Elbow Pain in the Throwing Athlete

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Disclosure

In Compliance with ACCME guidelines, I hereby declare:

I do not have financial or other relationships with the manufacture(s) of any commercial services discussed in this educational activity.

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Outline

- Anatomy/Functional Anatomy
- Throwing Motion
- Common Pathologic Conditions
- Work-up
- Treatment/Outcomes
Elbow Stability

- 1° Stabilizers
  - Ulnohumeral Articulation
    - 50% Elbow stability
    - 25% of pitchers s/p olecranon debridement require UCL reconstruction
    - Strain in UCL increases with >3mm posteromedial olecranon resection
  - UCL
    - Valgus Stress
  - LUCL
    - Varus Stress
Elbow Stability

- 2° Valgus Stabilizers
  - Radiocapitellar Articulation
  - FCU
    - 1° dynamic stabilizer
  - FDS
    - 2° dynamic stabilizer
Overhead Throwing

- Throwing motion is similar across sports
  - Baseball pitch, tennis serve, javelin throw, football pass, volleyball spike
- Rapid forceful extension of the elbow
- Valgus stress and pronation of the supinated forearm
Effects of Throwing on Elbow

- Angular velocity reaches 3,000°/sec as elbow extends from 110°-20° flexion
- 64N/m valgus torque at elbow
  - UCL tensile strength: 33 N/m
- 500 N compressive force on radiocapitellar joint
- Majority of injuries secondary to repetitive overload rather than acute trauma
Stages of Overhead Throwing

- Baseball Pitch
  - Best Studied
  - Divided into 5 stages

Diagram illustrating the five stages of a baseball pitch:

1. Start
2. Hands apart
3. Foot down
4. Maximal external rotation
5. Ball release
6. Deceleration
7. Follow-through
8. Finish
Stage IV: Acceleration

- Rapid acceleration of the UE
- Large forward-directed force on the extremity
  - Results:
    - IR & adduction humerus
    - Rapid elbow extension
    - Large valgus stress across elbow

- Most injuries occur in this phase; large stress/load across medial elbow structures
Stage V: Deceleration/Follow Through

- Dissipation of all kinetic energy
- Ends with full extension elbow
  - Shear stress in posterior compartment
- Rapid forceful decel of the UE
  - Rate of 500,000°/sec
Biomechanics of Throwing

- Net effect:
  - Tensile Stress - Medially
  - Shear Stress - Posteriorly
  - Compression - Laterally

- Together → Valgus Extension Overload Syndrome
Differential Diagnosis

**Medial**
- UCL
- Ulnar neuritis
- Medial epicondylitis
- Flexor pronator tendinosis/rupture

**Posterior**
- Olecranon osteophytes
- Loose bodies
- Olecranon stress fractures

**Lateral**
- OCD of the capitellum
- Radiocapitellar plica
History

- **Acuity**
  - Acute vs Chronic

- **Age**
  - Skeletal Maturity

- **Location of Pain**
  - Elbow is geographic
History

• Preceeding Events
  – changes in training regimen
  – number pitches/events

• Accuracy, velocity, stamina, strength

• Phase of throwing

• Associated Neurovascular Complaints
  – Paresthesia
  – Hand clumsiness
  – Cold intolerance
Physical Examination

• Inspection
  - Resting position
    - Effusion- elbow flexed 70° - 80°
  - Carrying angle
    - May be larger (adaptive not necc pathologic)
    - Professional throwers (valgus angles > 15 °)
  - Ecchymosis
Physical Examination

• ROM

  – AROM/PROM
    – Normal: F/E 0\(^{-140^\circ}\) P/S 80-90\(^\circ\)
    – Crepitus, pain, mechanical sx
      (chondral lesion/loose body)

  – Endpoints
    – Hard in extension - (osteophytes)

  – Flexion contracture
    – May or May not be pathologic
      (50% professional pitchers + flex contracture)
Physical Examination

• Palpation
  - Geographic- tender over pathology
  - Bony landmarks
    - Fx, Stress Fx, Insertional tendinitis
  - Soft tissues
    - Biceps/Triceps, Extensor Mass, Flexor-Pronator Mass
      • Be alert to possibility deeper pathology/instability
  - Neurovascular structures
    - Ulnar Nerve
      - Tinel's
      - Subluxation
Physical Examination

• Strength
  – Compare to unaffected extremity

• Stability
  – Medial Instability
    – Valgus stress test
    – Milking maneuver
  – Lateral Instability
    – Uncommon in throwers
  – Valgus Extension Overload Test
    – Posterior medial osteophytes
Imaging

- **Plain Radiographs**
  - AP, Lateral, 2 Oblique Views
    - Osteophytes, calcifications (UCL), OCD, loose bodies
  - Stress Radiographs
    - Fallen out favor

- **CT Scan/Bone Scan:**
  - Olecranon stress fx

- **MRI**
  - +/- Arthrogram
Differential Diagnosis

**Medial**
- UCL
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- Flexor pronator tendinitis/rupture

**Posterior**
- Olecranon osteophytes
- Loose bodies
- Olecranon stress fractures

**Lateral**
- OCD of the capitellum
Differential Diagnosis

- **Medial**
  - UCL
  - Ulnar neuritis
  - Medial epicondylitis/apophysitis
  - Flexor pronator tendinosis/rupture
UCL Injuries

• Valgus Stability of Elbow
  – 1° Stabilizer
    – Ulnar collateral ligament
  – 2°
    – Radio-capitellar joint
    – Flexor-Pronator Mass
      – FCU>FDS>PT

