Advances in Rehabilitation of the Throwing Athlete

Introduction

It is a "whipping" action that brings the hand and eventually the ball to a speed of 90 to 100 mph.

Elite level is 87 MPH
(Football is 55 MPH)

Biomechanics and Kinematics

Stride
- Occurs when hands break (knee at high point) to the point the lead leg (stride leg) is planted.
  - Foot pointed straight ahead.
  - Planted just off midline
- Body is rotated and moves forward by push from stance or push leg
- Elite throwers stride length is .73 (Greater in other studies) Body Height

Biomechanics and Kinematics

- Early Cocking
  - Hips "square up" toward target.
  - Arm position at end of stride
    - Abduction is 90-100º
    - Elbow is 90º
  - Injury potential is low in this phase

Biomechanics and Kinematics

- Range of Motion (End of Cocking Phase)
  - 180º of external rotation (combination of spinal hyperextension, scapular movement, and glenohumeral movements)
  - 90-100º of abduction at the glenohumeral joint
  - 20-30º of horizontal abduction at the glenohumeral joint
  - 90º elbow flexion
- Elite level have 185 degrees MER
- NFL QB have 158 degrees MER
- 125 msec from stride foot contact to MER

Biomechanics and Kinematics

  - Total ROM WNL in both groups
- Throwers had more ER in dominant arm and more IR in the non-dominant arm
  - 7 Degrees
- Throwers had significant humeral head retroversion
- Equal anterior and posterior laxity.

**Biomechanics and Kinematics**

- **Forces (End of Cocking)**
  - Due to centrifugal force of the whipping motion, the glenohumeral joint is trying to distract. The body will produce a compression force to counteract this at 800N @ 200lbs.
  - Also during this time, due to the horizontal abduction and corresponding arthrokinematics of the glenohumeral joint, there will be a stress on the anterior capsule for anterior translation of 400N @ 100 lbs.
  - As the trunk turns toward the plate, the horizontal adductors fire producing a horizontal adduction torque of 70 Nm.

**Biomechanics and Kinematics**

Arm Acceleration

- Maximum external rotation of glenohumeral joint to ball release (@ .25 msec).
  - Horizontal Add to Elbow Extension to Internal Rotation
  - Range of Motion
    - **Shoulder**
      - 180° external rotation to 70-90° of external rotation
      - 90-100° adduction
      - 20-30° horizontal abduction to 0° horizontal abduction
    - **Elbow**
      - 90 to 30-25° flexion

**Biomechanics and Kinematics**

- **Forces (Acceleration Phase)**
  - **Shoulder**
    - Internal rotation at 8000°/sec=60Nm (Football=3000)
    - Horizontal adduction at 7000°/sec
    - Glenohumeral joint compression
  - **Elbow**
    - Extension at 2500°/sec (FB=1500)
    - Varus torque (to resist valgus force) of 135 Nm (FB=110)
      - 54% from ulnar collateral ligament
      - 33% from the radiocapitellum joint
      - 13% from the posterior medial elbow

**Biomechanics and Kinematics**

- **Elbow flexion torque to resist the extension**
  - 60Nm
  - Provided by biceps, brachialis, and brachioradialis
  - **Wrist**
    - Flexion at 2700 degrees/sec

- High injury potential

**Biomechanics and Kinematics**

Ball Release
Biomechanics and Kinematics

Arm Deceleration
- Ball release to arm across chest (@40ms)
- Range of Motion
  - From ball release near ear until hand is at midline
- Forces
  - The humerus must be slowed from 8000º/sec and be kept from distracting to the plate!
  - 800N of posterior shear force is produced to stop this
- High injury potential

Biomechanics and Kinematics
- Muscles under stress
  - Posterior rotator cuff
    - Supraspinatus
    - Infraspinatus
    - Teres Minor
- High injury potential

Underhand?
- Comparison of underhand and overhand pitching show similar joint speeds and loads for each motion.
  - During delivery or acceleration with the underhand pitch, the forces to resist distraction at the shoulder and elbow are the greatest
  - In the overhand pitch, this occurred during deceleration

