Young Athlete Center

Children's Hospital • St. Louis

BJC HealthCare

Washington University in St. Louis

Physicians
DISCLOSURE

• David Piskulic, DPT, SCS, ATC
• Conflict of Interest: No conflicts of interest were identified.
• Non-Endorsement: Accreditation approval does not imply endorsement of any commercial products mentioned in this talk
OBJECTIVES

1. Discuss the phases of throwing and the movements occurring through the lower extremities, trunk, and the upper extremities at each phase.
2. Discuss common throwing injuries that occur in pediatric populations.
3. Review concepts of an evaluation for a throwing injury, including special tests, strength tests, and key concepts in regards to ROM, including GIRD and total arc of motion.
4. Identify common disordered throwing movements and dysfunctions of the body that lead to increased onset of injury.
5. Learn concepts of various treatments in application of specific exercises towards rehabilitation of throwing athletes.
6. Discuss components of return to throwing programs and discuss concepts of injury prevention with returning to full sports participation.
Some Perspective...

- 30-40% child and adolescent accidents are sports related
- 3.5 million children under 14 yo seen for sports injuries each year
- 30% of pitchers 9-14 report shoulder pain during season
- 18-69% of baseball athletes between the ages of 9-19 reported or will report elbow pain

Injuries of the Throwing Athlete
Mechanisms of Injury: Shoulder and Elbow

FIGURE 4. Posterior view of the elbow showing (1) tension along the medial side, (2) compression along the lateral side, and (3) posteromedial shear.
Imaging of Youth Injuries

• Normal physeal alignment (medial epicondyle)

• Abnormal physeal alignment (physeal widening @ medial epicondyle)
  • “Little League Elbow”

• R = Normal Proximal Humerus Physeal alignment

• L = Proximal humeral physeal widening
  • “Little League Shoulder”
Observation: Posture

- **Weak**: Deep neck flexors, middle and lower trapezius, serratus anterior, external rotators of the RC (Supraspinatus*, Infraspinatus, Teres Minor)

- **Tight**: Upper trapezius, levator scapulae, pectorals, posterior deltoid (possibly posterior capsule)

- **Laxity**: Anterior capsule, Middle and inferior GHL, UCL, Internal rotators of RC (subscapularis, though may still test strong)
Observation: SICK Scapula

• **SICK** scapula:
  • **S** capular malposition
  • **I** nferior medial border prominence
  • **C** oracoid pain and malposition
  • **dysK** inesia of scapular movement
  • Observed not only at rest, but with active shoulder abduction

Burkhart et al, 2003
What is GIRD?

- **Glenohumeral Internal Rotation Deficit**
- Marked by limited internal rotation greater than 13 degrees
- Often have associated increase in external rotation
- Measured at 90 degrees abduction
- Demarcated by feeling of “stretch” or “pain”
Evaluation

• ROM (measured at 90 degrees abduction in scapular plane)
  • Mobility into all planes of motion
  • Normal scapulo-humeral rhythm
    • 60° scapular, 120° glenohumeral
    • Adequate lowering from abduction/flexion without scapular winging
  • Being able to correctly identify GIRD and Total Rotation Motion
    • Within 13 degrees IR of nondominant arm
    • Within 5 degrees total ROM of nondominant arm
    • Total ROM shouldn’t exceed 184 degrees (= hypermobility; often present with this population)
• Do we address the restricted motion?
Evaluation: Strength

- Strength
  - IR/ER
    - ER/IR ratio @ 70% or >
  - Scapular Stabilizers (mid/lower trap, serratus anterior)
  - Biceps, Triceps

- Handheld Dynamometer
  - Intratester Reliability = 🤚
  - Intertester Reliability = 🙅‍♂️
• **Impingement**
  - Neer’s (Sensitivity = 88.7%; Specificity = 30.5%; Reliability = 98%)
  - Hawkins-Kennedy (Sensitivity = 62-92%; Specificity = 25-69%)
  - Jobes Empty Can (Sensitivity = 57-86%; Specificity = 57-77%)
  - Posterior Impingement Sign for internal impingement (Sensitivity = 95%; Specificity = 100%)
Special Tests (Con’t)

