Pediatric Fractures

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Objectives

• Pediatric bone anatomy and physiology
• ED assessment and management
• Fracture description
• Fractures unique to pediatrics
• Upper extremity pediatric fractures

Anatomy and Physiology

• Pediatric vs. adult
  – Epiphyseal complex
  – Bony matrix
  – Ligaments
  – Periosteum

Epiphyseal Complex

• Located at ends of long bones
• Longitudinal growth
• 3 components
  – Epiphysis
  – Physis
  – Metaphysis

Bony matrix

• Pediatric matrix
  – More porous
  – Higher water content
  – Less mineral content
• Reduced stiffness and bony strength
• Increased incidence of fractures in children

Ligaments

• Ligaments of a child
  – Great elasticity
  – Relatively strong compared to bone, especially the physis
• Consequently, injuries that typically cause sprains in adults are more likely to cause fractures in children
**Periosteum**
- Thicker and stronger
  - Usually remains intact on one side of fracture
  - Decreases fracture displacement
  - Aids fracture reduction and stability
- Physiologically active
  - Exuberant callus formation
  - Non-unions rare

**ED Assessment and Management**

**History**
- Pain assessment
- Mechanism and force of injury
- Weakness/numbness/paresthesia
- Fracture consistent with injury
- Last PO

**Physical Examination**
- Neurovascular assessment
  - Pulses and capillary refill
  - Sensory and motor examination
- Obvious deformity
- Significant swelling, bruising
- Lacerations and puncture wounds
- Examine joint above and below site of injury

**Initial ED Management**
- Pain medication
- Splint placement
  - Deformed fractures must be immobilized
  - Prevent further deformity and soft-tissue injury
- NPO
- Radiographs

**Radiographic Examination**
- Joint above and below the fracture
- Obtain two views (AP and Lateral)
- May need oblique view (Hand, ankle, foot)
- May need comparison view (normal variability in bony anatomy of growing bones)
Speaking With Orthopedics

- Accurate description using appropriate terminology

Clinical Fracture Description

- Age and sex
- Mechanism of injury
- Anatomic location
- Neurovascular status
- Extent of associated soft tissue injury
  - Open
  - Closed

Radiographic Fracture Description

- Anatomic location of fracture
- Pattern of fracture
- Relationship of fracture fragments
- Physeal involvement (Salter-Harris Type)
- Joint involvement--dislocation

Anatomic Location of Fracture

- Proximal
- Midshaft
- Distal

Fracture patterns

- Transverse----perpendicular to bony axis
- Oblique----angle to bony axis
- Spiral----curvilinear to bony axis
- Comminuted----3 or more fragments
Relationship of fracture fragments

- Angulation
- Shortening
- Distraction
- Displacement

Fractures Unique To Children

- Physeal fractures
- Torus (Buckle) fractures
- Greenstick fractures
- Bowing fractures
- Avulsion fractures
- Toddler’s fracture
Physeal Fractures

- Weakest point of pediatric skeleton
- Up to 30% of pediatric fractures involve the growth plate
- Most common in early adolescence
- Ligaments stronger than growth plate
- Physeal fractures occur in children where sprains commonly occur in adults

Physeal Fractures

- Salter-Harris Classification
  - Type 1-5
  - Prognosis worsens from 1-5
- Remember = ME

Salter-Harris Type I

- Fracture through the physis (5%)
- Separation of the epiphysis from the metaphysis
- Radiographic findings
  - Normal film—Clinical Diagnosis
  - Widening of physis
  - Epiphysial displacement
Salter-Harris Type I

• Point tenderness over area of growth plate with a normal radiograph = SH – I fracture

• Avoid pitfall of diagnosing sprain in children

Salter-Harris Type I

• Generally benign, with little chance of growth disturbance
• Exceptions include:
  – Femur, proximal radius and tibia
  – High risk of premature physeal closure
• Immobilize and follow up with orthopedics if there is no displacement

Salter-Harris Type II (M)

• Most common physeal fracture (75%)
• Fracture through the metaphysis and physis
• Fracture produced
  – Entire epiphysis with attached metaphyseal fragment
• Like type I, generally are benign
• Immobilize and follow up with orthopedics if not displaced
Salter-Harris Type III (E)

- Fracture through epiphysis and physis (10%)
- Intra-articular injury
- Fracture produced
  - Epiphyseal fragment with no attachment to metaphysis
- Prognosis can be poor
- Re-establish anatomic position
  - Prevent growth arrest
  - Restore normal joint function

Salter-Harris Type IV (ME)

- Fracture through the metaphysis, physis, and epiphysis (10%)
- Intra-articular injury
- Fracture produced
  - Single fragment consists of both metaphysis and physis
- Prognosis can be poor
- ORIF almost always necessary to restore joint mechanics and prevent growth arrest
Salter-Harris Type V

- Compression injury to the physis (1%)
- Difficult to diagnose
- Radiograph
  - Normal
  - Subtle physeal narrowing
- Diagnosis is often made in hindsight after a growth arrest becomes evident

Torus (buckle) Fractures

- Occur in the metaphysis from a compressive load
- Cortex of the bone buckles in a small area
- Stable fracture
- Immobilize and follow up with orthopedics

