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

- **Direction of stress**
- **Tensile force** (signal to resorb bone arises)
- **Compressive force** (signal to form bone arises)
- **Bone resorbed**
- **New bone formed**
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

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>I</td>
<td>Transepiphysal</td>
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<tr>
<td>II</td>
<td>Transcervical</td>
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<tr>
<td>III</td>
<td>Cervicotrochanteric (Basal)</td>
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<td>IV</td>
<td>Intertrochanteric (Pertrochanteric)</td>
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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
Femoral Shaft Fractures

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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

- 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 physeal 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