Recognition and Treatment of Shoulder and Elbow Injuries in Baseball Pitchers

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Course Objectives

• Participant will gain knowledge of the background related to shoulder and elbow injuries in baseball pitchers
• Participant will gain knowledge of common injuries of the shoulder and elbow in baseball pitchers
• Participant will gain knowledge of assessment and treatment for common shoulder and elbow injuries in baseball pitchers
• Participant will gain knowledge of unique aspects of baseball pitching including those at the youth level
The Shoulder

- Injury background
- Adaptations
- Common Injuries
- Assessment
- Treatment

Background for Injury

- High velocity: shoulder rotation around 7,000° per second
- Extreme range of motion: shoulder external rotation around 165°
- High volume: starting pitchers may throw 60-100 times in competition not including warm-ups
- Youth pitchers are often playing multiple positions and on multiple teams
- Training, preparation and management is still developing

Background for Injury

- Complex movement requiring coordination of the entire body
- Many pitchers are throwing too much at an age when coordination and musculoskeletal system is still developing
- Muscles to accelerate are often stronger than those to decelerate
- Competition has taken priority over practice at an age when this should be reversed
Background for Injury

• Quality of training and expertise of personnel is reversed... those at the professional level have access to what should be promoted at the youth level
• Pitching mechanics at the youth level is being taught predominantly by those with little training and expertise
• Medical professionals capable of proper management are few

Common Adaptations

• Total arc (TA)
• Glenohumeral internal rotation deficit (GIRD)
• Humeral head shift
• Tight pectoralis minor
• SICK scapula
• Thoracic spine rotation asymmetry
Pitcher Norms

- The concept of pitcher norms relates to the previous slide of adaptations that are considered normal for pitchers up to a certain point
- TA and GIRD are the two most common discussed in the literature
- Many of the adaptations improve performance and decrease injury risk up to a certain point but research is limited
- In general there is a 10-20% increase for the various movements with a few exceptions
- Symmetry is still of concern but I allow the 10-20% shift and consider it within the pitcher norm

Pitcher Norms

- Increased stride foot pronation
- Increased stride knee laxity
- Increased trail hip extension and hip flexor flexibility
- Increased stride leg hamstring flexibility
- Increased stride leg hip internal rotation
- Increased trunk rotation to throwing arm side
- Increased throwing arm shoulder ER
- Decreased throwing arm shoulder IR
- Increased throwing arm elbow carrying angle

Total Arc

- Total arc also referred to as total range of motion (TROM)
- This is the addition of shoulder internal and external rotation in the functional throwing position (90° of abduction and 90° of elbow flexion)
- Generally considered to be normal if TA of the dominant arm is within 5° of TA of the non-dominant arm
- Research studies have reported that those with TA greater than 5° are three times more likely to have a shoulder injury
- I am ok with TA being used as one part of a comprehensive assessment but should not be considered normal if the shift toward ER is greater than 20°
- There is still a necessary amount of shoulder IR to allow for enough range to decelerate so TA could be considered normal but GIRD could be greater than the acceptable 15-20°
- Too much ER also puts a pitcher at risk for anterior instability
GIRD

- Glenohumeral internal rotation deficit is perhaps the most studied and talked about throwing adaptation
- Said to be caused by the posterior and inferior shoulder capsule being stretched beyond failure point at ball release and initial follow through of the shoulder
- General consensus that 15-20° should be the cutoff for increased risk with a recent systematic analysis study stating that 18° is the cutoff
- I have seen as little as 10° being problematic and as much as 30° being asymptomatic
- Again it is important to use GIRD as part of a comprehensive assessment
- I use the amount of GIRD and the feel from first end point to how much extensibility exists
- I also like to assess this pre and post activity to see how well the tissue responds to movement
- Some of the hardest throwers have stiff and limited GIRD by usual standards that is capable of good extensibility to an acceptable range which I believe is actually the best physiological nature for it. The added stiffness is more durable as long as it also has the flexibility once the tissue is warmed up

Common Shoulder Injuries

- Rotator cuff strain/tendonitis
- Shoulder impingement
- Biceps tendonitis
- SLAP tear

Rotator Cuff Strain/Tendonitis

- Very similar presentation
- History and mechanism for injury
- Signs and symptoms
- Clinical assessment
Shoulder Impingement

• 3 types based on location around acromion
  – Anterior with likely biceps involvement. Sometimes referred to as secondary impingement
  – Primary which is the one often referred to as just shoulder impingement.
  – Posterior with varying amount of involvement of supraspinatus, infraspinatus and teres minor

• Shoulder impingement history and presentation is similar to rotator cuff tendonitis but differentiated with impingement tests and abnormal alignment of humeral head

