Shoulder and Elbow Injury Prevention in Adolescent Baseball Pitchers

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My Background

- Doctor of Physical Therapy degree from the University of Iowa, 2004
- Bachelor of Science in Exercise Science/Athletic Training from the University of Iowa, 2002
- Certified Strength and Conditioning Specialist, 2005
- Member of the American Society of Shoulder and Elbow Therapists
- Interest in the treatment and prevention of shoulder and elbow injuries in overhead athletes
Purpose

• Bring attention to the increase in injuries to youth pitchers

• Address the inherent risk factors for injury

• Help to reduce the number of pitching related injuries
25th Annual Injuries in Baseball Conference
Birmingham, Alabama
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James R. Andrews, M.D.

Biomechanics Lab
Recent Trends

- Youth baseball pitching injuries are becoming an epidemic
  - Increase in surgery rates
  - Pitchers are throwing more
  - Breaking ball frequency is increasing
Increased Surgery Rates
Dr. James Andrew at ASMI

Throwing shoulder surgeries have increased 6 fold in the last five years

![Graph showing increased surgeries from 1995-1999 (43 surgeries) to 2000-2004 (259 surgeries).]
Increased Surgery Rates
Dr. James Andrew at ASMI

"Tommy John" (UCL) Surgery in H.S. Baseball Pitchers

Year

1995-1998
1999-2002
2003-2006

# of Surgeries

9
61
148

Series 1
Youth Pitching Trends in Little League World Series

- Percentage of starting pitchers throwing more than 75 pitches per game increased from 50% to 80% between 1996 and 2006 (1)
- Frequency of breaking ball pitches increased from 23% in 1991 to 31% in 2006 (1)
- Becoming a year-round sport (2)
- Becoming single sport athletes at younger ages (2)
“OK, there’s some duct tape. Are you happy now, Mr. Prima Donna? ... So just get us out of this inning, and then we’ll talk about surgery to repair the torn tendon in your elbow.”
Kids should be having fun!
Frequently Asked Questions

• Q: How many pitches should my child be allowed to throw?
• Q: How old should my child be before learning the curve ball?
• Q: Can a pitcher’s mechanics prevent injury?
• A: No one really knows!
Biomechanics of Pitching

- Angular velocities in excess of $7500^\circ$/sec \(^{(3)}\)
  - Fastest joint movement in sport
  - Equals 20 revolutions in 1 sec!

- 305N of anterior force at the shoulder during throwing
  - Takes 25N of force to dislocate the shoulder in cadaver studies \(^{(4)}\)
Biomechanics of Pitching

- 64 N-m of varus torque at the elbow in maximal external rotation \(^{(5)}\)
  - Cadaver studies demonstrate tensile strength of the UCL to be only 32 N-m. \(^{(4)}\)

- Importance of strength and conditioning for prevention
Adolescent Pitching Challenges

- Growth plates are open
  - 2-5 times weaker than capsule and ligaments (6)
  - Injury generally occurs through the epiphysis rather than ligament failure (7)
  - Medial epicondylar ossification center closes as late as 15-16 years of age (4)
Adolescent Pitching Challenges

- Bones grow faster than muscles \(^{(6)}\)
  - Growth spurt 10-18 at years, peak is 12-14 in boys
  - Bones become longer and heavier
    - Importance of strength and stability
  - Flexibility decreases as bones grow
    - Flexibility is important in injury prevention
  - Greater demands on muscle and tendon, but they are one year behind
Adolescent Pitching Mechanics

• 1999 study comparing youth, high school, college and professionals (8)
  – Velocity and kinetic parameters all increased with age
    • Likely due to increased muscle mass
  – 16/17 positional and temporal measurements were the same
    • supports the philosophy that a child should be taught “proper” pitching mechanics for use throughout a career

• 2007 study demonstrated less shoulder rotational torque among professional pitchers because they significantly delayed trunk rotation compared to younger groups (9)
Adolescent Pitching Faults

• Use less leg and trunk muscles (6)

