Common Orthopaedic Injuries in Children

Rakesh P. Mashru, M.D.
Division of Orthopaedic Trauma
Cooper University Hospital
Cooper Medical School of Rowan University
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Learning Objectives

- Children are not little adults
  - Differences in pathology and development
- Epidemiology of Sports Injuries in Children
- Salter Harris Classification
- Specific fracture patterns
Pediatric Sports Injuries

• Benefits
  – Physical Fitness
  – To Make Friends
  – Build Self Esteem
  – Motor Development
    • Learn new skills
    • Improve skills
Epidemiology

- 42 million people > age 6 participate in organized sports
- Under age 10, most injuries are secondary to recreational activities rather than organized sports
- Approximately 3 million ER visits/annually related to sports injuries
Epidemiology

• Body part most likely injured in the high school athlete
  – Ankle
  – Knee
  – Wrist, hand, elbow
  – Head, neck, clavicle
Development

• Differences in musculoskeletal system
  – Pediatric bone more aqueous and less dense
    • Stronger periosteum
    • Better blood supply
  – Physis
    • Structurally weaker than bone hence more predisposed to injury than bone
Development

- Physeal structure
Properties of immature skeleton

Adult vs pediatric

- Stress–strain curves for mature and immature bone. The increased strain of immature bone before failure represents plastic deformation.
Plastic deformation
Remodeling/Overgrowth

- Fractures heal more rapidly than those in adults, but once healed, they remodel residual deformity.
- Factors affecting remodelling potential:
  - amount of growth remaining (the patient's skeletal age)
  - the plane of the deformity in relation to adjacent joints
  - the deformity's proximity to the physis and
  - the growth potential of the particular physis
Accelerated growth

• Potential of overgrowth in injured limb
  – Most commonly seen in diaphyseal femoral fractures
  – Shortening corrected up to 2cm
• Hyperemia effect???
Development

• Clinical pearls
  – Younger children -> upper extremity
  – Older children -> lower extremity

• Role of closed reduction in pediatric patient
  – Ability to heal and remodel
  – Strict adherence to principles of open reduction may not be applicable
    • Articular congruity
    • Anatomic reduction
Salter Harris classification
Non-accidental trauma/Child Abuse

• 1%-2% of all children abused annually
• Younger children are also more likely to die from abuse
• After skin lesions, fractures are the second most common physical presentation
• Femoral shaft, hands and feet fractures in nonambulatory infants
Suspicious Injuries

- Spiral humerus/femur fractures (non-ambulatory patients)
- Corner fractures (junction of metaphysis and diaphysis)
- Posterior rib fractures
SCIWORA

- Spinal Cord Injury without radiographic abnormality
- overwhelmingly found in children (15% to 35% of SCIs in children)
- Most, if not all, will have abnormal findings on MRI
- Spinal column is more elastic than the spinal cord
- More common in children under 8 years of age than in older children
- Predisposing factors
  - cervical spine hypermobility,
  - ligamentous laxity, and
  - an immature vascular supply to the spinal cord
Pediatric pelvic fractures

- Torode and Zieg classification
Pediatric polytrauma treatment

- Principles of damage control orthopaedics apply
- Neurovascular exam/compromise
- Open fracture – excisional debridement with bony stabilization
- Examination of the soft tissues – compartment syndrome
- Provisional stabilization of long bone injuries
- Closed reduction and application of splints
- Remember...ABCs come first.
Pediatric Trauma Scoring Systems

- Injury Severity Score (ISS)
  - Six body regions each assigned an AIS score
  - Top three AIS scores are each squared and then added.
  - ISS >16 indicates polytrauma

<table>
<thead>
<tr>
<th>Region</th>
<th>Injury Description</th>
<th>AIS</th>
<th>Square Top Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head &amp; Neck</td>
<td>Cerebral Contusion</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Face</td>
<td>No Injury</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>Flail Chest</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Minor Contusion of Liver, Complex Rupture Spleen</td>
<td>2 5</td>
<td>25</td>
</tr>
<tr>
<td>Extremity</td>
<td>Fractured femur</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>External</td>
<td>No Injury</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Injury Severity Score: 50
Pediatric Trauma Scoring Systems

- Pediatric Trauma Score

<table>
<thead>
<tr>
<th>Assessment Component</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+2</td>
</tr>
<tr>
<td>Weight</td>
<td>Weight &gt;20 kg (&gt;44 lb)</td>
</tr>
<tr>
<td>Airway</td>
<td>Normal</td>
</tr>
<tr>
<td>Systolic Blood Pressure</td>
<td>&gt;90 mm Hg, good peripheral pulses and perfusion</td>
</tr>
<tr>
<td>Level of Consciousness</td>
<td>Awake</td>
</tr>
<tr>
<td>Fracture</td>
<td>None seen or suspected</td>
</tr>
<tr>
<td>Cutaneous</td>
<td>None visible</td>
</tr>
</tbody>
</table>