Greenstick Fractures

- Most common fracture type in children.
- Incomplete fractures in which the cortex remains intact on one side
- In most instances, the fracture must be completed to obtain anatomic reduction
**Bowing Fractures**

- Force exceeds elastic limits of bone
- Bowed deformation
- Fracture line not apparent radiographically
- Histologically see multiple oblique microfractures
- Reduction depends on age and degree of angulation

**Avulsion Fractures**

- Apophysis-bone growth center that has a strong muscular attachment
- During intense muscular contraction (sports), fractures occur through the apophyseal plate.
- Pelvis most common site

**Pelvic Avulsion Fractures**

- Athletic teenagers
  - Running, kicking
  - Hip pain, point tenderness, decreased range of motion
Treatment

- Partial or No weight bearing for 4-6 weeks
- Pain control
- Slow resumption of activity
- Avulsion greater than 2 cm may require ORIF

Toddler’s Fracture

- Spiral/oblique fracture of distal tibia
- Ages 1-5 years
- Sudden onset of limp or refusal to bear weight
- Typically after a fall with a twist
  - Actual fall is often unWitnessed
- Fracture may be radiographically invisible (oblique view)
- Long leg splint, ortho follow up
Common upper extremity fractures

- Clavicular fracture
- Proximal & Mid-shaft humerus fracture
- Supracondylar fracture
- Forearm fractures
- Hand fractures

Clavicle fractures

- Most common fracture in childhood
  - Fall on outstretched arm
  - Shoulder pain (don’t forget to feel clavicle)
  - Most are midshaft (85%)
- Immobilize in sling for 3 weeks
- Followed by 3 weeks of sports restriction
- Lump/callus will form and persists ~ 1 year

Proximal Humerus Fracture

- FOOSH or direct trauma
- Potential axillary nerve injury

<table>
<thead>
<tr>
<th>Patient Age (yr)</th>
<th>Allowable Displacement or Angulation</th>
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<tr>
<td>&lt;5</td>
<td>Up to 70° angulation, 100% displacement</td>
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<tr>
<td>5–12</td>
<td>Up to 40–70° angulation</td>
</tr>
<tr>
<td>&gt;12</td>
<td>Up to 40° angulation, 50% displacement</td>
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</tbody>
</table>

Sling or shoulder immobilizer
Midshaft Humerus Fracture

- Uncommon fracture
- FOOSH or direct blow
- Radial nerve injury, vascular injury rare
- ED ortho consult
  - Complete displacement
  - Angulation > 20° in children
  - Angulation > 10° in adolescents
- Coaptation splint

Supracondylar Fracture

- Most common fracture of the elbow
- Mechanism of injury
  - Fall onto outstretched hand
  - Hyperextension of elbow
- Severe fractures
  - Neurovascular compromise common
  - Long term deformities
  - Range of motion abnormalities
- Treatment dependent on type

Supracondylar Fracture

- Keys to radiographic diagnosis—ABC’S
  - Adequate views (True lateral, AP)
  - Alignment
    - Anterior humeral line
    - Radiocapitellar line
  - Bones
  - Cartilage
    - Ossification centers
  - Soft tissue
    - Anterior and Posterior Fat pads
Elbow ossification centers

<table>
<thead>
<tr>
<th>Ossification center</th>
<th>C-R-I-T-O-E</th>
<th>Age of appearance</th>
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<tbody>
<tr>
<td>Capitellum</td>
<td>C</td>
<td>1 year</td>
</tr>
<tr>
<td>Radius</td>
<td>R</td>
<td>3 year</td>
</tr>
<tr>
<td>Internal epicondyle</td>
<td>I</td>
<td>5 year</td>
</tr>
<tr>
<td>Trochlea</td>
<td>T</td>
<td>7 year</td>
</tr>
<tr>
<td>Olecranon</td>
<td>O</td>
<td>9 year</td>
</tr>
<tr>
<td>External epicondyle</td>
<td>E</td>
<td>11 year</td>
</tr>
</tbody>
</table>
Monteggia fracture
- Proximal ulnar fracture with radial head dislocation
- Ulna rarely fractures alone (even bowing)
- Failure to recognize radial head dislocation can result in permanent joint dysfunction
- Orthopedic consult in ED

Galeazzi fracture
- Distal radius shaft fracture with dislocation of the distal radial-ulnar joint
- Orthopedic consult in ED

Scaphoid Fracture
- Most common carpal bone fracture
- Mechanism of injury
  - Fall onto outstretched arm with wrist hyperextension
- Clinical diagnosis
  - Snuffbox tenderness
  - Pain with longitudinal compression of thumb
- Radiographs may be normal (oblique view)
- Treatment: thumb spica splint and ortho f/u
Boxer’s Fracture

- Distal 5th metacarpal fracture
- Most common metacarpal fracture
- Mechanism of injury--punch with closed fist
- Treatment
  - Ulnar gutter splint and ortho follow up
    - Non-displaced, and less than 40 degrees of angulation
  - Closed reduction

Conclusion

- Pain control and splint prior to x-ray
- Physeal fractures
  - Salter-Harris
  - M, E, ME
- Clinical Diagnosis
  - SH-1 Fracture
  - Toddler’s Fracture
  - Scaphoid Fracture