• RC Strength/Strain
  • Full Can (Supraspinatus) (Better EMG compared to empty can)
  • Lift-Off (Subscapularis)
  • Dropping Sign (Supra/Infraspinatus) (Sp/Sn = 100%)
  • Speed’s (Long head of Biceps) (Specificity = 14-75%; Sensitivity = 32-90%)
  • Yergason (Long head of Biceps) (Specificity = 58-79%; Sensitivity = 43-74%)
• **Labral Tests**
  • Speeds
  • Biceps Load I (90°) and II (120°)
    • I and II: Specificity = 97%, Sensitivity = 90%
  • Crank Test
  • O’Brien’s (Specificity = 31-98%; Sensitivity = 63-100%)
Special Tests (Con’t)

- **UCL Sprain/Tear**
  - Varus/Valgus
  - Milker’s/Milking Maneuver
  - Elbow Extension/Hyperextension

- **Instability**
  - Crank Apprehension/relocation (anterior capsule laxity)
    - Specificity = 85%; Sensitivity = 90%
  - Sulcus (multidirectional instability)

- Several more to consider
Biomechanics Assessment
Phases of Throwing

- Stage 1: Wind Up
- Stage 2: Cocking (Early and Late)
- Stage 3: Acceleration
- Stage 4: Deceleration
- Stage 5: Follow-through
Biomechanics of Throwing

Whitley JSSM 2007
Stage 1: Wind-up

- Very individualized action, may include “stride” phase
- Ends with ball leaving glove and body balanced on pivot foot
- Thrower begins to move glove hand down
- Body rotation away from target
- EMG activity low for shoulder girdle and upper extremity

Juan Marichal
Stage 2a: Early Cocking

- Pivot leg extension propelling forward stride
- Shoulder abducts
  - Deltoid and supraspinatus
- Trapezius and Serratus Anterior: Upward rotation and protraction of scapula
- Progress towards peak humeral torque in youth athletes
Stage 2b: Late Cocking

• Stride foot hits ground
• Throwing arm ER: 46° -> 170° degrees
  • Been recorded in excess of 210°
• Dominant shoulder begins to rotate forward.
• Inertia forces: horizontal abduction, ER, abduction
• Scapular stabilization: trapzius, rhomboids, levator scapulae, and serratus anterior

Randy Johnson
Stage 3: Acceleration

- Internal rotation of 100 degrees in one-half second (torque of 14,000 inch*lbs)
- Large GH joint compressive force: 860 N
- Peak distraction force
- Ends with release of ball

Felix Hernandez
Stage 4: Deceleration

- Throwing arm cross in front of body
- Back foot off surface
- Trunk and dominant lower extremity rotate forward
- Shoulder adducts and internally rotates
- Large eccentric forces on rotator cuff

Nolan Ryan
Stage 5: Follow-Through

- Often thought of as “optional” phase
- All major muscle groups are eccentrically loaded
- Ends when motion is complete
Recognizing Poor Mechanics

Evidence Based Biomechanical Analysis
Observation

• Wide variation in individual pitching mechanics
• Transfer of energy from legs to trunk to shoulder to elbow to hand
• Positioning and timing key for proper energy build-up, transfer, and release
  • Eccentric control for energy conservation and joint protection against excessive stress/strain
Freeze Frame on Mechanics

• Inverted “W”
  • Can create a timing problem (aka rushing) and cause the arm to be late.
  • Increases the distance, and thus the force, of the external rotation of the Pitching Arm Side (PAS) upper arm.
    • That in turn increases the momentum that occurs during the external rotation of the PAS upper arm which increases the load on the elbow and the shoulder.
• Inverted “L”
  • Similar to inverted “W”, it causes the arm to be late, thus placing increased distance for the arm to move through and therefore increased force at the elbow and shoulder
Freeze Frame (Con’t)

• Hyperabduction
  • Pitching side elbow too high or too long
  • Increased stretch on inferior and middle glenohumeral ligament due to “levering” on these ligaments to throw
• Will lead to loosening of the shoulder or worse
  • Anterior labral tear, dislocation, instability, impingement
Characteristics of Disordered Throwing

• Foot
  • Open or Closed (>10 cm away from back foot)

• Knee
  • Flexed upon front foot landing (can indicate short stride length)

• Hips
  • Facing away from home plate
  • Opening early (before throwing arm begins ER moment)

• Trunk
  • Hyperextension

• Scapula
  • Anterior tilt or protraction

• GH Joint and Elbow
  • Hyper-Horizontal Abduction, Elbow dropped (adduction) or elevated (abduction)

• Hand/Fingers
  • Under of Side of Ball

Biomechanical Analysis: Video

• Several apps
  • Hudl Technique, DartFish, Coach’s Eye

• Smart Phones
  • “SloMo” Settings

• Should they be used by anyone?
  • Nicholls et al 2003
    • Standard video Camera vs 6 camera lab investigation
    • Poor inter-rater reliability (33% agreement between raters)
      • Poor lighting, poor video capabilities
Biomechanical Analysis: Video

