Evaluation of the Pediatric Upper Extremity: A Case-Based Review of Shoulder and Elbow Injuries, Including Fractures

Henry Bone Ellis, Jr. MD

July 9, 2019
I have nothing to disclose
Objectives

- Describe history and findings for pediatric elbow exam for sports-related injuries.
- Describe history and findings for pediatric shoulder exam for sports-related injuries.
- Present case examples to emphasize unique features of upper extremity conditions in active pediatric population.
- Review recommendations for sport specialization and care for overuse injuries.
The Shoulder and Elbow Exam
2 Athletes with shoulder or elbow pain

**ACUTE**

17 year old with a loud pop while falling to the ground

**CHRONIC**

12 year old with 6 months of shoulder pain
2 Athletes with shoulder or elbow pain

**ACUTE**

12 year old who heard a loud pop to her elbow

**CHRONIC**

17 year old quarterback with 3 months of elbow pain
Shoulder Pain

Acute
- Shoulder Dislocation
- Shoulder Separation
- Proximal Humerus Fracture
- Clavicle Fracture
- Sternoclavicular Dislocation
- Labral tear
- Tendon Rupture

Chronic
- Scapular Dyskinesis
- Shoulder Instability
- Proximal Humerus Epiphyseolysis
  - Labral Tear
- Snapping Scapula
- Impingement
- Tendonitis
The Shoulder and Elbow Exam in 6 minutes……

- Must always include
  - Neurovascular Exam
    - Vascular Exam
      - Radial Pulse
      - Capillary Refill
    - Neurologic Exam
      - Axillary/C5 Nerve Root
      - Musculocutaneous
      - Median/Anterior Interosseous Nerve (AIN)
      - Radius/Posterior Interosseous Nerve (PIN)
      - Ulnar
  - Cervical Spine Exam
  - Hyperlaxity Exam
- If a fracture is suspected, joint above and below deformity should be evaluated and imaged
The Shoulder and Elbow Exam in 6 minutes......

Sternoclavicular Injury: evaluate for dysphagia/difficulty breathing, CT scan
The Shoulder and Elbow Exam in 6 minutes.......
The Shoulder and Elbow Exam in 6 minutes……..

Type 3 Supracondylar Elbow Fracture

6 month old with a transphyseal fracture with possible non-accidental trauma
Clavicle Fracture
The Shoulder and Elbow Exam in 6 minutes......
Labral Cyst (Spinoglenoid Cyst)
Scapular Winging
The Shoulder and Elbow Exam in 6 minutes……

1. Sternoclavicular Joint
   - Proximal Clavicle Fracture
   - SC Joint Separation
2. Clavicle
   - Clavicle Fracture
3. Acromioclavicular Joint
   - AC or Shoulder Separation
4. Acromion
5. Coracoid
   - Scapular Dyskinesis
6. Humeral Head
   - Little Leaguer’s Shoulder
7. Biceps Tendon
   - SLAP Tear
   - Tendinitis
   - Snapping Biceps
The Shoulder and Elbow Exam in 6 minutes......

1. Medial Epicondyle
2. Ulnar Nerve
3. Triceps
4. Olecranon
5. Capitellum
6. Lateral Condyle
7. Radial Head
SHOULDER

- Forward flexion: 160 - 180°
- Extension: 40 - 60°
- Abduction: 180°
- Adduction: 45°
- Internal rotation: GT/SI/L12/T12/T5
- External rotation: 80 - 90°
SHOULDER

- Forward flexion: 160 - 180°
- Extension: 40 - 60°
- Abduction: 180°
- Adduction: 45°
- Internal rotation: GT/SI/L12/T12/T5
- External rotation: 80 - 90°

Video courtesy of Philip Wilson, MD
The Shoulder and Elbow Exam in 6 minutes

ELBOW

• Extension – Flexion
  0° – 140°

• Supination – Pronation
  90° – 90°
The Shoulder and Elbow Exam in 6 minutes……

- Deltoid
  - Axillary Nerve
- Empty Can Sign
  - Rotator Cuff/Supraspinatus
- Forward Flexion
  - Biceps Tendon
- Internal Rotation
- External Rotation
- Elbow Flexion/Extension
  - Brachialis/Biceps
  - Triceps
- Supination
  - Biceps
  - Musculocutaneous Nerve
- Wrist Extension and Flexion
  - Radial Nerve
  - Forearm Flexor/Extensor Overuse
- Thumb Flexion/Extension
  - AIN/PIN
- Wide Fingers
  - Ulnar Nerve
The Shoulder and Elbow Exam in 6 minutes......

