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

- "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.

Biomechancs 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
    - **180º** external rotation to **70-90º** of external rotation
    - **90-100º** adduction
    - **20-30º** horizontal abduction to **0º** horizontal abduction
  - Elbow
    - **90 to 30-25º** flexion

Biomechanics and Kinematics

- Forces (Acceleration Phase)
  - Shoulder
    - Internal rotation at 8000º/sec–60Nm (Football=3000)
    - Horizontal adduction at 7000º/sec
    - Glenohumeral joint compression
  - Elbow
    - Extension at 2500º/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 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 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%)Surgical Considerations
- 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.

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

Age	1	2	3	4	Days Rest
8-10	20	35	45	50	
11-12	25	35	55	60	
13-14	30	35	55	70	
15-16	30	40	60	80	
17-18	30	40	60	90	#Pitches

USA Baseball Medical/Safety

Maximum Pitches

8-10:	50 p/g	2 g/w
11-12:	65	2
13-14:	75	2
15-16:	90	2
17-18:	105	2

Age to Learn Pitches

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

Summary