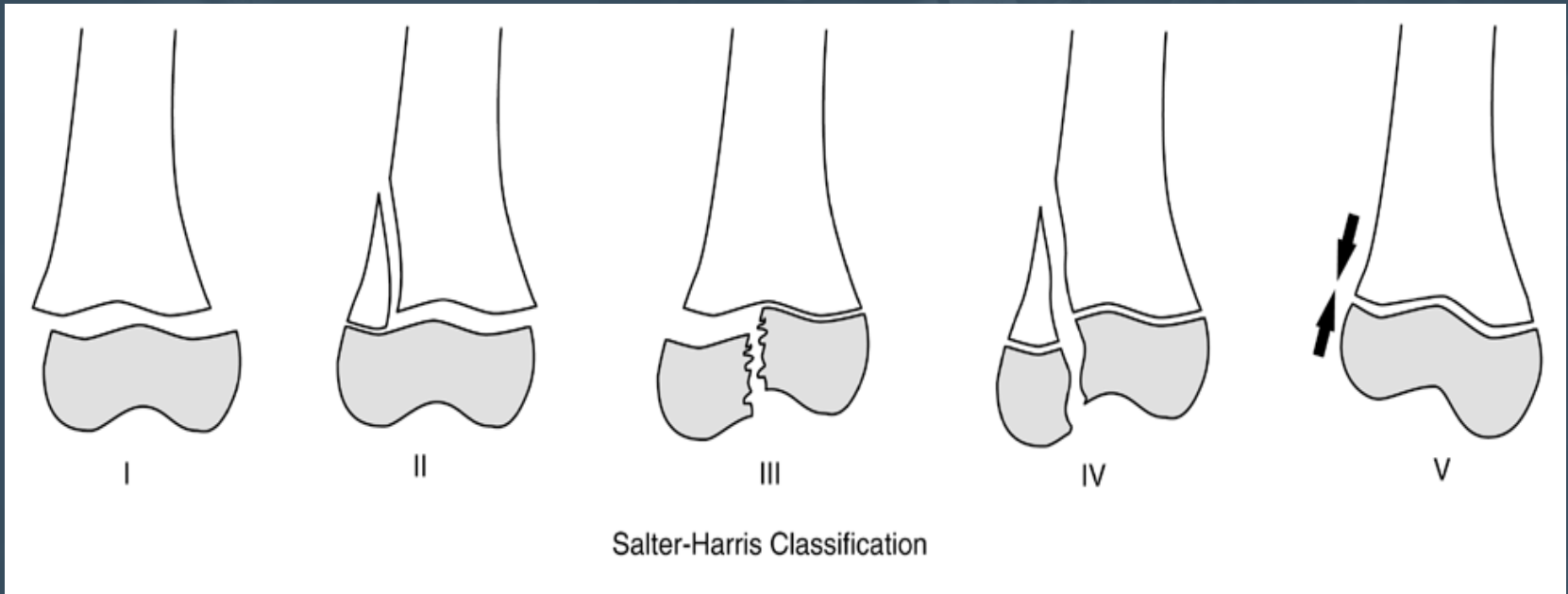
Physeal Fractures

- 20 % of all children's fractures
- 1% will develop growth arrest



Classification

Salter – Harris I-V



Worse prognosis with greater #



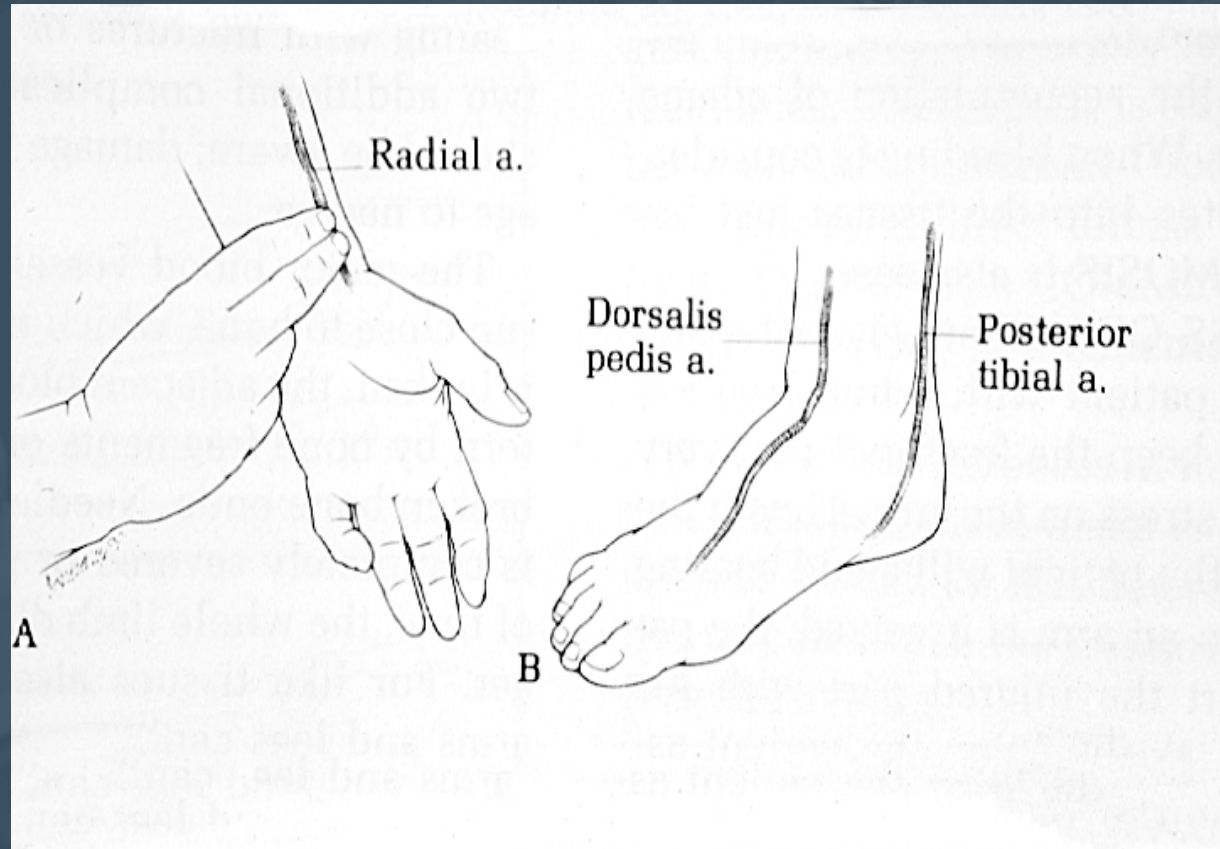
Describing fractures

- Type
- Location
- Angulation
- Displacement



Orthopaedic Evaluation

- Neurovascular check



Evaluation of Extremity

- Temperature
- Capillary refill
- Pulses
- Neurologic Function



Open fractures

- Always check for a break in the skin
- Require Operative I&D
- Admission for antibiotics
- At risk for infection



Lower Extremity Neurologic Exam

- Dorsiflex Toes (Deep Peroneal N): don't let rebound motion fool you
- Plantar Flex Toes (Post. Tib N)



Pediatric Hip Fractures


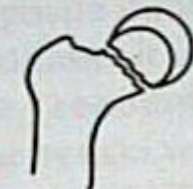


- “Hip fractures in children are of interest because of the frequency of complications rather than the frequency of fractures.”
 - *Canale*



Pediatric Hip Fractures

- Appropriate transfer to Level 1 Center



TYPE		DESCRIPTION
I		Transepiphyseal
II		Transcervical
III		Cervicotrochanteric (Basal)
IV		Intertrochanteric (Pertrochanteric)