- Shoulder Instability
  - Sulcus Sign
  - Apprehension/Relocation Sign
- Labral Tear
  - O’Brien SLAP Test
- Ulnar Collateral Ligament Instability
  - Milking Maneuver
  - Dynamic Milking Maneuver
Shoulder Instability
Sulcus Sign
Apprehension/Relocation Sign
Labral Tear
O'Brien SLAP Test
Ulnar Collateral Ligament Instability
Milking Maneuver
Dynamic Milking Maneuver

The Shoulder and Elbow Exam in 6 minutes......

Positive Sulcus Sign
Live Shoulder/Elbow Exam
Case Example
Thrower’s Overuse Shoulder Injury
Dave, 13 year old male

- Shoulder pain while pitching x 6 weeks
- Coach/Dad said my rotator cuff was inflamed
Dave, 10 year old male

- Shoulder pain while pitching x 6 weeks
- Coach/Dad said my rotator cuff was inflamed
Evaluation of a Youth Athlete

• History
  • Acute vs. Chronic
  • Time Management
    • Sports = Complaints
  • Parents Influence
  • Pain
    • Activity Related
    • Mechanical Symptoms

• Exam
  • Inspection
  • Palpation
  • ROM
  • Strength
<table>
<thead>
<tr>
<th>Condition</th>
<th>Mechanism of Injury</th>
<th>History / Exam</th>
<th>Imaging</th>
<th>Treatment</th>
<th>When to Refer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Leaguer’s Shoulder</td>
<td>OVERUSE – repetitive injury; typically seen when pitching guidelines are not followed</td>
<td>Progressively worsening upper arm pain and pitching form with throwing laxity</td>
<td>XR: AP Grashey view with IR and ER; contralateral imaging for comparison; Finding: physic widening, compare with contralateral</td>
<td>Rest until pain free, pitch training, physical therapy, reinforce pitching guidelines and oversee education</td>
<td>Persistent pain after forced rest</td>
</tr>
<tr>
<td>(Humeral Epiphysiolysis)</td>
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<tr>
<td>Multidirectional Instability</td>
<td>OVERUSE – sometimes presents with a single acute occurrence</td>
<td>Generalized ligamentous laxity (Beighton Criteria), activity-related pain, instability on exam, but not reported as symptom</td>
<td>XR: AP Grashey view, axillary view, and scapular Y-view; Finding: normal</td>
<td>Physical Therapy: shoulder/scapular stabilization, progress to rotator cuff training, core and postural training</td>
<td>Recurrent instability or persistent pain</td>
</tr>
<tr>
<td>Scapular Dyskinesia</td>
<td>OVERUSE – poor mechanics</td>
<td>Generalized ligamentous laxity (Beighton Criteria), activity-related pain, pain with overhead activities, peri-scapular atrophy</td>
<td>XR: AP Grashey view, axillary view, and scapular Y-view; Finding: normal</td>
<td>Physical Therapy: shoulder/scapular stabilization, core and postural training</td>
<td>Recurrent or persistent pain</td>
</tr>
<tr>
<td>Internal Impingement</td>
<td>OVERUSE – chronic rotator cuff and labral compression with repetitive motions</td>
<td>Activity related pectoral shoulder pain, internal rotation deficit compared to contralateral side</td>
<td>XR: AP Grashey view, axillary view, and scapular Y-view; Finding: normal</td>
<td>Rest, pitch training, scapular stabilization/sleeper stretch and oversee education</td>
<td>Recurrent or persistent pain</td>
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<tr>
<td>Shoulder Dislocation</td>
<td>ACUTE or RECURRENT - Fall on outstretched arm is most common</td>
<td>Focal sharp pain – anterior shoulder, empty lateral arm, anterior prominent mass.</td>
<td>XR: AP Grashey view, axillary view, and scapular Y-view; Finding: normal</td>
<td>Urgent closed reduction, immobilization</td>
<td>Any patient with suspected or confirmed shoulder dislocation</td>