• Signs and symptoms
  • Clinical assessment

Biceps Tendonitis

• History and mechanism
• Signs and symptoms
• Clinical assessment
• This often occurs when the labrum is strong enough to hold during the peel back mechanism and when excessive anterior translation of the humeral head is present
• Differentiated from anterior impingement through location of pain, restriction of biceps and speed’s test
SLAP tear

- History and mechanism
- Signs and symptoms
- Clinical assessment
- Most notable difference is the presence of pain, instability and clicking in certain positions, movements and special tests

Clinical Assessment

- Scapulohumeral rhythm
- Scapular active movement testing
- Shoulder mobility test
- Shoulder horizontal abduction test
- Shoulder MMT
- Neck AROM
- Thoracic spine rotation
- Special testing
- Supine shoulder PROM
- Prone thoracic spine extension
- Prone scapula MMT
Scapulohumeral Rhythm

• May be performed in multiple planes with the most common being flexion, scaption and abduction
• Looking for symmetry of movement, coordination and especially end range which is often the first positive sign for capsular restriction or abnormal alignment of the humeral head
• There are specific tests and measurements that may be used to document the abnormal position

Scapular Active Movement

• Scapular elevation and depression
• Protraction and retraction
• Retraction with shoulder external rotation and posterior tilt
• Five repetitions in each direction while noting symmetry and coordination

Shoulder Mobility Test

• I prefer to use one sweeping movement with the hands open instead of making a fist
• It is important to note movement of the scapula as there is often compensation there to gain range of motion
• This is a great screen to further identify abnormal humeral head position and capsular restrictions
• I will often have them do this twice on each side alternating each repetition
• Normal is the ability to touch fingers and often see a normal deficit with dominant arm into internal rotation
Shoulder Horizontal Abduction

- Forearm in neutral to isolate pectoralis major and anterior shoulder capsule
- Be careful with this movement as throwing shoulder often has increased anterior mobility and is uncomfortable especially at end range
- Normal is around 180 degrees from neutral, which is 90 degrees of flexion
- This is a great test to get a feel for shoulder mobility in a direction that is critical for maximum shoulder external rotation

Shoulder MMT

- Recommend to test strength in multiple positions throughout the assessment
- I perform the following in sitting at this point:
  - Flexion
  - Scaption
  - ER in 90/90
  - ER side
  - IR side
- These tests are ok to get a surface level understanding of strength, stability and coordination
- I use them more so for pain provocation and overall shoulder complex control

Neck AROM

- Always good to screen for possible cervical issues that may cause pain in the shoulder
- Also good for possible asymmetries through neck and upper thoracic spine, which are very common for baseball pitchers
- I will check flexion, extension, side bending bilateral, rotation bilateral and chin to shoulder combo
Thoracic Spine Rotation

• In seated position with arms crossed so hand lays on opposite shoulder
• Be sure to isolate trunk rotation and may use a pillow squeezed between knees to avoid movement at the pelvis and hips
• Almost always greater rotation to the throwing arm side
• Normal is head turned 180 degrees with acromial line around 70 degrees of rotation
• I like for baseball pitchers to have at lest 10 and more like 20 degrees more than the norm

Special Tests

• So many to choose from
  – Neer’s
  – Hawkin’s
  – AIM
  – Obrien’s
  – Speed’s
  – Slaprehension
  – Clunk test
  – Crank and relocation (my favorite)
• I really like Cleland’s work on sensitivity and specificity when certain signs, objective tests and special tests are grouped together

Shoulder PROM

• Performed in supine and looking at total range, quality of feel and end feel
  – Flexion
  – Scaption
  – ER at 90
  – IR at 90
  – Horizontal adduction
• Most important movements are ER and IR in the functional throwing position
• Remember that it is normal to have a shift in the arc but I have found that the quality of the feel of each of these is just as important
Prone Thoracic Spine Extension

• Prone on elbows looking straight forward to note isolated thoracic spine and position of shoulder blades
• Reset, prone on elbows and look up to ceiling
• May give overpressure through the thoracic spine
• Looking at range and where the movement is produced

Prone Scapula MMT

• Looking to isolate different muscle groups of the scapula
• I like to use these to look at coordination and control during the movement as much as isometric strength
  – Shoulder extension
  – Shoulder horizontal abduction
  – Shoulder flexion at 135 degrees

Videos
Common Shoulder Problems and Treatment

- I like to categorize problems as either mobility/flexibility or strength/stability and you will find that many of these hold true in multiple areas for pitchers
- Mobility is related to joint structure, alignment and soft tissue extensibility
- Stability is related to joint structure, alignment, strength and coordination