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



- 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



Femur 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



- 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

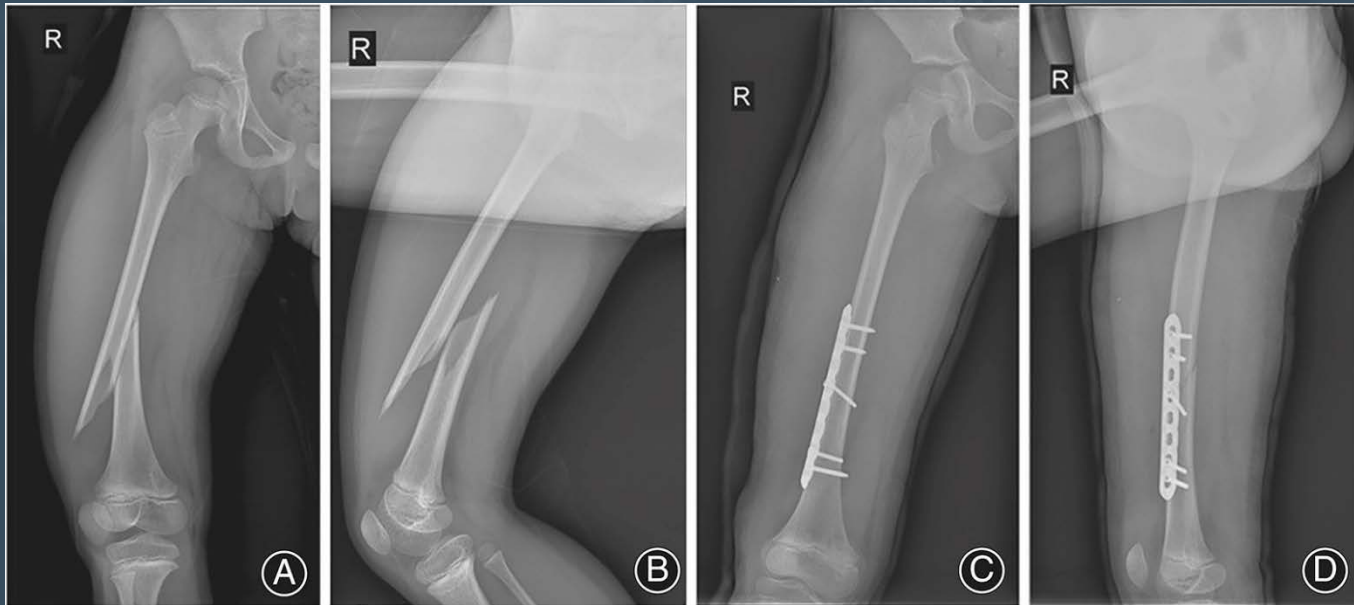


Femoral Shaft Fractures

- 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

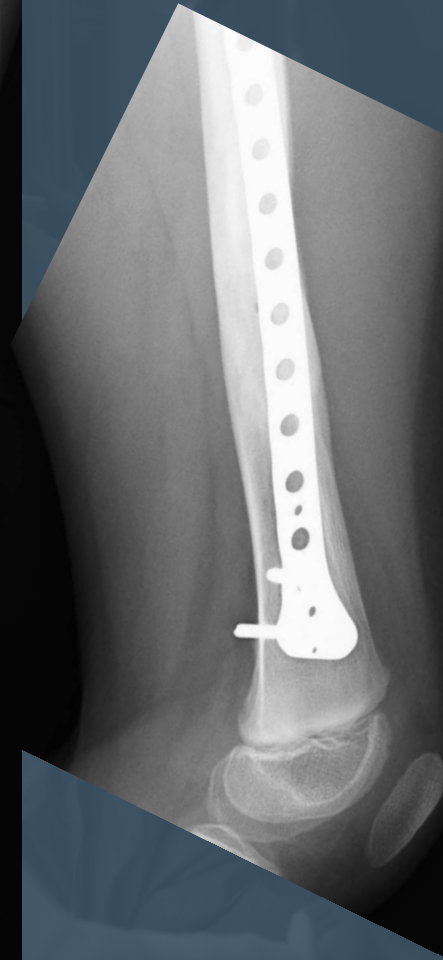


Femoral Shaft Fractures



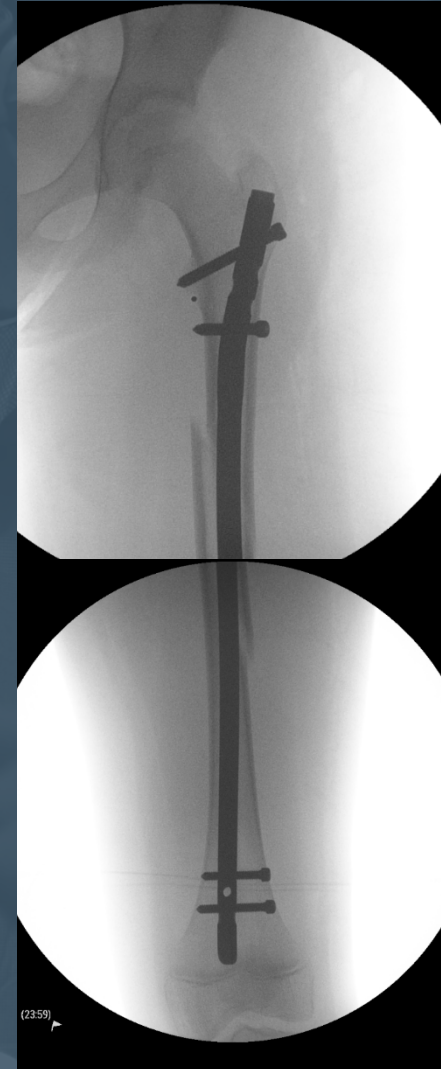