</tr>
<tr>
<td>Clavicle Fracture</td>
<td>ACUTE – sudden injury; often a direct hit or fall on shoulder</td>
<td>Pain with palpation – clavicle with soft tissue swelling; prominence clavicle</td>
<td>XR: AP and 15 degrees Cranial View; Finding: fracture or displacement</td>
<td>Depends on shortening, displacement, hand dominance, and activity restrictions</td>
<td>Any patient with suspected or confirmed clavicle fracture</td>
</tr>
<tr>
<td>Shoulder Separation – Acromioclavicular (AC) Injury</td>
<td>Fall onto shoulder with arm to the side</td>
<td>Pain with palpation distal clavicle, acromioclavicular (AC) joint and acromion</td>
<td>XR: AP Grashey view, axillary view, and scapular Y-view; Finding: asymmetry in AC alignment</td>
<td>Little to no displacement – sling and early range of motion. Displaced lesion may require surgical management</td>
<td>Visible displacement</td>
</tr>
<tr>
<td>Sternoclavicular (SC) Injury</td>
<td>Direct blow to chest</td>
<td>Pain and deformity over sternoclavicular joint. Evaluate for dysphagia and shortness of breath</td>
<td>XR: Scapulodipity view, typically requires CT; Finding: subclavicle height asymmetry; CT scan axial diagnostic</td>
<td>May require surgical management</td>
<td>All injuries to sternoclavicular (SC) joint</td>
</tr>
</tbody>
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Legend: XR - X-ray; MRI - Magnetic Resonance Imaging; AP - Anterior-Posterior view; Lat - Lateral view
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<td>XR: AP Grashey view, axillary view, and scapular Y-view</td>
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<tr>
<td>Finding: glenoid margin loss, humeral head Hill Sachs Depression</td>
</tr>
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<td>XR: AP and 15 degrees Cranial View</td>
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<td>XR: Serendipity view, typically requires CT</td>
</tr>
<tr>
<td>Finding: subtle clavicle height asymmetry; CT scan axial diagnostic</td>
</tr>
<tr>
<td>5700 Dallas Parkway • Frisco, TX 75034 • Phone: 469-515-7100 • UT Southwestern Medical Center</td>
</tr>
</tbody>
</table>
IMAGING - KEY

- Anteroposterior
- Scapular – Y or Axillary
Dave, 10 yo male

- Shoulder pain while pitching x 6 weeks
- Coach/Dad said my rotator cuff was inflamed
  - No injury/event
  - Lateral shoulder soreness
  - Activity-related
  - Improves with rest
  - All-star pitcher
  - Play in 3 leagues
  - Played for the last 12 months
  - Dad is my pitching coach
Shoulder - Overuse

- Humeral Epiphysiolsis (Little League Shoulder)
- Multidirectional Instability
- Scapular Dyskinesia
- Internal Impingement
Humeral Epiphysiolysis
AKA: Little League Shoulder (LLS)

- An injury to the proximal humeral growth plate
- Male baseball pitchers ages 11-14 have the highest incidence of LLS
Humeral Epiphysiolysis
AKA: Little League Shoulder

- **Signs**
  Poor form, especially when fatigued

- **Symptoms**
  Progressively worsening upper arm pain with throwing

- **Diagnosis**
  Radiology – plain films show widening proximal physis
Humeral Epiphysiolysis
AKA: Little League Shoulder

RECOMMEND CONTRALATERAL IMAGING
Humeral Epiphysiolysis
AKA: Little League Shoulder

- **Signs**
  Poor form, especially when fatigued

- **Symptoms**
  Progressively worsening upper arm pain with throwing

- **Diagnosis**
  Radiology – plain films show widening proximal physis

- **Treatment**
  - REST
  - PITCH TRAINING
  - SCAPULAR STABILIZATION
  - EDUCATION
50% of middle school and high school sports injuries are overuse injuries
What is the big deal??

