Throwing Injuries and Prevention: The Physical Therapy Perspective

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Western States 100: 15hr 36min
Western States 100: 10hr 46min!!
Throwing
Throwing
Throwing Related Injuries

• Pain during the season
  – Approximately 50% of youth pitchers report arm pain during a season
  • Pitchers age 9 – 14:
    – 32% c/o shoulder pain
    – 26% c/o elbow pain

• Increasing incidence of surgery
  – % of UCL surgeries on young athletes increased 3 fold from 1998 to 2006

• Drop out rates from sport
Clinical findings

• **Subjective**
  – Insidious onset of pain
  – Often worsening pain over several seasons
  – Dull, and aching
  – Located in the proximal shoulder
  – Worse in the late cocking phase of throwing
Clinical findings

• *Functional Complaints*
  – Loss of control
  – Loss of velocity
  – Difficulty sleeping
Clinical findings

• **Objective Findings**
  – Anterior instability
  – Loss of internal rotation range of motion
  – Palpation tenderness
    • Posterior shoulder
    • Coracoid process
  – Weakness
    • Glenohumeral external rotation
    • Scapular retraction and upward rotation
  – Prominent medial border and inferior angle
  – Inappropriate timing
Stress

- **Physical Stress Theory**
  - “Physical stress causes a predictable adaptive response in all biological tissue”

- **Functional adaptations**
  - Increased range of motion
    - Osseous
    - Capsular / ligamentous
  - Increased muscular strength

- **Non-functional adaptations**
  - Instability
  - Loss of range of motion
  - Muscle imbalance / weakness
Anatomic requirements

• A joint complex that allows for large range of motion (ROM)
• A neuromuscular system to control that ROM and channel forces through the chain
• Strong core and lower body to develop and deliver power
Anatomy

- **Clavicle**
  - Serves as a strut

- **Scapula**
  - Articulates with the clavicle
  - Rests and moves on the rib cage

- **Humerus**
  - Articulates with the scapula
  - Forms the glenohumeral joint
Anatomy

- Ligaments / Joint capsule
  - Control motion between the scapula and the collar bone
  - Help to stabilize the GH joint
Anatomy

- Glenoid labrum
  - Deepens the socket
  - Helps to stabilize the GH joint
Anatomy

- **Rotator cuff**
  - Reinforces the joint capsule
  - Balances the potentially injurious forces generated by the larger, “power” muscles
  - Helps to maintain the head of the humerus in the glenoid
• **Scapula**
  – Acts as the base of operations for the rotator cuff
  – Contributes approximately 1/3 to the ROM of the arm
  – Its motion is largely guided by the neuromuscular system, within constraints dictated by the collar bone
Phases of Throwing

Fig. 1  The 4 phases of throwing
Phase changes
Late cocking / early acceleration

- Body has moved ahead of the hand
- Forces generated with the legs and trunk are transferred through the shoulder and elbow
- Stresses accumulate
  - Humerus
  - Anterior capsule of the shoulder
  - Elbow (UCL)
End Acceleration / Deceleration

- Peak acceleration of 7000 deg / per second (GH joint)
- Posterior inferior capsule absorbs up to 750 N of force
  - Rotator cuff muscles
  - Posterior inferior glenohumeral ligament
  - Scapular stabilizers
Effects of Mechanics Stresses: Some Evidence

Mechanics: Stresses in the arm

- **HIRTs**
  - Humeral Internal Rotation Torques
  - Measure of stress through the shoulder

- **EVLs**
  - Elbow Valgus Loads
  - Measure of stress through the elbow
Throwing Efficiency

• $nHIRT + nEVL / \text{Velocity} = \text{Efficiency}$
  – Forces through the arm were normalized to body weight
  – These normalized forces were divided by pitch velocity to arrive at a measure of pitching efficiency

• $\downarrow \text{Force} / \uparrow \text{Velocity} = \uparrow \text{Efficiency}$
Mechanics

• **Parameter 1—Leading with the hips:**
  - Correct performance was defined as the pelvis leading the trunk toward home plate during the early cocking phase

• **Parameter 2—Hand-on-top position:**
  - Performance was defined in terms of whether the throwing hand was on top of the ball as it comes out of the glove during early cocking

• **Parameter 3—Arm in throwing position:**
  - Correct performance was defined as the elbow reaching its maximum height (glenohumeral abduction) by stride foot contact

• **Parameter 4—Closed-shoulder position:**
  - Correct performance was defined as the lead shoulder being in a closed position, pointing toward home plate at stride foot contact

• **Parameter 5—Stride foot toward home plate:**
  - Correct performance was defined in terms of whether the stride foot was pointed toward home plate at stride foot contact
1 - Leading with the hips