- Can consider submuscular plating for unstable fractures or heavier children
- Helps with comminuted, length unstable fractures
- Consider for very proximal or distal fractures





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



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Distal Femur Fractures



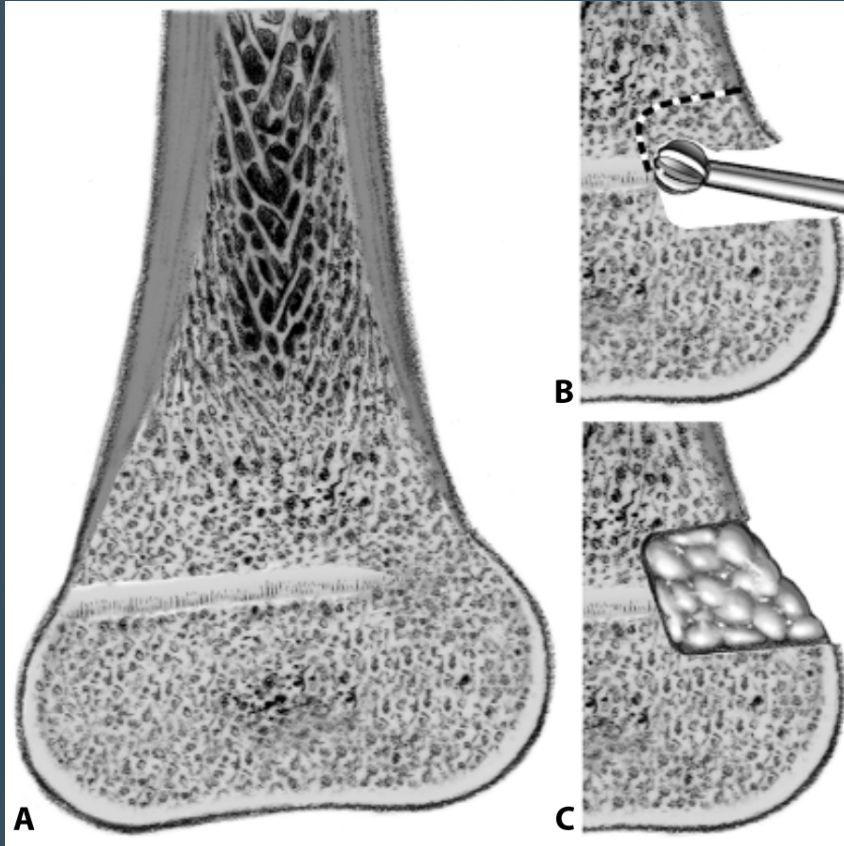
- Can occur thru the physis prior to skeletal maturity
- Often is a Type II SH Fracture
- Can often see with radiographs
- May need stress views or MRI if non-displaced