- Less free play
- More competition
- Single sport play
- Poor mechanics
- Year-round play
Pressure, Media, Means to an End

- Less free play
- More competition
- Single sport play
- Poor mechanics
- Year-round play

2000
Average Little Leaguer took 3.4 months off per year

2011
Average Little Leaguer took one week off per year
Top 10 Articles for Parents of Youth Athletes.....
Resources

- stopsportsinjuries.com
- scottishritehospital.org/sports
- https://www.positivecoach.org/
- http://orthokids.org/
SPORTS SPECIALIZATION
Top 10 Articles for Parents of Youth Athletes.....
• Physical Exam – stick with the basics
• Imaging – consider contralateral imaging and ALWAYS request 2 views with either scapular-Y or axillary views
• Overuse Injuries – REST, Prevention, Physical Therapy/Proper Mechanics
• Educate athletes/parents on injury prevention strategies
• No more hours of organized sports than age of your child
Case Example
Overuse Elbow Injury: Osteochondritis Dissecans
Lexie, 11 yo Female

- 11+2 yo F – Level 9 gymnast

- Several month history of right elbow pain
Elbow Exam in a Throwing Athlete
Elbow Exam in a Throwing Athlete

- Medial Epicondylitis
- Capitellar OCD
- Olecranon Osteophyte
Elbow Exam in a Throwing Athlete

Medial Epicondylitis

Capitellar OCD

Olecranon Osteophyte
Elbow Exam in a Throwing Athlete

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### ELBOW

#### Common Problems in Active Youth

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<th>Treatment</th>
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<td>Fracture/Dislocation</td>
<td>ACUTE - sudden injury; three mechanisms: direct trauma, avulsion, or dislocation; fall on outstretched hand</td>
<td>Reports elbow &quot;popped&quot; or buckled during a single event; restricted ROM and valgus laxity on exam; focal pain, with or without deformity; patient describes single event, swelling</td>
<td>XR-AP and Lat</td>
<td>Refer any fracture, suspected fracture or dislocation. Open fractures or visible deformity may require urgent referral to pediatric orthopedic surgeon or emergency room.</td>
</tr>
<tr>
<td>Medial Epicondylo Apophysitis</td>
<td>OVERUSE - pain with repetitive throwing activity</td>
<td>Focal pain with palpation at medial epicondyle and medial flexor, loss of elbow extension. Pain with resisted wrist flexion</td>
<td>XR-AP Lat. and internal oblique</td>
<td>Forced rest; physical therapy to focus on shoulder and elbow; pitcher may need a pitch progression program prior to returning to throwing. Recurrent or persistent pain, change in appearance of medial compared to contralateral side, or any displacement.</td>
</tr>
<tr>
<td>Capitellar Osteochondritis Dissecans</td>
<td>OVERUSE - pain with repetitive throwing or impact activity, e.g. pitching, gymnastics, throwing</td>
<td>Lateral mechanical symptoms, lateral dull pain that worsens with activity, popping, locking; posterior-lateral pain with palpation</td>
<td>XR-AP and Lat; MRI may be ordered by specialist to assist with definitive care</td>
<td>Forced rest in early stages. Surgery often required.</td>
</tr>
<tr>
<td>Ulnar Colateral Ligament Tear</td>
<td>OVERUSE or ACUTE - underlying history of overuse common, though sudden, forceful injury can occur; throwing</td>
<td>Medial elbow activity related; pain with tenderness over medial elbow distal to medial epicondyle.</td>
<td>XR-AP and Lat</td>
<td>Majority treated with rest, activity modification, and physical therapy. Bone avulsion, acute injuries, or continued pain may require surgical treatment.</td>
</tr>
<tr>
<td>Lacer’s Disease</td>
<td>NOI overuse</td>
<td>&lt;10 years of age; self-limiting</td>
<td>XR-AP and Lat</td>
<td>Rest, do not immobilize. Persistent pain with rest.</td>
</tr>
<tr>
<td>Olecranon Osteophytes / Impingement</td>
<td>OVERUSE</td>
<td>Posterosmedial or posterolateral elbow pain with extension</td>
<td>XR-AP and Lat</td>
<td>Rest, physical therapy, may require arthroscopy. Persistent pain with rest.</td>
</tr>
<tr>
<td>Olecranon Stress Fracture</td>
<td>OVERUSE</td>
<td>Vague pain moves from medial to lateral to posterior</td>
<td>XR-AP and Lat</td>
<td>Rest, pitch training, pitch counts and overuse education; may need surgical intervention. Persistent pain with rest.</td>
</tr>
<tr>
<td>Synovial impingement of the posterolateral elbow</td>
<td>ACUTE</td>
<td>Often recall a specific injury, tenderness over posterolateral elbow</td>
<td>XR-AP and Lat</td>
<td>Forced rest, mechanics training for arm, physical therapy; occasional surgical resection. Refer all</td>
</tr>
<tr>
<td>Nursemaid’s Elbow</td>
<td>ACUTE - longitudinal traction injury, typically in ages 2-3 yrs, not older than 7 yrs; recurrence is common</td>
<td>Initial pain that subsides quickly, residual pain/pseudoparalysis, presents with forearm pronation, pain with palpaton at radial head and with resistance to supination</td>
<td>XR - typically not needed</td>
<td>Non-operative reduction maneuver by trained personnel.</td>
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*Note: This guide was created as a reference for primary care providers to evaluate a young athlete’s joint pain. The list is NOT inclusive. Other diagnoses including infection, neoplasia, or fractures/dislocation may also be considered.*