*PTS > 8 should have 0% mortality.
All injured children with PTS < 8 should be triaged to an appropriate pediatric trauma center.
## Pediatric Trauma Scoring Systems

- **Pediatric Glasgow Coma Score**

<table>
<thead>
<tr>
<th>PEDIATRIC GLASGOW COMA SCALE (PGCS)</th>
<th>&gt; 1 Year</th>
<th>&lt; 1 Year</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EYE OPENING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneously</td>
<td>Spontaneously</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>To verbal command</td>
<td>To shout</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>To pain</td>
<td>To pain</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>No response</td>
<td>No response</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>MOTOR RESPONSE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obeys</td>
<td>Spontaneous</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Localizes pain</td>
<td>Localizes pain</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Flexion-withdrawal</td>
<td>Flexion-withdrawal</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Flexion-abnormal (decorticate rigidity)</td>
<td>Flexion-abnormal (decorticate rigidity)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Extension (decerebrate rigidity)</td>
<td>Extension (decerebrate rigidity)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>No response</td>
<td>No response</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL PEDIATRIC GLASGOW COMA SCORE (3-15):</th>
<th>&gt; 5 Years</th>
<th>2-5 Years</th>
<th>0-23 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriented</td>
<td>Smiles/coos appropriately</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Disoriented/confused</td>
<td>Cries and is consolable</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Inappropriate words</td>
<td>Persistent inappropriate crying and/or screaming</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
<td>Grunts, agitated, and restless</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>No response</td>
<td>No response</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Multiply injured patient

- Initial assessment includes
  - ABCs
  - PALS
- Children are not small adults
- Differences include:
  - Pediatric physiology is more elastic, injury insult may not fully manifest on physical exam
  - Hemodynamic instability may not occur until 30% of blood volume is lost
Specific fracture patterns

• Elbow
  – Supracondylar distal humerus
  – Little League elbow
  – OCD
• Knee
  – Tibial tubercle
  – Tibial spine
• Ankle
  – Tillaux
  – Triplane
Elbow

- Ossification centers of the elbow
- CRITOE (CRIMeTOLE)
Elbow

• Supracondylar distal humerus fracture
  – Gartland classification
    • Type I – non-displaced
    • Type 2 – displaced with intact posterior cortex
    • Type 3 – complete displacement (both cortices)
Elbow

• Type 1 supracondylar distal humerus
  – Treatment: Closed reduction + cast
Elbow

- Type 2 supracondylar distal humerus
  - Treatment: Closed vs open reduction, pin fixation
Elbow

- Type 3 supracondylar distal humerus fracture
  - Treatment: Closed vs open reduction, pin fixation
Elbow

- Little League elbow
  - Apophysitis of the medial epicondyle of the elbow
Elbow

- Osteochondritis Dissecans (OCD)
  - Most frequently involves the anterolateral surface of the humeral capitellum
  - Radiographs, MRI
Knee

- Tibial tubercle classification
  - Ogden classification center
    - Type 1 – fracture of secondary ossification center (insertion of patellar tendon)
    - Type 2 – fracture propagates to primary ossification center
    - Type 3 – fracture crosses the primary ossification center
    - A – nondisplaced, B - displaced
Knee

• Tibial tubercle fracture
  – Differentiation from Osgood Schlatter’s
Knee

• Tibial eminence fractures
  
  – Meyers and McKeever classification
    
    • Type 1 – nondisplaced
    • Type 2 – displaced with intact posterior hinge
    • Type 3 – completely displaced
Knee

• Tibial Spine fracture
  – Assess instability
    • ACL laxity
  – Operative vs. Non-operative management
    • Closed reduction with immobilization in 0 to 20 degrees of flexion, assess reduction
    • Open reduction vs arthroscopic repair
      – Suture fixation
      – Screw fixation
Ankle

- Tillaux fracture
  - Salter III fracture of the distal tibial epiphysis
  - Closed vs. open reduction
  - Non-operative indications
    - Non-displaced or less than 2 mm displacement
Ankle

• Tillaux fracture
Ankle

- Triplane fracture
  - Differentiate from Tillaux
  - Must understand fracture geometry to plan operative fixation
    - Salter Harris IV fracture in all 3 planes
    - AP view depicts SH III fracture
    - Lateral view depicts SH II fracture
Ankle

• Triplane fracture
Ankle

- Triplane fracture fixation
Injury management

• Ice is a vital sports medicine drug
• When in doubt - > IMMobilize and REST
• Refer child and adolescent athletes to sports medicine specialists
Summary

• Understand anatomy and interpretation of radiographs
• Many injuries can be managed non-operatively
• When in doubt, immobilize and refer
Thank You!

Cooper
Bone & Joint Institute