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



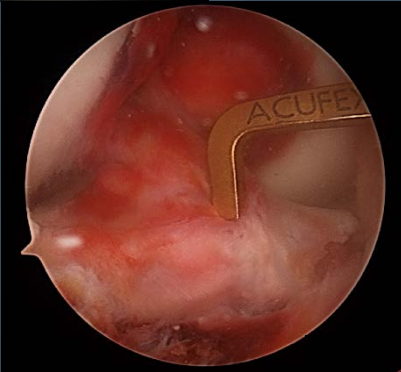
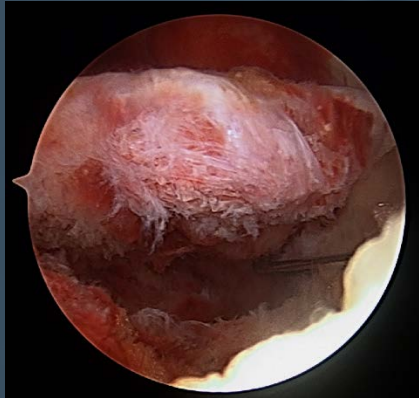
- Fairly rare occurrence
- Most commonly off the inferior pole
- Can see patella alta
- For displacement, need ORIF to repair fragment and cartilage
- Use darts, screws or suture