- Recent Technology:
  - Oyama et al 2016
    - High to moderate validity with some measures in 2-D planes
      - Ex: Shoulder elevation at foot contact, Max shoulder ER
  - DeFroda et al 2016
    - 2-D vs 3-D
      - Correct 2-D observations correlated with 3-D analysis of decreased torque and valgus loading
      - 2-D presents with acceptable results for planar movements
    - Cons:
      - 2-D alone lacks comparison to 3-D “gold standard”
      - Movements in 1 plane at a time
• **Wind-up and Early Cocking**
  • Head balanced over stance leg; foot, knee, hip, shoulder in line

• **Stride (Cocking, Late-Cocking, Early Acceleration)**
  • Hand on top of ball, progress to hand facing between 2\textsuperscript{nd}/3\textsuperscript{rd} (Righty) or 1\textsuperscript{st}/2\textsuperscript{nd} (Lefty)
  • Hands moving away from each other equal and opposite, throwing arm leading with scapula
  • Stride length ~87% of height; within 10 cm from trailing ankle

• **Foot Contact!!!**
  • Stride foot heel strikes first with toe towards home, perpendicular to stance foot
  • Ball hand at or above height of elbow, to side of body (If facing pitcher, ball should be relatively well hidden by body)
  • Elbow bent at 90 degrees, shoulder abduction approx. 90 degrees
  • Initiate trunk rotation (belt buckle facing 3\textsuperscript{rd} or 1\textsuperscript{st} and beginning to face towards home)
General Guidelines (Con’t)

• Acceleration
  • Shoulders open towards plate without arm lag (GH external rotation in scaption; avoid excessive hyperabduction)
  • Trunk forward lean without excessive sidebend/tilt

• Ball Release to Follow-Through
  • Avoid valgus/extension overload (maintain slightly flexed elbow at release)
  • Body turns into glove side (glove side pulls body towards it)
  • Trunk bends forward to avoid excessive eccentric strain on shoulder and elbow
  • Full follow-through of throwing arm across body (adequate IR and arm finishes to outside of stride leg)
Exercise Progression

Mobility and Strengthening While Controlling Mechanics
Concepts of Common Stretches

• “Sleeper Stretch”
  • Stretch or Hawkins-Kennedy test?

• Cross-body stretch
  • Stretch for posterior capsule or mid-lower traps?
Modification of Stretches

• Modified Sleeper Stretch
  • Sustained hold, LOW intensity

• Cross-body with scapular stabilization
  • Can complete in sidelying or standing

Throwing Exercises

- Classic:
  - Thrower’s 10

- Ballistic 6
Throwing Exercises

• Recent:
  • Advanced Thrower’s 10 (Wilk et al 2011)
    • Addition of core strengthening (planks, swiss ball)
  • Addition of Legs and Core
    • Previously under utilized in strength programs
Strengthening in Pediatrics


- Reduction of injuries in adolescent groups with resistance based strength programs
- HOWEVER!!
  - Unsupervised/Supervised by unqualified instruction and inappropriate training loads = INJURY!
  - Excessive training with inadequate recovery = Overtraining syndrome
    - Physiological concerns and psychosocial consequences
GUIDELINES

• All training programs should be consistent with age, competency, and maturational status; progressed by trained professional

• **Exercise Selection** - Motor skill competency; free weights with technically competent youths

• **Training Volume and Intensity** - Greater load (intensity) → lower volume (repetitions); do not sacrifice technique for intensity or volume

• **Progression of Volume/Intensity** - Increase once technique competency improves; monitor fatigue

• **Repetition Velocity** - Slower with limited training experience; slow with high mass and gradually increase with training competency

• **Rest Intervals** - Approx 1 minute; 2-3 minutes at higher intensity of training; avoid high-intensity resistance training without recovery time

• **Training Frequency** - # of sessions performed in a week; 2-3 times per week on non-consecutive days
WHEN CAN I THROW?!?!?!

• Dependent upon severity and type of injury
  • *Little Leaguer’s Shoulder*- Discontinued pitching for 3 months
  • *SLAP Lesion*- Non-surgical = 3 months; Surgical = up to 6 months or more
  • *Scapular Dyskinesis*- 6-8 weeks or more
  • *Little Leaguer’s Elbow*- Apophysitis = Rest 4-6 weeks; Avulsion Fracture = Position players up to 12 weeks, Pitchers 4-6 months.

