Shoulder Injuries in the Young Throwing Athlete

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Sports Medicine Conference
Objectives

- Describe epidemiology and presentation of common adolescent shoulder injuries
- Discuss humeral head retroversion
- Discuss intrinsic and extrinsic factors of these injuries
- Discuss rehabilitation and prevention considerations
- Promote a new throwing analysis program with indications for referral
Epidemiology

- 2.6 million athletes in Little League in 2007
  - Ages 9-14
  - 380K in Pop Warner in 2007
- ~30% of pitchers self-report shoulder pain per season; 9% of pitching outings produce pain
  - 20% ages 8-12 report arm pain, 45% ages 13-14
- Dx’s: Little Leaguer’s shoulder, fractures, instability, RTC (os acromiale), SLAP
Current Data- UNC
(Marshall and Mueller)

- 5 year study with annual questionnaires
  - year 1- 404 pitchers from ~50 Little Leagues across the US involved at Year 1
  - year 2- f/u LL and initial HS
  - year 3- f/u LL, f/u HS, initial college
  - year 4- f/u all 3 groups
  - year 5- ?
Current Data- UNC

- Major Year 1 findings:
  - 42% also pitched in another league
    - 24% pitched in LL and Travel League at same time
  - 99% throw a fastball, 75% change-up, 33% curve, 19% knuckleball, 9% slider
  - 18.9% report elbow pain, 18.6% shoulder pain
  - 38.6% have pitched when arm was tired
  - 50% use ice as pain relief, 20% use NSAIDs
    - 5% use NSAIDs to pitch
Pitching Biomechanics

- Youth Pitching Data, 2008
  - 29 athletes 12.5 (+/- 1.7) y.o.
  - Max GH ER= 178 (+/- 12)°
  - Shoulder IR torq= 35 (+/- 16) Nm
  - Elbow varus torq= 35 (+/- 15) Nm
  - IR velocity= 7182 (+/- 1313)°/sec
  - Shoulder proximal force= 466 (+/- 170) N
- Above data with fastballs- 58.8 (+/- 8.5) mph
Little Leaguer’s Shoulder

- An injury to the proximal humeral physis secondary to torsional overload-epiphysiolysis
- Male baseball pitchers b/w ages 11-14 have the highest incidence of LLS
  - poor muscular development
  - active physis at its peak (80% of longitudinal growth)
  - physis strength ↓’s as testosterone ↑’s
Little Leaguer’s Shoulder

- Signs and symptoms
  - Proximal humeral pain during (hard) throwing, typically asymptomatic otherwise
  - Correlation with throwing >12 months
  - Visual exam typically unremarkable
  - Possible painful arc, typically no ROM loss
  - TTP over prox humerus in up to 80%
Little Leaguer’s Shoulder

**Radiographs**

- Plain AP IR/ER views (with comparison) can demonstrate physeal widening, metaphyseal sclerosis, osteopenia, fragmentation, capital slip of the humeral head, or fracture in severe cases.
- Represents a pseudo Salter-Harris I fx
- MRI can help confirm if suspicion is high, but x-rays are neg
- Normal radiographs are NOT required before return to throwing
Humeral Head Retroversion

- Throwing athletes consistently display greater HH retroversion in the dominant arm.
- Stress arising from the high torque late in the arm-cocking phase is large enough to lead to deformation of the weak proximal humeral epiphyseal cartilage, causing either humeral retroversion or proximal humeral epiphysiolysis over time.

This creates an increase in ER and a decrease in IR with maintenance of the total arc.

**Changes at this age are BONY**
Humeral Head Retroversion

- As the athlete matures, the physis closes
  - Decreased ability to plastically deform and remodel through the growth plate
    - Stress fx and acute fx can occur (13-16 y.o. males)
    - Increased soft tissue adaptation into HS and college
- Whiteley et al (JSAMS 6/09) found that less non-dominant arm retroversion is a significant predictor of dominant arm throwing injury
  - Genetic vs acquired version
Acute proximal humeral physeal fracture

- <5% of all child fx’s
- most common 13-16 y.o., peak at 15
- Salter-Harris II
- Usually occur with contact, but can occur with single throw
  - prodromal arm pain / Little Leaguer’s shoulder?
- Surgical tx if significant displacement or with advanced skeletal age
‘Throwing Fracture’

- Spiral fracture of the humeral shaft
- Seen in baseballers and *hand grenade throwers*
- Mainly in adults, 8% under age 15
  - Risk factors typical with other throwing injuries
- Important to rule out pathologies—cysts, tumors, cortical defects
Instability

- GH macroinstability uncommon in young throwers
  - 2.5-4.7% of all GH dislocations <12 y.o.
- Atraumatic MDI more common
  - Generalized ligamentous laxity in this age group with recurrent microtrauma of throwing
    - Pathologic laxity vs normal generalized hypermobility
      - Compare to other UE => translation and apprehension testing
Instability

- **Signs and symptoms**
  - Pain (max ER vs follow through)
  - Decreased velocity and/or control
  - Crepitus / subluxation?
    - Adolescents may not ID during throw
  - Pain / weakness with RTC testing
  - +/- impingement signs
  - + Sulcus sign, + load and shift, +/- apprehension
  - Normal x-rays
Rotator Cuff Injuries

- Adolescents => tendonitis and strains (<1% of tears)
- Rarely primary impingement, more likely secondary to underlying instability
  - similar S&S to instability
    - pain at or after release, loss of speed/control
    - pain/weakness with RTC MMT
- OVERUSE
  - excessive throwing and/or poor preseason conditioning
Rotator Cuff Injuries