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

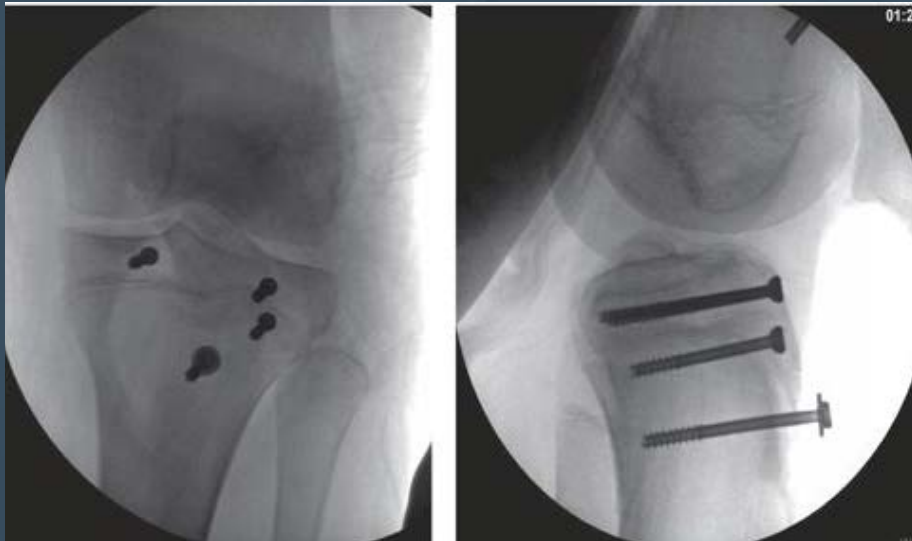
Tibial Tubercle Fractures

- 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



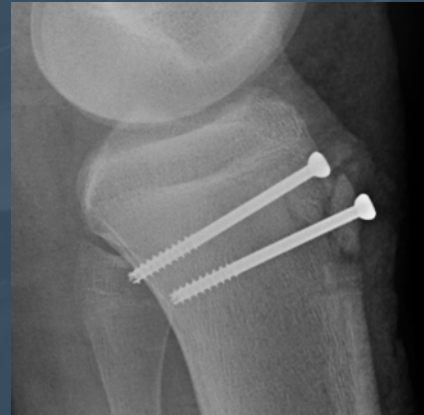
Tibial Tubercle Fractures

- 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

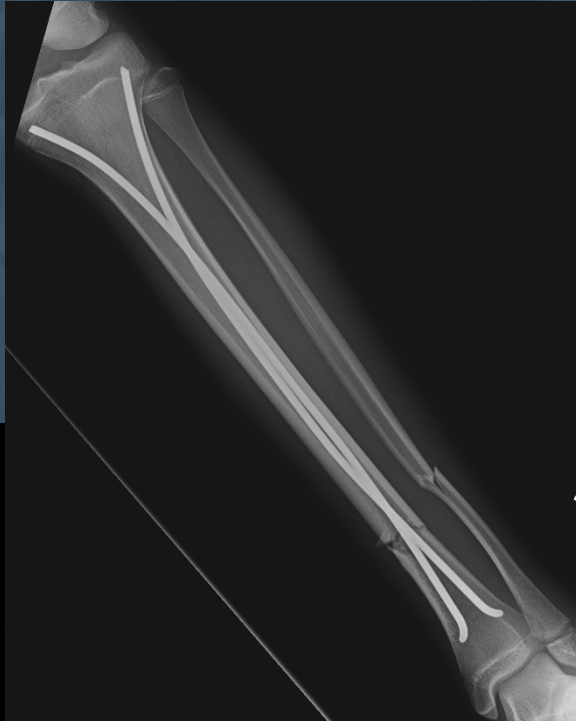


Tibial Shaft Fractures

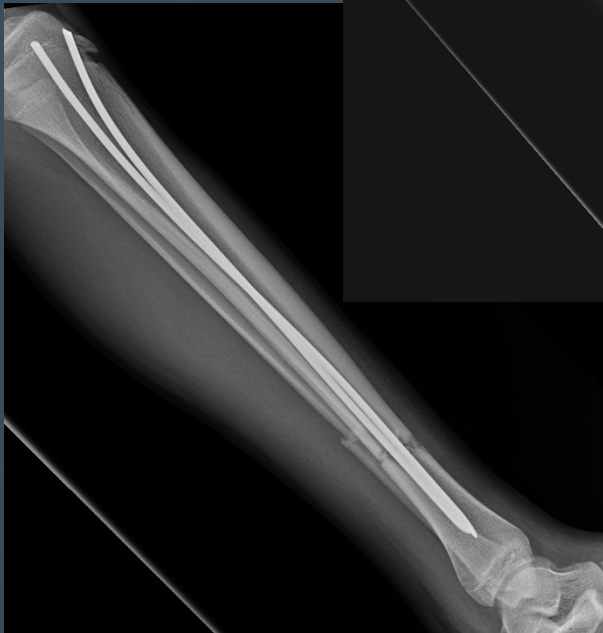
- Can occur with higher energy in older patients
- Limited displacement acceptable
- 5-10 deg angulation, <1 cm shortening, <50% translation



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



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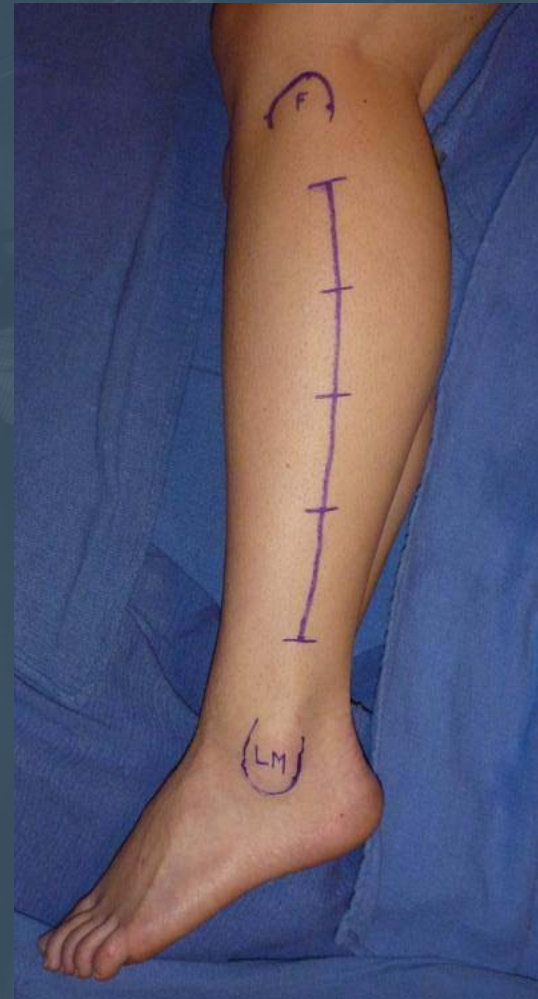
Tibial Shaft Fractures



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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

