

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
 - Anconeus 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 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
 - Debridement

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