Common Shoulder Problems and Treatment

- Shoulder capsuloligamentous complex restriction
  - Most often posterior and inferior
  - Warm it up, mobilize it, work mobility exercises and reinforce with exercises gradually increased to be more sport specific
- There are a lot of options for warm-up exercises. I tend to use those that are low stress to the shoulder, avoid impingement and try to recruit the cuff for the most direct activity of the shoulder
- Mobilizations that I prefer are posterior glide in the loose packed position, posterior and inferior glide in the functional throwing position, inferior glides at end range flexion
- Reinforcement exercises are usually cuff specific, functional throwing position with light tubing progressing to medicine ball or weighted ball throws, throwing drills and finishing with actual throwing progression with a baseball

Common Shoulder Problems and Treatment

- Muscle restriction and flexibility problems
  - Most often pectoralis major and minor, biceps and posterior rotator cuff
  - Warm it up, make sure joint mobility is good, manual stretches, self stretches, reinforcement exercises progressing to sport specific
- Very similar warm-up and progression as passive soft tissue restrictions with the addition of specific muscle groups to be stretched and use of reinforcement exercises
Example Treatment Sequence

- Arm bike
- Shrugs
- Biceps curls
- Rows
- Pulldown
- Triceps extension
- Foam roll thoracic spine and shoulder complex
- MT
  - posterior scapula tilt
  - posterior glide humeral head
  - Shoulder #1 stretch
  - Soft tissue mobilisation
- Prone scapular exercises (T,V,W)
- Standing ER, IR
- Standing ER, IR 90/90 position
- Flexion, scaption with dumbbells
- Medicine ball bounces, rebounds, throws
- Throwing drills
- Throwing progression

Videos

The Elbow

- Injury background
- Adaptations
- Common Injuries
- Assessment
- Treatment
Background for Injury

- High velocity and force toward extension of the elbow at release and follow through
- High valgus stress during acceleration said to be at or near the maximum tensile strain of the ulnar collateral ligament (UCL)
- Many of the same mechanisms for shoulder injury hold true for the elbow: inexperienced pitchers throwing too much, lack of preparation, playing on multiple teams, etc.

Common Adaptations

- Increased carrying angle
- Restriction into extension and supination
- Restriction of the biceps
- Adaptations at the shoulder among others also said to increase stress at the elbow

Common Elbow Injuries

- Valgus extension overload
- Biceps tendonitis
- Forearm tendonitis
- UCL sprain
Valgus Extension Overload

- Increased compression and shear force on the posterior and medial aspect of the elbow
- The medial side of the olecranon rubs on the medial aspect of the olecranon fossa
- May be acute but more often seen as a chronic problem with hypertrophy of bone, bone spurs and loose bodies
- Eventually limits extension and supination

Biceps Tendonitis

- Tendonitis to the distal biceps is common due to the rapid acceleration of the elbow toward extension which is controlled by eccentric activity of the biceps

Forearm Tendonitis

- Medial epicondylitis or “golfer’s elbow” is common due to the high valgus stress and forearm flexor activity in gripping the ball
- Lateral epicondylitis or “tennis elbow” may also occur but much less common
- Also possible to have tendonitis in forearm flexors with the flexor digitorum superficialis the most common due to fingertip grip of the baseball
UCL Sprain

- Possibly the most talked about injury to baseball pitchers due to incidence and the association with Tommy John’s surgery
- Ulnar collateral ligament sprain may be acute but is much more common to see as a chronic problem of medial elbow pain that eventually leads to an acute tear
- The repetitive valgus overload during acceleration with the ulnar collateral ligament in position, joint alignment and joint angle is the primary mechanism for injury

There is still quite a bit of controversy surrounding this issue
- Is it pitch count?
- Is it mechanics?
- Is it strength and conditioning?
- Is it shoulder adaptation?

As is true with so many injuries, it is often a combination of these things
UCL Sprain

- Given the valgus stress at the elbow consistently at or near the failure point of the UCL, even slight problems with fatigue in other areas, mechanical changes and increase of pitch count beyond preparation may increase risk for injury
- This is often misdiagnosed as forearm tendonitis
- MRI doesn’t pick up the chronic nature of the problem and often not done soon enough to pick up acute inflammation
- Many times there is not sufficient rest taken to allow the UCL to heal
- Conservative rehab often fails because the level of stress during throwing is not handled properly
- The only way to sufficiently stress the UCL to strengthen it is with throwing and it is very difficult to walk the fine line between enough stress to strengthen and too much stress to injure