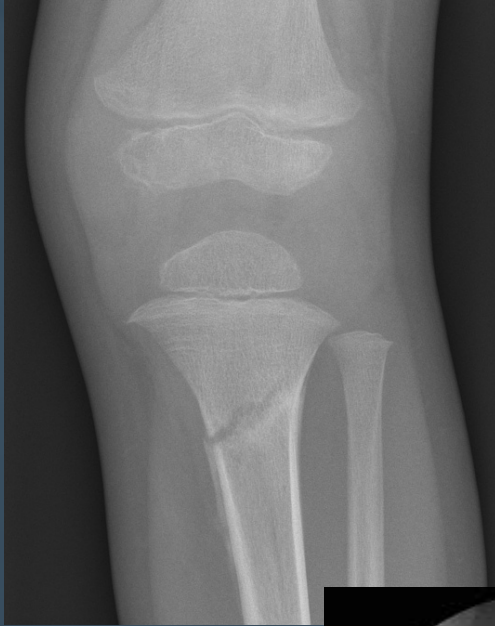


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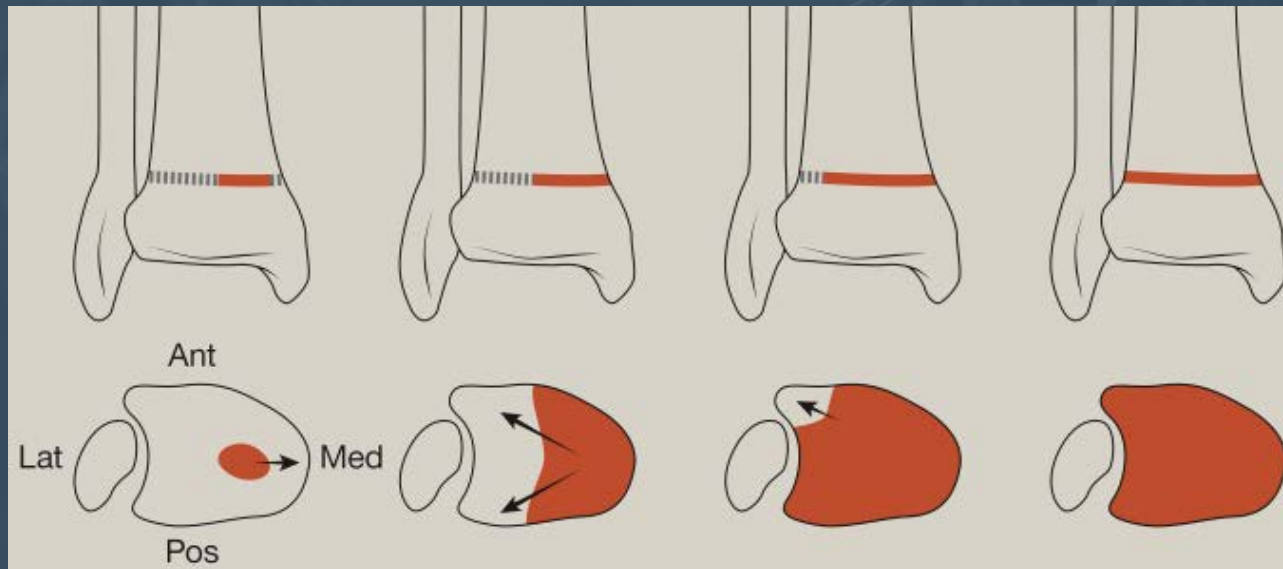