• Suggested that after season completion, young pitchers should take an adequate 2-3 months of rest for sufficient healing

Injury Prevention
Addressing the Problems Before They Start
Overuse and Specialization

• **Specialization** - intense year round training in 1 sport
  - High correlation to overuse injuries, burnout

• Erickson et al 2015
  - Fatigue in core/legs → Altered UE kinematics

• Valovich et al 2011
  - Young athletes playing multiple sports spaced out throughout the year = fewer injuries, play longer and maintain a higher level of physical activity than those who specialize in a sport before puberty

• **Recommendations on Rest:**
  - 1-2 days off per week, 2-3 months off from specific sport per year, 1 sport per season
• Survey of over 200 coaches.
  • 43% of coaches answered questions regarding pitch count and rest periods correctly
  • 73% reported that they followed recommendations, while only 53% felt that other coaches in the league abided by the recommendations
  • 35% stated their pitchers reported elbow or shoulder pain during the season
• Evidence that education on throwing is not just for the patient and their parents
• Summary: If choosing to throw at another position, encourage positional play that requires fewer or shorter throws (1st or 2nd base)

Barrett and Burton, *Research Quarterly for Exercise and Sport*, 2002
Pitch Count and Rest Recommendations

No set regulations on pitch type
  - Youth throwers who threw curveball or slider 50-80% more likely to report elbow/shoulder pain

General Recommendations:
  - 8-14 Fastball and Change-up
  - >14 – Add Curveball
  - >16 – Add Slider

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[2] ASMI Position Statement
[3] Lyman et al
Summary for Young Throwers

• Biomechanical Analysis (trained professional)
  • Observe possible faulty mechanics (observation, not diagnosis)
  • Discuss mechanical implications towards injury

• Pre-Season warm-up
  • Accompanied with proper off-season rest (3 months recommended)

• Pitch Count

• Pitch Type Progression

• Proper Conditioning/Strengthening/Coaching
Clinical Resources

Injury Prevention: Overuse Injuries in Youth Baseball Pitches

The competitive nature of youth baseball places young players at risk for overuse injuries. Overuse injuries are common in youth baseball and can lead to significant pain, decreased performance, and even career-ending injuries.

Pitches Count

Parents and coaches can reduce a child’s risk for overuse injuries even more by keeping an eye on the pitches count. The American Academy of Pediatrics recommends limiting the number of pitches thrown per season to no more than 250 pitches. Nine-year-olds should throw a maximum of 150 pitches per season.

Multiple Sports is the Best Game Plan

Year-round specialization in a single sport at an early age can affect motor development and coordination. There is value in cross-training and playing different sports; and the risk of injury is lessened in the long-term.

Down Time is Good Time

Players should take at least one to two rest days each week, and take a break from all sports for one month each year.

For more information or to schedule an appointment, please call 314.454.KIDS, or visit Stlouischildrens.org/youngathlete.

The above information was provided by Dr. Jeffrey Logan, director of the Division of Sports Medicine at St. Louis Children’s Hospital.


Baseball Injuries

Injuries in young athletes are on the rise, but elbow and shoulder injuries in children are on the rise as well, with an increase in the number of young athletes engaging in baseball. These injuries are often caused by overuse and can lead to significant pain and decreased performance.

Baseball Shoulder

Overuse injuries in the shoulder can be caused by repetitive motions, such as throwing a baseball repeatedly. The symptoms may include pain, swelling, and limited range of motion. Treatment typically involves rest, physical therapy, and possibly surgery in severe cases.

Baseball Elbow

The ulnar collateral ligament (UCL) is the most common injury sustained in baseball. This ligament is responsible for stabilizing the elbow during pitching. Overuse and repetitive motions can lead to UCL tears, which can be treated with rest, physical therapy, and possibly surgery.

For more information or to schedule an appointment, please call 314.454.KIDS, or visit Stlouischildrens.org/youngathlete.

Sports Tips

- Stretching before and after playing can help prevent injury.
- Wearing proper protective gear, such as masks and helmets, can reduce the risk of injury.
- Resting and hydrating properly can help prevent overuse injuries.
- Eating a balanced diet can help support joint health.

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St. Louis Children’s Hospital | St. Louis Children’s Specialty Care Center
314.454.KIDS (5437) | 800.678.KIDS (5437) | StLouisChildrens.org/youngathlete | stlyac.wustl.edu
References