Assessment

- Elbow AROM
- Carrying angle
- Elbow PROM
- Forearm flexibility
- Varus/valgus stress test
- Elbow distraction
- MMT
- Functional throwing valgus stress test

Elbow AROM

- Seated position or standing elbow flexion, extension, forearm pronation, supination, wrist flexion, extension
- May also perform combo shoulder IR, elbow extension and wrist flexion; shoulder ER, elbow extension and wrist extension
- Looking for total range, quality of movement and side to side differences
Carrying Angle

• In sitting have the pitcher extend elbows fully with forearm in full supination and wrist in neutral
• Normal to have increased carrying angle up to 5 degrees
• May also add overpressure here and attempt to realign elbow to determine true carrying angle as it often appears greater due to soft tissue tightness

Elbow PROM

• I will often perform this along with AROM by giving overpressure during each of the active movements
• Looking at total range, end feel and pain provocation
• Common to have limitation into elbow extension and forearm supination that is easily increased with overpressure

Forearm Flexibility

• Shoulder ER, elbow extension and wrist extension to check forearm flexors
• Shoulder IR, elbow extension and wrist flexion to check forearm extensors
• Common to have tightness that is easily reduced to normal for forearm flexors
Varus/Valgus Stress Tests

• A very important movement for pitchers
• Test in seated with elbow in full extension and approximately 30 degrees of flexion
• I will often bounce the valgus test through the last 30 degrees and into extension to get a good feel for medial elbow stability
• This is a good test for feel of medial elbow stability but use caution in using this as a determining factor for UCL sprain as you will often get a negative test even in the presence of a UCL sprain
• Varus stress test can be a good indicator of posteromedial impingement

Elbow Distraction

• In seated position with the elbow around 70-90 degrees of flexion and apply a distraction force at the humeroulnar joint
• This position is more common to note instability and is associated with the initial acceleration angle of the elbow during throwing
• I like this as a pain provocation test for UCL sprain

MMT

• Elbow flexion and extension, forearm pronation and supination, wrist flexion and extension
• May test these in multiple positions but most done with arms at side and elbow in 90 degrees of flexion
• Getting a general idea for muscle recruitment, stability, coordination and side to side differences
Valgus Test in the Functional Throwing Position

• Also called milking the cow test
• In seated position with shoulder at 90 degrees of abduction, elbow at 90 degrees of flexion, grab the thumb and apply a valgus stress at the elbow while palpating along the UCL
• Said by the team physician of the Houston Astros to be the best test for UCL sprain and I would agree
• If two out of these three: valgus test in functional throwing position, valgus stress test and elbow distraction test are positive then a good chance for UCL sprain

Video

Treatment for Common Elbow Problems

• Valgus-extension overload (posteromedial elbow impingement)
  – Warm it up, mobilize the elbow joint, soft tissue mobilization if needed, manual stretches into extension and supination, strengthen to tolerance and advance to throwing specific exercises
  – The most difficult aspect of this problem is mobilizing the elbow joint which requires very specific control of varus/valgus at the elbow while moving into extension and supination
Treatment for Common Elbow Problems

- Biceps and forearm tendonitis
  - Warm it up, soft tissue mobilization, restore range of motion and flexibility, strengthen to tolerance and advance to throwing specific exercises
  - Usually the best time to pick up on other problem areas and work on the dysfunctional non-painful problems
  - Rarely do these require much time off given the gradual nature of overuse and the many other problems that lead to it
  - Occasionally the tendonitis is bad enough where only 4-6 weeks of rest from throwing and gradual return to throwing is the only treatment... can be very difficult to convince pitchers and especially parents for the time off

- UCL sprain
  - Warm it up, soft tissue mobilization directly over the UCL, strengthen to tolerance, work on other problem areas, advance to throwing specific exercises, gradual throwing progression with close monitoring of response
  - Usually plan on 4-6 weeks of exercises without picking up a baseball
  - Plan on 2-4 weeks of throwing of gradually increasing intensity and volume with another 2-4 weeks of increasing amount of full intensity throws toward the demands of the pitcher (reliever vs starter)
  - If you add it up on the fastest side to full return to competition is around 2 months and 3 months at the slowest
  - The time when I may speed this up is when there are other obvious problems that are adding stress to the elbow that when corrected will significantly reduce the stress on the medial elbow
  - I will carefully test the response of the UCL with certain controlled throwing drills and if pain free may return the pitcher in a shorter amount of time