- Imaging:
  - X-ray Elbow
  - AP and Lateral
Differential Diagnosis

- Osteochondritis dissecans
- Medial epicondylitis
- Olecranon stress fracture
- Subluxating ulnar nerve
- Snapping triceps
- Ulnar collateral ligament tear
- Flexor-pronator tendonitis
- Little League Elbow
- Panner’s Disease
- Posterolateral synovial impingement
- Fracture
  - Medial epicondyle, radial head, SCH, lateral condyle
Medial Epicondylitis

• AKA Little League Elbow

• **Signs**
  • History of repetitive throwing or tumbling

• **Symptoms**
  • Medial pain and loss of extension

• **Diagnosis**
  • Focal epicondyle and medial flexor pain

• **Treatment**
  • Forced rest
Medial Epicondylitis

• AKA Little League Elbow

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- Flexor-Pronator tendonitis
- Little League Elbow
- Panner’s Disease
- Posterolateral Synovial Impingement
- Fracture
  - Medial epicondyle, radial head, SCH, lateral condyle
Posterolateral Synovial Impingement

- Rest, rest, rest
- Rehab & Mechanics

- Occasionally arthroscopic resection
Lexie

- 11+2 yo F – Level 9 gymnast
- Several month history of right elbow pain
- ROM: 10-135
- Tender to palpation over lateral elbow
Osteochondritis Dissecans of the Capitellum

• Commonly occurs in:
  • Pitchers
  • Gymnasts

• Presents primarily with:
  • Lateral elbow pain
  • Loss of motion
  • Occasionally mechanical symptoms
Osteochondritis Dissecans of the Capitellum

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Classification

MRI

- Grade 0 – Normal
- Grade 1 – Intact cartilage with signal changes
- Grade 2 – High signal breach of cartilage
- Grade 3 – Thin rim of high signal intensity behind osteochondral fragment
- Grade 4 – Loose body
Treatment Outcomes

- Osteochondritis Dissecans of the Capitellum
Treatment Options – Non-Operative

• Non-operative
  • Early grade, stable lesion

• Cessation of sports for 3-6 weeks, return to sport in 3-6 months

• Once pain subsided, strengthen and stretching exercises

• Monitored Interval Throwing Rehabilitation Program
Treatment Outcomes – Non-Operative