- External impingment in this group more d/t anatomical variants- type III acromion, coracoid or CA ligament hypertrophy, or…
- Os Acromiale
Os Acromiale

- Failure of the anterior acromial ossification center to fuse to the acromial process
- Present in 8% of population, 33% bilateral
- Comparison axillary / Stryker notch best

-Surgery is indicated if symptomatic
  - Decompression
  - Excision
  - ORIF
SLAP Injuries

- Low SLAP incidence with skeletally immature throwers
  - 2009 study - 5% of all shoulder injuries in junior high, 22% in HS, 26% in college
- Internal impingement is also rare at this age
  - Again, ROM changes are d/t bony remodeling at the proximal humeral physis (Wolff’s Law), not posterior soft tissue
  - Posterior labral fraying and articular surface partial RTC tear incidence increases with age
SLAP Injuries

- Signs and Symptoms
  - Pain at late cocking (ER) or with follow-through
  - c/o ache ‘deep’ in the shoulder, occasional mechanical Sx
  - decreased performance
  - +/- O’Brien’s or crank
- Rehab to reduce stress
- Repair Type II’s, debride I’s and III’s
Young Thrower Injury Presentation

- Pain with throwing, not at rest
- Losing velocity and location
- Continuous play without rest
- Hard thrower (?)
- Good ROM
  - Increasing ER, decreasing IR?
- Hypermobile
- Poor muscular development
- Decreased neuromuscular control
  - core and LE’s => mechanics
Intrinsic Factors

- Anatomy - humeral head, AC joint, etc.
- Skeletal Age
- Mass, size, height
- Muscular strength and development
- Mechanics
  - up to 85% of force is generated before the shoulder
- Conditioning
- Ball velocity
Extrinsic Factors

- Level of play
  - mound-home distance
  - game length, amounts, frequency
- Sport demands
  - pitcher > catcher > IF > OF shoulder complaints
- Pitch counts
- Pitch type?
  - 52% increased risk of shoulder pain with curveball
  - Recent data shows fastballs generally have higher elbow and shoulder force moments
### TABLE 1
Recommended Maximum Number of Pitches

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Maximum Pitches per Game</th>
<th>Maximum Games per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-10</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>11-12</td>
<td>65</td>
<td>2</td>
</tr>
<tr>
<td>13-14</td>
<td>75</td>
<td>2</td>
</tr>
<tr>
<td>15-16</td>
<td>90</td>
<td>2</td>
</tr>
<tr>
<td>17-18</td>
<td>105</td>
<td>2</td>
</tr>
</tbody>
</table>

*Recommendations were modified with permission from the USA Baseball Medical & Safety Advisory Committee.*

### TABLE 2
Recommended Minimum Rest After Pitching

<table>
<thead>
<tr>
<th>Number of Pitches</th>
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</thead>
<tbody>
<tr>
<td>Age, y</td>
</tr>
<tr>
<td>1 Day of Rest</td>
</tr>
<tr>
<td>2 Days of Rest</td>
</tr>
<tr>
<td>3 Days of Rest</td>
</tr>
<tr>
<td>4 Days of Rest</td>
</tr>
</tbody>
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<tr>
<th>Age, y</th>
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<tr>
<td>8-10</td>
<td>20</td>
<td>35</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>11-12</td>
<td>25</td>
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<td>60</td>
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<td>70</td>
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<tr>
<td>15-16</td>
<td>30</td>
<td>40</td>
<td>60</td>
<td>80</td>
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<tr>
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<td>30</td>
<td>40</td>
<td>60</td>
<td>90</td>
</tr>
</tbody>
</table>

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### TABLE 3
Age to Learn Types of Pitches

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Age, y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fastball</td>
<td>8</td>
</tr>
<tr>
<td>Change-up</td>
<td>10</td>
</tr>
<tr>
<td>Curveball</td>
<td>14</td>
</tr>
<tr>
<td>Knuckleball</td>
<td>15</td>
</tr>
<tr>
<td>Slider</td>
<td>16</td>
</tr>
<tr>
<td>Forkball</td>
<td>16</td>
</tr>
<tr>
<td>Splitter</td>
<td>16</td>
</tr>
<tr>
<td>Screwball</td>
<td>17</td>
</tr>
</tbody>
</table>

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*These ages reflect results from a survey by the USA Baseball Medical & Safety Advisory Committee. The authors of the current study believe that these pitches should not be thrown before the player is 18 years old.*
Rehabilitation

- Must address intrinsic and extrinsic factors
- Consider physiologic age
- REST!!!
  - LLS=> no throw for 12 wks (PT for 2nd 6 wks)
  - Post fx => no throw 6 months post fx
  - Others=> variable and based on Sx
    - ‘asymptomatic’ and normal RTC function
- Thrower’s Paradox- mobility (excessive ER), but functionally stable (no symptoms)
Rehabilitation

- Educate on rest
- Normalize ROM if necessary
- Comprehensive RTC and scap strength
  - concentric, eccentric, plyometric
- Core and LE control and integration
- Conditioning
- Interval throwing program
  - short toss => long toss
  - flat ground => mound (throw => pitch)
  - increase effort (speed gun), reps
  - fastballs => breaking balls
- Mechanical analysis?
Prevention

- Education of players, parents, coaches, trainers, MD’s, etc.
  - Pitch count and type
  - Off-season conditioning
  - Interval throwing
- ID hard throwers
- ID mechanical flaws
References