• Rely more on shoulder and elbow
  – Increasing stresses on the arm

• Less hip and shoulder separation

• Inadequate dynamic strength/stability to resist high biomechanical forces (7)
Risk Factors for Injury
Lymen et al 2001: 9-14 year old pitchers over 2 seasons (n=298) (10)

• Elbow pain correlated with:
  – Pitching with arm fatigue
  – Number of pitches thrown per season
  – Type of pitches thrown (breaking balls)
  – Increased age
  – Increased weight
  – Decreased height
  – Lifting weights
  – Playing outside the league
  – Decreased satisfaction with one’s pitching

• Shoulder pain correlated with:
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  – Number of pitches thrown per game
  – Number of pitches thrown per season
  – Types of pitches thrown (breaking balls)
  – Decreased satisfaction with one’s pitching
Risk Factors for Injury

Olsen et al 2006: Retrospective survey of 95 adolescent pitchers who had shoulder or elbow surgery to 45 controls (14-20 years old) (11)

• Amount of pitching
  – More than 80 pitches per game increased the risk of injury by 3.8 times
  – Pitching for more than 8 months of the year increased the risk of injury by 5 times
  – When a pitcher regularly pitched with fatigue, the risk of injury increased by 36 times!

• Velocity
  – Velocity of greater than 85 mph increased the risk of injury by 2.6 times
Risk Factors for Injury

• Olsen et al (cont.)
  – Showcase participation
    • Injured players averaged 4 showcases vs. 1 for non-injured
  – Injured group used more NSAIDs and ice
  – Injured group was taller and heavier
  – More than 50% of pitchers in the study received private instruction.
    • Difficult to quantify proper technique
  – Most performed stretching and strengthening
    • Difficult to document “good physical conditioning”
  – Study failed to show a relationship between the age at which a breaking ball was first thrown and risk for surgery
Recommendations from Study

1. Avoid pitching with arm fatigue
2. Avoid pitching with arm pain
3. Avoid pitching too much
   - Avoid more than 80 pitches per game
   - Avoid pitching competitively for more than 8 months of the year
   - Avoid pitching more than 2500 pitches in competition/year
Recommendations from Study

4. Monitor pitchers with the following characteristics
   – Pitchers who regularly use anti-inflammatories or ice
   – Regularly starting pitchers
   – Pitchers who throw greater than 85 mph
   – Taller and heavier pitchers
   – Pitchers who warm up excessively (34 pitches vs. 28 pitches)
   – Pitchers who participate in showcases
...scalpel... suction... ok, let's close him up and just cross our fingers that his elbow holds up for another inning.
Pitch Count Recommendations

- **2008 Little League**
  - 7-8 yrs: 50
  - 9-10 yrs: 75
  - 11-12 yrs: 85
  - 13-16 yrs: 95
  - 17-18 yrs: 105
  *Cannot move to catcher*

- **ASMI**
  - 8-10 yrs: 52
  - 11-12 yrs: 68
  - 13-14 yrs: 76
  - 15-16 yrs: 91
  - 17-18 yrs: 106
  *Cannot move to catcher*
Days Rest After Pitching

• 2008 Little League Regulations (16 and under)
  – 61 or more pitches 3 days
  – 41-60 pitches 2 days
  – 21-40 pitches 1 day

• ASMI Recommendations

<table>
<thead>
<tr>
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<th>1 day</th>
<th>2 days</th>
<th>3 days</th>
<th>4 days</th>
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<td>34</td>
<td>43</td>
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<td>17-18</td>
<td>27</td>
<td>45</td>
<td>62</td>
<td>89</td>
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ASMI Pitch Type Recommendations

- Fastball 8-10 yrs
- Change-up 10-13 yrs
- Curve ball 14-16 yrs
- Knuckle 15-18 yrs
- Slider 16-18 yrs
- Fork ball 16-18 yrs
- Screw ball 17-19 yrs
Stretching

- Is stretching important?