Injury

Arm Acceleration
- Anterior capsule micro-trauma
- Secondary impingement
- Posterior impingement
- Muscles under stress
  - Horizontal adductors--pectoralis major
  - Internal rotators--pectoralis major, latissimus dorsi, subscapularis, and teres major
  - Triceps and biceps
  - Ancanues and wrist flexors
- Anterior superior glenoid labrum--"Shoulder Grinding Factor" and pull of long head of biceps on elbow deceleration
- Riseball affects superior labrum in windmill
- Stress on vertebra cause stress fractures in windmill

Injury

Arm Acceleration
- Humeral shaft stress
- "Valgus Extension Overload"
  - Medial elbow ligaments
  - Ulnar nerve
  - Radio-capitellum joint
  - Medial olecranon fossa
- Same for windmill
Injury
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Injury
Arm Deceleration
- Rotator cuff tears
  - Supraspinatus
  - Infraspinatus
  - Teres Minor
- Capsular stress-posterior
- Biceps long head
- Superior glenoid labrum

Injury
Follow-through
- Injury potential
  - Being hit by a returned batted ball (pitcher is now only @55 feet from the batter at 125 MPM!)

Clinical Presentation
- Isokinetic
  - ER/IR @60-80%
  - Add @20-30% stronger on throwing side
  - Abd @5-10% stronger on throwing side
  - Abd/Add @66-72%
  - ER concentric strength equal bilaterally
  - IR 20% stronger on throwing side
Clinical Presentation
• Pitchers to control group
  – Throwing arm supraspinatus weaker than non-throwing side
  – Pitchers weaker in abd, supra, ER, and IR than control
  – PITCHING INSUFFICIENT TO PRODUCE STRENGTH GAINS AND MAY LEAD TO WEAKNESS

Clinical Presentation
• Laxity
  – Thrower’s Laxity
    ● Acquired?
    ● Congenital?
  – Bigliani et.al. AJSM 1997
    ● 61% of pitchers/47% position players had sulcus on throwing arm
    ● 100% position and 89% pitchers with sulcus on throwing side also had sulcus on opposite side
  – Humeral Retroversion or Tight Posterior Capsule

Treatment
• Exercise Positions:
  – Scapula
    ● Sitting dip
    ● Push-up with a plus
    ● Scaption
    ● Bent Row

Treatment
  – Rotator Cuff
    ● Prone horizontal abduction
    ● Prone external rotation
  – Others
    ● Shoulder shrugs
    ● Scapula adduction
    ● Triceps
    ● Biceps

Treatment
• Flexibility and Instability
  – Work in “safe” ROM/toward “unsafe”
  – Proprioception
• Flexibility
  – External rotation
  – Horizontal abduction
  – Internal rotation
– Horizontal adduction

**Treatment**
- Proprioception
  - Rhythmical stabilization
  - “Body Blade”/“Boing”
  - Inertial impulse/Inertial-less cable columns
- Monitored Rehabilitation Systems
- Closed Chain
  - Weight bearing
  - Ball

**Return to Throwing**
- Long and short toss
- Throw two days, rest one
- Gradually progress to working off the mound and then curve balls and finally fast ball

**Return to Throwing**
- Phase I Long Toss
  - To 90 Feet
- Phase 2 Long Toss
  - To 120 Feet
- Phase 3 Long Toss
  - To 150 Feet
- Phase 1 Short Toss
  - 30 Ft / 1/2 Speed
- Phase 2 Short Toss
  - 60 Ft / 1/2 Speed
- Phase 3 Short Toss
  - 60 Ft / 3/4 Speed

**Return to Throwing**
- Phase 4 Long Toss
  - To 180 Feet
- Phase 5 Long Toss
  - To 210 Feet
- Phase 6 Long Toss
  - To 250 Feet
- Phase 4 Short Toss
  - 60 Ft / 3/4 Speed / Mound
- Phase 5 Short Toss
  - 60 Ft / 3/4 Speed / Mound / Curve, etc.
- Phase 6 Short Toss
  - 60 Ft / 4/4 Speed / Mound / Game Sim
Treatment/Prevention
- Aerobic and anaerobic conditioning
- Leg strength
- Trunk strength
- Trunk rotation flexibility
- Throwing routines
- Cuff and Scapula routines

