Shoulder Throwing Biomechanics

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Disclosures

• AOSSM Committee Member
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Shoulder Complex

Primary function of the shoulder complex:
Position the hand in space

Made up of 4 joints
• Glenohumeral
• Scapulothoracic
• Acromioclavicular
• Sternoclavicular

Biomechanics

Kinetic Chain:
Footplant → Trunk Rotation → Shoulder Rotation → Elbow translation → Wrist Translation

• Shoulder angular velocity: ~7600 deg/sec
• Elbow angular velocity: ~2500 deg/sec

How To Throw At 105 mph

Stride Length and Speed
• Usually 87% pitcher’s height
• 120% for Chapman
• Stride Speed:
  • 0.8sec (15% faster than avg)

Hip to Shoulder Separation
• Usually 40°-60°
• 65° for Chapman

Acceleration Phase
• Avg 0.07-0.09 sec
The Pitching Cycle

Wind Up
- Initial movement to max knee lift
- Minimal muscle activity during this phase
  - Upper trapezius MVIC is 18%, serratus anterior 20%, anterior deltoid 15%
  - Produces upward rotation of scapula
- Anterior deltoid and pectoralis major work concentrically at GH joint

Early Cocking
- Max knee height to front foot contact
- Shoulder is ‘semi-cocked’
  - 90° Abd, 30° horizontal Abd, 50° ER
  - Supraspinatus and deltoid work together to abduct the arm
- Serratus anterior and scapular retractors (middle trapezius, rhomboid, and levator scapulae) position the glenoid in upward rotation and retraction, providing a stable base on which the humerus can rotate
- Lower extremity and core are building energy
  - Hip extensors/abductors, knee flexors
Early Cocking

- Front foot contact to maximum shoulder ER
- Serratus anterior and pectoralis major are very active (bring arm into horizontal adduction)
- Infraspinatus and teres minor have peak activity to externally rotate the arm
- Subscapularis produces significant eccentric contraction
- Biceps is active to limit anterior translation and compression of the humeral head
- Scapula is brought into a position of retraction
  - Increases in scapular elevation and upward rotation are crucial, ensuring sufficient subacromial space to accommodate the 90° to 100° of humeral abduction in the throwing position without impingement

Late Cocking

- Front foot contact to maximum shoulder ER
- Serratus anterior and pectoralis major are very active (bring arm into horizontal adduction)
- Infraspinatus and teres minor have peak activity to externally rotate the arm
- Subscapularis produces significant eccentric contraction
- Biceps is active to limit anterior translation and compression of the humeral head
- Scapula is brought into a position of retraction
  - Increases in scapular elevation and upward rotation are crucial, ensuring sufficient subacromial space to accommodate the 90° to 100° of humeral abduction in the throwing position without impingement
Acceleration

- Maximum shoulder ER to ball release
  - Most explosive phase
- Rapid shoulder IR occurs
  - Shoulder moves from 175° of ER to 100° of IR in about 42 to 58 millisec
- Latissimus and subscap are very active to aid in IR

Deceleration

- Ball release to max shoulder IR
- Greatest amount of joint loading is generated during this phase (most violent phase)
- Shoulder compressive forces are generated to resist shoulder distraction, while a posterior shear force of 40-50% of bodyweight is generated to resist shoulder anterior subluxation
  - Posterior shoulder soft tissues dissipate these forces (likely why post capsule becomes non-compliant)
- Trapezius, serratus anterior, and rhomboids produce high MVIC to decelerate arm
- Teres minor, infra, supra, and deltoid are active to resist anterior humeral head translation, horizontal adduction, and internal rotation

Deceleration
Follow Through

- Max shoulder IR until body stops moving
- Not much force on shoulder
- Getting into fielding position

Bringing It Home

- Kinetic Chain
- Scapula
- Proper Mechanics

Thank You
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