- Range of motion significantly decreases immediately following pitching and 24 hours later (12)
  - Shoulder internal rotation
  - Total motion ER + IR
  - Elbow extension

*Eccentric loading of muscles/joint capsule
Stretching

• Decreased internal rotation has been correlated with increased risk of shoulder injury (13) (14)

• Total Motion Concept (14)
  – IR + ER should be equal between shoulders to within 5 degrees
  – ER is about 7 degrees more in the throwing shoulder
  – IR is about 7 degrees more in the non-throwing shoulder

• Where is the tightness from?
  – Differing opinions for posterior capsule or posterior rotator cuff
When to Stretch

• Michael Reinold — Physical Therapist and Assistant Athletic Trainer for the Boston Red Sox (15)

• Recommends
  – Before throwing (before batting practice)
  – Before game (starters and relievers)
  – After game (those who participated)
  – End of day (non-playing starters)

• Maintenance is the key
How Should We Stretch?

• Reinold’s technique for the Red Sox (15)
  – Elevation in scapular plane
  – ER at 90 degrees
  – ER at 100-105 degrees
  – IR at 90 degrees
  – Horizontal adduction
  – Pectorals
  – Wrist flexion and extension
  – Scapular mobilizations/lift
Stretches for Adolescents

- Doorway pecs
- Doorway lats
- Sleeper stretch
- Biceps
- Wrist flexion and extension

*If performed routinely, stretching does not need to be aggressive

*Maintenance is the key
Strength and Conditioning Programs

• Need to have adequate strength stability and endurance to protect joints, ligaments and tendons

• Athletic performance may be enhanced (16)
  – Anaerobic component of baseball/explosive strength
  – Increased motor coordination
  – Increase in throwing velocity
*Improves strength, flexibility and endurance for games and throughout the season
Strength and Conditioning Programs

• Guidelines for youth (16)
  – Supervised and progressed appropriately by a trained person
    • Medical clearance
  – Exercises should be performed in a controlled and non-ballistic manner
  – High repetition, moderate weight
    • 12-15 reps 2x/week
  – Gains can be lost 6 weeks after cessation
Strength and Conditioning Programs

Age-specific guidelines

• 7 years or younger
  – Teach proper technique with little or no weight
  – Introduction to stretching
  – E.g., push-up, pull-up, abdominal crunches, mini squats

• 8-10 yrs
  – Gradually increase number of exercises
  – Keep exercises simple and very light
  – 1-2 sets of 10-15 reps
  – E.g., chest press, seated row, bicep/triceps, leg press, hamstring curl, calf
  – Emphasize proper technique
Strength and Conditioning Programs

Age specific guidelines (16)

• 11-13 yrs
  – Basic proprioceptive drills
    • Balance on unstable surfaces
    • rhythmic stabilization
  – Introduce more advanced lightweight exercises
Strength and Conditioning Programs

Age specific guidelines (16)

• 14-15yrs
  – Begin sport-specific exercises
    • Rotator cuff and scapular exercises
    • 2-3 sets of 8-12 reps
    • Core stabilization
    • Light plyometrics

• 16 and up
  – Begin a basic adult program
Medical Pitching Evaluation

- Identifies the individual’s risk factors that may lead to injury in throwers
- Aids in treatment of care of those returning to sport
- Can be used as a screening tool
- Consists of a thorough history and physical exam
Medical Pitching Evaluation

- Multiple angle video analysis of mechanics
- Dartfish technology
Key Points for Youth Pitchers

- Parents/coaches should listen and react appropriately when athlete complains of pain or arm fatigue
- Pitch counts should be monitored and regulated
- Avoid breaking pitches until the recommended age
- Develop proper mechanics as early as possible
- Avoid stressful overhead activities for at least 3 months/yr (pitching/quarterback/javelin/swimming)
- Include year-round physical conditioning as body develops
- Closely monitor high velocity pitchers and those who participate in showcases
Resources

- www.ASMI.org
- www.littleleague.org
- http://qcbaseball.com/
Thank You