Surgical Considerations
- Labrum tears
  - Debridement
  - Symptomatic return to sport
  - Reconstruction
    - Three weeks before aggressive movement
    - Six weeks before aggressive strengthening
    - Twelve weeks before throwing

Injury Classification
- TYPE I
  - FRAYED AND DEGENERATED

Injury Classification
- TYPE II
  - LABRUM AND BICEPS TENDON IS AVULSED FROM LABRUM

Injury Classification
- TYPE III
  - VERTICAL TEAR IN CENTRAL AREA

Injury Classification
- TYPE IV
  - VERTICAL TEAR INTO BICEPS

Injury Classification
- TYPE V
  - SLAP extends to anterior inferior glenoid
  - Bankart/stabilize biceps anchor
- TYPE VI
  - SLAP with an unstable anterior flap
  - Debride flap/stabilize biceps anchor
• TYPE VII
  – SLAP extends into MGHL
  – Repair MGHL/stabilize biceps anchor

  • Maffet, Gartsman, Moseley, AJSM ’95

Surgical Considerations
• Rotator cuff tears
  – Partial tears with debridement/decompression
    • Symptomatic ROM and strengthening
    • Six weeks before throwing program
  – Reconstruction of complete tears
    • “Mini-Repair”
      – ROM immediately
      – Three weeks lift against gravity
      – Twelve weeks before throwing

Surgical Considerations
• Elbow
  – Ulnar Nerve Transposition
  – Medial elbow ligament repair/reconstruction
  – Debridment

Surgical Considerations
• Instability
  – Thermal stabilization

Surgical Considerations
• Baseball Players
  – Andrews: Traditional vs Traditional + TACS
    • F/U 1 yrs
      – 80% vs 90% return to competition
    • F/U 2 yrs
      – 67% vs 93% return to competition
      – 61% same or higher level vs 86%
    • Return at 7.2 vs 7.4 months

Surgical Considerations
• Toth et.al. / Krishman et.al. AOSSM 02
  – 31% failure rate/39% failure rate

Surgical Considerations
• Joseph et.al. AJSM Vol.31 No. 1
  – Thermal capsulorrhaphy may be effective for ‘acquired instability’ (17%) but not for other categories of instability such as traumatic (33%), and congenital MDI (60%)

Surgical Considerations
• Instability
  – Reconstruction: Open/Arthroscopic
    • Post-op positioning
    • ROM immediately
    • Strengthening symptomatically
    • Twelve weeks before throwing program

Surgical Considerations
• Rehabilitation in the safe positions
Little Leaguers
• Joe Chandler MD
  – Braves Pitchers
    • 9-10 start pitching
    • 11 start change-up
    • 14.6 start curve
    • 18.6 start slider
  – Little leaguers
    • 7-8 start pitching
    • 10 start change-up
    • 11.6 start curve
    • 14.5 start slider

Little Leaguers
• Joe Chandler MD
  – Numbers of pitches
    • 8-10  50 pitches
    • 11-14  75 pitches
    • 15-18  90-100 pitches
  – Routine
    • Two days rest
    • 50 pitches or 15 batters
    • Watch other activities!
  – “If you want to win, you have to throw a curve”-Little league coach in Atlanta.

Little Leaguers
• Olsen etal AJSM Vol. 34 2006: Risk Factors
• 95 Adolescent pitchers with elbow/shoulder surgery
• 45 with no significant injury
• Overuse and fatigue was the major factor
• Not instruction, exercise, age when pitched thrown, pitch type,
• Those injured pitched more months, more games, more innings, more pitches, more warm up, starting pitchers, more showcase games, higher velocity, pitched through more pain, used more anti-inflamatories and used more ice.
Recommended Minimum Rest after Pitching

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<th>Age</th>
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USA Baseball Medical/Safety

**Maximum Pitches**

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<tr>
<th>Age</th>
<th>Fastball</th>
<th>Change up</th>
<th>Curveball</th>
<th>Knuckleball</th>
<th>Slider</th>
<th>Forkball</th>
<th>Splitter</th>
<th>Screwball</th>
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Age to Learn Pitches

- Fastball: 8
- Change up: 10
- Curveball: 14
- Knuckleball: 15
- Slider: 16
- Forkball: 16
- Splitter: 16
- Screwball: 17

Summary