- A is correct, B is incorrect
2 - Hand on top position

- A is correct, B is incorrect
3 - Arm in throwing position

- A is correct, B is incorrect
4 - Closed shoulder
5 - Foot towards home

• A is correct, B is incorrect
Proper Mechanics = Increased Efficiency

Hand on top
+ Closed shoulder
↑’d Efficiency
Late cocking / early acceleration

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- Forces generated with the legs and trunk are transferred through the shoulder and elbow
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Little Leaguer’s Shoulder

- Growth Plates
Little Leaguer’s Shoulder

- Pain with the act of throwing
- Radiographic findings in the proximal humerus
  - Epiphysiolysis
  - Physeal widening
- Occurs in skeletally immature athletes (age 9-18)
Humeral Retroversion

• Adaptive?
  – Changes in humeral version can occur when the growth plate is open; i.e., retroversion
  – May be protective against injury

• Maladaptive?
  – Cause of pain in young athletes
Evidence

• Retrospective, descriptive study of 79 youth baseball players, 8 - 15 years old

• Data
  – Radiographs of both shoulders
  – Arm dominance
  – History of throwing related shoulder pain
  – GH range of motion - external rotation

Evidence

• Physeal widening *did* correlate with arm dominance
• Physeal widening *did not* correlate with pain associated with throwing
• *However* - the greater the gap in the physes, the greater the likelihood of pain
• Increased external rotation ROM correlated with increased age

Mair, SD et al. *Journal of Shoulder and Elbow Surgery*, 2004. “*Physeal changes and range-of-motion differences in the dominant shoulders of skeletally immature baseball players*”2
Little Leaguer’s Shoulder

Normal? or Abnormal?
Discussion

• Changes in the proximal humeral physis of skeletally immature throwers are a common, and perhaps normal finding.
• Increased ER (retroversion) of the humerus is a normal adaptation to the stresses of throwing that begins in youth baseball.
Recommendations

• In the evaluation of young throwers, history and physical examination, may be more important than radiographic findings.

• Players should be instructed not to play through shoulder pain.
Other Causes of Shoulder Pain

- Rotator Cuff Tears
- Biceps Tendinopathies
- Labral Tears (SLAP lesions)
- Anterior Instability
- Impingement Syndromes
  - Internal
  - External
Other Causes of Shoulder Pain

- Rotator Cuff Tears
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- Anterior Instability
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  - Internal
  - External
Shoulder impingement
Soft tissue and Neuromuscular Adaptations

- GIRD
- Scapular dyskinesia
GIRD

- Glenohumeral Internal Rotation Deficit (GIRD)
  - Loss of internal rotation that does not match the gain in external rotation
    - Anterior instability
    - Tight posterior capsule
    - Weakness of the posterior aspect of the rotator cuff
Clinical findings

• At the GH joint
  – Anterior instability
  – Loss of internal rotation
  – Palpation tenderness
  – Weakness of external rotation

• Around the scapula
  – Tenderness at the coracoid process
  – Prominent medial border and inferior angle
  – Scapular retraction weakness and loss of motion
  – Weakness of scapular protraction
  – Inappropriate timing
Prevention of GIRD

• Stretching: of the posterior capsule
• Strengthening: of the GH rotators - especially the external rotators
Clinical findings

• At the GH joint
  – Anterior instability
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Prevention of Scapula Dyskinesia

- **Stretching**: pectoralis minor, latissimus dorsi muscles, biceps
- **Strengthening**: serratus anterior, lower traps, middle traps
Prevention: General Principles

• Adherence to safe pitch counts
• Correction of faulty throwing mechanics
• Maintenance of strength, ROM, and control
• Use of a proper warm-up
• Observation of an off-season
• Return to seasonal throwing with an interval program
• Don’t play with pain!
## Recommendations

### Pitch Counts: daily limits / per game limits

<table>
<thead>
<tr>
<th>Age in years</th>
<th>2006 USA Baseball Guidelines</th>
<th>2008 Little League Baseball Regulations</th>
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<tbody>
<tr>
<td>17-18</td>
<td>N/A</td>
<td>105/day</td>
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<tr>
<td>15-16</td>
<td>N/A</td>
<td>95/day</td>
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<tr>
<td>13-14</td>
<td>75</td>
<td>95</td>
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<tr>
<td>11-12</td>
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<td>75</td>
</tr>
<tr>
<td>7-8</td>
<td>NA</td>
<td>50</td>
</tr>
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</table>
## Recommendations

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<tr>
<td>17-18</td>
<td>N/A</td>
<td>26-50 → 1 day rest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>51-75 → 2 days rest</td>
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<tr>
<td></td>
<td></td>
<td>76-105 → 3 days rest</td>
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<tr>
<td>15-16</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>13-14</td>
<td>125/w; 1000/season</td>
<td>21-40 → 1 day rest</td>
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<td>11-12</td>
<td>100/w; 1000/season</td>
<td>41-60 → 2 days rest</td>
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<td>75/w; 1000/season</td>
<td>Over 60 → 3 days rest</td>
</tr>
<tr>
<td>7-8</td>
<td>NA</td>
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