Exercises for the Elbow

- Arm bike
- Shoulder shrugs, biceps curls, scapula rows, shoulder pulldown, triceps extension
- Wrist flexion, wrist extension, forearm supination, forearm pronation
- MT: STM, joint mobilization, PROM
- Shoulder IR, shoulder ER, 90/90 shoulder IR, 90/90 shoulder ER
- Weight bearing stability exercises
- Medicine ball rebounds and throws
- Throwing drills
- Throwing
Post-op Treatment

• Varies depending on the surgery and there are sufficient protocols available
• I use the protocols of a well known, local orthopaedic surgeon specializing in working with baseball pitchers
• Protocols serve as a good guideline for the phases of protecting and promoting healing, restoring range of motion and strength, returning to sport specific strength and conditioning
• Much of the variation in approach also depends on what was done in the surgical procedure and always a good idea to review that with the surgeon

Injuries to Youth Pitchers

• There are two specific injuries that are unique to youth pitchers and worth reading the literature for more detail
• Little Leaguer’s Shoulder is an injury to the growth plate at the greater tuberosity of the shoulder
• Little Leaguer’s Elbow is an injury to the growth plate of the medial epicondyle of the humerus
• May see the Salter Harris classification
• I think of these in three degrees of severity: inflammation, separation and fracture
• Both injuries are an avulsion type injury
Injuries to Youth Pitchers

- Open growth plates are the weakest point and during growth spurts may be weak enough that even the most efficient and well trained pitcher is at risk.
- Certainly poor mechanics, lack of preparation and high pitch counts increase risk.
- Another risk factor that is not mentioned as much is throwing velocity.

Research for the Shoulder and Elbow

  - A great discussion of many aspects related to the shoulder and review of previous research.
  - This is a really good overview of risk factors such as pitch count, throwing breaking pitches, etc.
  - Excellent discussion of biomechanics and injury.
- Prevalence of Ulnar Collateral Ligament Surgery in Professional Baseball Players
  - A good discussion of UCL injury including information on UCL injuries in youth pitchers.

Throwing Biomechanics

- As controversial and as many “experts” as there are for the golf swing.
- What makes it so complex and controversial:
  - Many different movement patterns that are successful.
  - Total body so a lot of moving parts.
  - Each individual has variations at each of the joints which makes simplifying to a single or even a few movement patterns difficult.
  - There is no cookie cutter approach that works for all.
  - In my opinion there are few experts in the nation that I would trust to teach it, train pitchers and train others to do it.
  - There are too many self proclaimed pitching coaches with very little knowledge of the biomechanics, anatomy and physiology, strength and conditioning, etc.
Throwing Biomechanics

- Full body plyometric
- Part momentum, part leverage and part rotational torque
- Lead hip initiates rotation
- Pelvis and lower trunk maintain stability and also add to the rotational force
- Mid trunk and higher maintains rotation in the other direction to create hip and shoulder separation (stretching the elastic component along a diagonal created from lead hip through trunk and up to throwing shoulder)
- Rotation of thoracic spine, retraction/posterior tilt of shoulder blade and external rotation of the shoulder place the arm into maximum shoulder external rotation
- Very specific timing to take advantage of the elastic stretch portion of the plyometric, a short amortization phase and transfer into acceleration of the shoulder into internal rotation
- During the timing of the plyometric, the momentum of the body is moving forward to release of the baseball ahead of the lead leg
- At release and follow through certain areas of the body have already begun a controlled deceleration of the elbow, shoulder, trunk, lead leg hip and trail leg swinging through

The commonly used nomenclature and something to use in discussion and as a way to relate to those that already know it but this is one of the reasons that physical therapists can and should be the experts for throwing biomechanics

- 7 phases: wind up, stride, early cocking, late cocking, acceleration, release, follow through

Videos
Throwing Biomechanics

• Tom House is perhaps the most well known expert for throwing biomechanics
• He has written several books that are worth reading and the description of biomechanical movements are done in a way that is easier to visualize and relate to pitchers, parents, coaches, etc

Throwing Biomechanics

• Ron Wolforth’s Texas Baseball Ranch specializes in the assessment and training of baseball pitchers
• In my opinion this is the best school there is for learning about throwing biomechanics, which he prefers to refer as a movement pattern
• The assessment and training incorporates several fields and aligns very well with biomechanics, motor control, strength and conditioning, etc
• He has books and instructional dvds for many aspects of throwing biomechanics including workouts specific to pitchers

Conclusion

• Throwing a baseball is a unique and inherently stressful movement
• The biomechanics of throwing are complex and take years to gain a good understanding
• There are still a lot of misconceptions and improper management of pitchers
• In my opinion, physical therapists have the capability to be the experts for this patient population
• Collaboration with orthopaedic surgeons, physical therapists, pitching coaches and strength and conditioning coaches is the best team available for proper management
Questions?

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