

# 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 90-100°
  - Elbow is 90°
- Injury potential is low in this phase

## Biomechanics and Kinematics

- Range of Motion (End of Cocking Phase)
  - 180° of external rotation (combination of spinal hyperextension, scapular movement, and glenohumeral movements)
  - 90-100° of abduction at the glenohumeral joint
  - 20-30° of horizontal abduction at the glenohumeral joint
  - 90° 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

- “Osseous Adaptation and ROM at the Glenohumeral Joint in Professional Baseball Pitchers”, AJSM Vol. 30 #1 (J/F) 2002. Crockett, et.al.
  - 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 8000°/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
  - Ancaneus 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 MPH!)

# 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 1 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 a 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
  - Debriedment

## Surgical Considerations

- Instability
  - Thermal stabilization
- 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
- 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%)
- Instability
  - Reconstruction: Open/Arthroscopic
    - Post-op positioning
    - ROM immediately
    - Strengthening symptomatically
    - Twelve weeks before throwing program
- 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.

## **Summary**