- Mitsunaga et al – J Trauma 1982
  - 84 patients seen during a 43 year period
  - >50% of patients had mild discomfort at 13.6 years

- Takahara – CORR 1999
  - 53 patients – average follow up of 12.6 years
  - 50% had poor outcome
  - No patient returned to previous sport

- Mihara et al – AJSM 2009
  - 39 baseball players (Mean 12.8 years)
  - 16/17 patients with open physes healed, compared to 11/22 with closed physes
  - 27/39 returned to sport
Surgical Treatment Indications

• Indications
  • Presence of loose bodies
  • Mechanical symptoms
  • Unstable lesions
  • Stable lesions that have failed 6 months of nonsurgical management
Open Debridement and Fragment Excision

- **Bauer et al – CORR 1992**
  - 31 patients with 23 year outcomes
  - 40% recurrence of symptoms and loss of elbow extension
  - 60% with degenerative joint disease

- **Takahara et al – JBJS 2007**
  - 55 patients with 9.6 year follow up
  - 35% reported moderate or severe pain, 35% reported no pain, and 30% reported mild pain
  - 50% returned to competitive sport
Open Debridement and Marrow Stimulation

- Jones, Weisel, Sankar & Ganley JPO 2012
  - N=25, average age 13.1
  - 12 require mini-arthrotomies
  - Improvement of 17 degrees of extension and 10 degrees of flexion
  - 86% Returned to participate at same level of sports

- Lewine et al JPO 2015
  - N=21
  - Nine with resolution on MRI
  - 4 Revision surgery
  - Timmerman improved 30 points
  - 57% Baseball Players & 67% of gymnast returned to their primary sports
Fragment Fixation

• Harada et al – JSES 2002
  • Staples and ICBG in 4 patients over 7.5 years
  • 100% union, full ROM and painless ADL’s
  • 3 out of 4 returned to sport

• Takada et al – AJSM 2002
  • 10/11 returned to competitive pitching (treated with pullout wires)

• Kuwahata and Inoue – Orthopedics 1998
  • 7 patients treated with Herbert screws and bone graft
  • At 32 mo f/u - pain resolved in all 7, all returned to sports, and 18 degree ROM increase
• JPO 2015
• 26 elbows – In-situ fixation of OCD of Capitellum
• 20/26 healed
  • Younger healed better (<15)
  • Smaller sagittal plane widths healed better (<13 mm)
• 66% returned to sport at prior level without elbow complaint
Surgical Treatment Options

- Osteochondral Autograft / Allograft Transplantation
  - Indications
    - ICRS grade IV
    - >50% articular surface area
    - Disruption of lateral buttress
    - Radial head engagement
Osteochondral Autograft Transplantation

- Yamamoto et al – AJSM 2006
  - 16/18 returned to sport with 3.5 year follow up
  - All patients with good to excellent outcome

- Iwasaki et al – JBJS 2009
  - 18/19 male athletes reported good to excellent results at 3.75 yr follow up
  - 17/19 returned to previous competitive level of sport

- Shimada et al – CORR 2005
  - 10 patients with 2 year follow up
  - 8/10 excellent clinical and radiologic results, 2/10 poor
• OJSM 2016
• 24 studies – 492 patients

• 86% return to sport at 5.6 months
  • OATS was highest return to sport (94%)
  • Significantly better when compared to debridement/microfracture (71%)
  • Fracture fixation (64%)

• 15.9 degree improvement in range of motion
• Diagnostic scope

• OCD – undersurface was primarily cartilage with non-viable bone
  • Resection instead of fixation

• Debride to healthy bone
Lexie......
Lexie - 1 year post-op
Elbow Summary

- Physical exam can often be the key to diagnosis in elbow injuries in the young athlete
- Overuse conditions can present in multiple conditions in the elbow
- Initial imaging of the elbow consists of an AP and Lateral elbow
  - Consider contralateral imaging if needed
- Treatment often times is REST, but may be require surgery for some conditions.
Thank You

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