Cozen's Phenomenon



- 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

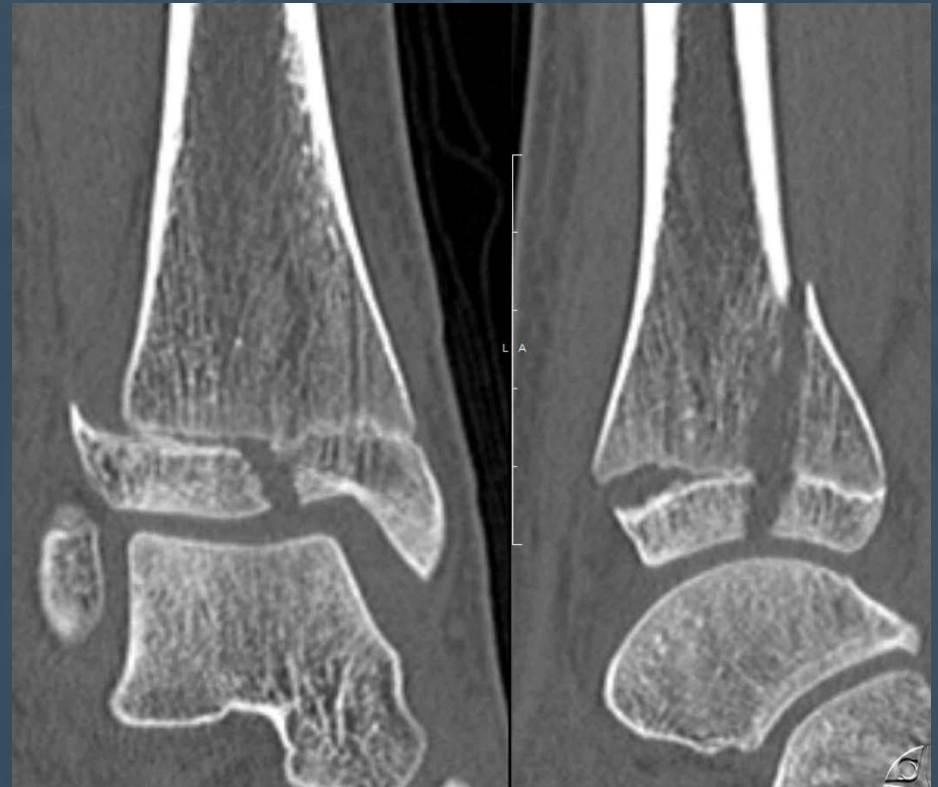
Triplane Fractures

- 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

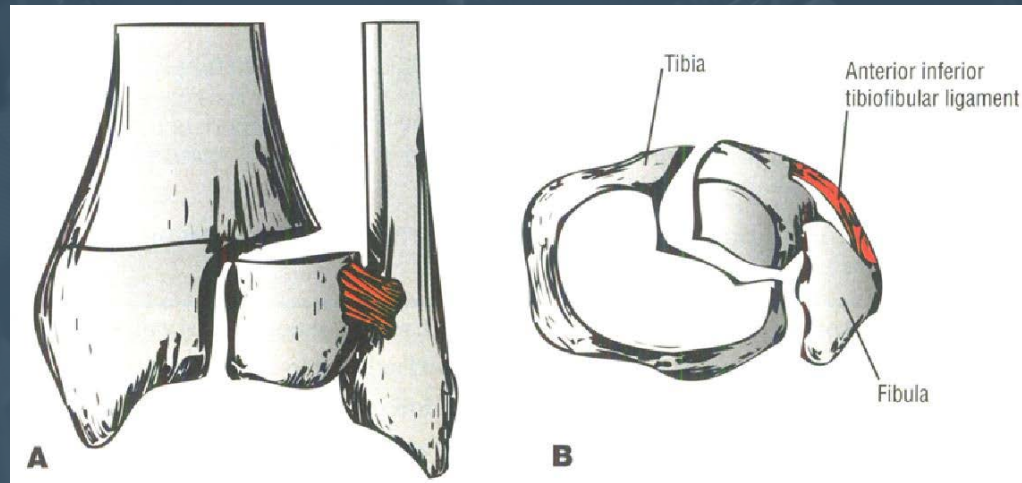


Triplane Fractures



- 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 they occur during physal closure
- Can cause premature OA in ankle with >2 mm of displacement
- Controversy about whether to remove epiphyseal screws

Malleolar Ankle Fractures

- Lateral Malleolus
Physeal fracture:
benign
- Fibula likes to grow
- Medial Malleolus
Physeal Fracture:
Significant risk of
growth arrest



Growth Arrest with Bar Resection



Success



Summary

- Children are not just little adorable adults
- Bones are less brittle
- Remodeling potential due to growth plates
- Growth arrest possibility due to growth plates



Thank you