• Mid-range of motion from 20-120°
  – Unlocked ulno-humeral joint
**Ulnar Collateral Ligament**

- **3 Bundles**
  - **Anterior Bundle**
    - Anterior Oblique Ligament
    - Inf Med Epi- Sublime Tub
  - **Posterior Bundle**
    - Posterior Oblique Ligament
    - Inf Med Epi- Sigmoid Notch/post coronoid
  - **Transverse Ligament**
    - Olecranon-Coronoid
Ulnar Collateral Ligament

- 3 Bundles
  - Anterior Bundle
    - 2 Bands
      - Anterior Band
      - Posterior Band
Ulnar Collateral Ligament

- **3 Bundles**
  - **Anterior Bundle**
    - 2 Bands
      - Anterior Band
        - 1° stabilizer @ lower flexion angles (<90)
      - Posterior Band
        - 1° stabilizer @ higher flexion angles (>90)
UCL Injury: Pathophysiology

- Throwing Motion Generates:
  - Large Valgus & Extension Forces
  - Tensile Stress along Medial Structures
  - Repetitive Tensile Stresses- Leads to microtrauma to UCL
  - May lead to UCL attenuation or failure
UCL Injury: Presentation

• Soreness along inner elbow during and after throwing

• Occasionally report episode of giving way or sudden severe pain ± popping sensation

• Pain
  – acceleration
  – ball release
  – point of impact in hitting the ball
UCL Injury: Presentation

- Loss of pitch velocity/control
- +/- Ulnar nerve symptoms
- Catching or locking of the elbow if loose bodies are present
UCL Injury: Physical Exam

- Point tenderness 2 cm distal to medial epicondyle
- Laxity/Pain with valgus stress
- Absence of pain with resisted wrist flexion (epicondylitis)
- Ecchymosis in acute injury
UCL Injury: Physical Exam

- **Valgus Stress Test**
  - Classically described with elbow flexed 20-30°
  - Moving Valgus Stress Test
    - supine, with humerus maximally ER
    - Valgus stress throughout flexion/extension
  - 100% sensitive/75% specific
UCL Injury: Physical Exam

- Milking Maneuver
  - Shoulder abd 90°, Elbow flex 90°
  - Examiner grabs thumb; applies valgus stress
  - Valgus stress on elbow flexed >90°
  - Pain is positive finding
    - Often at sublime tubercle
UCL Injury: Imaging

- **X-rays**
  - Calcification
  - Avulsion

- **Stress X-rays**
  - Used less frequently
  - > 3mm opening positive
  - Increased opening common in throwers

- **MRI**
  - +/- Arthrogram is the study of choice
UCL Injury: Treatment

- **Non-Operative Rx**
  - **Indications**
    - Non-throwing athlete
    - Non-throwing arm
    - Low demand patient
    - Partial Tears
  - **Rehab**
    - 2-6 wks “Active Rest”
      - Brace (no valgus stress)
      - Rest, Ice, NSAIDs, Motion
    - Functional Exercises/Plyometrics
      - Flexor pronator strengthening
    - Interval throwing program
UCL Injury: Treatment

- **Operative Rx**
  - Indications
    - Acute rupture
    - Complete tear thrower
    - Partial tears that failed Rehab
    - Symptomatic tears in non-thrower, that failed Rehab
  - Technique
    - Repair vs Reconstruction?
UCL Injury: Treatment

- **UCL Repair:**
  - Historically was the mainstay of Rx
  - Several comparative studies demonstrated superior results w/ reconstruction
  - Currently Limited Indications for Repair:
    - Acute proximal avulsions
    - Pediatric population (Savoie)
    - Good quality ligament

![Anatomic origin illustration](image)
UCL Injury: Treatment

• UCL Reconstruction:
  - Rx of Choice:
    - Reconstruction of the Anterior Bundle of the UCL w/ free tendon graft
  - Multiple Grafts Choices
    - Palmaris Longus
      - Contra-lateral?
    - Hamstring
    - Plantaris
    - 4th Toe Extensor
    - Allograft
UCL Injury: Treatment

- **UCL Reconstruction: Historical Perspective**
  - 1986, Jobe et al. 1st to report results of reconstructive technique
    - "Tommy John" Procedure
  - Prior to this, UCL tear in a throwing athlete was a career ending injury
UCL Injury: Treatment

- Multiple Reconstruction Techniques
  - Classic “Tommy John”
  - Modified “Tommy John”
  - Docking Procedure
  - Interference Screws
  - Hybrid Reconstruction
  - Bone Anchor Reconstruction
UCL Injury: Treatment

- UCL Reconstruction: Classic “Tommy John”
  - Extensive medial exposure
  - Transected and reflected flexor pronator mass
  - Free tendon graft recon, w/ bone tunnels through the posterior humeral cortex
  - Submuscular ulnar nerve transposition

- Excellent exposure, at expense significant morbidity associated with nerve transposition and muscle detachment
UCL Injury: Treatment

- UCL Reconstruction: Modifications
  - Modified “Tommy John”
    - Muscle-splitting approach vs. elevation of flexor-pronator mass without detachment
  - Ulnar nerve transposition uncommon
UCL Injury: Treatment

- **UCL Reconstruction: Modifications**
  - Modified “Tommy John”
    - Bone tunnel in Ulna
  - Anteriorly directed converging tunnels in medial epicondyle
UCL Injury: Treatment

- UCL Reconstruction: Modifications
  - Docking Procedure
    - Two Drill Holes in Ulna
    - One drill hole in Humerus (blind end humeral tunnel)
    - Less bone tunnels
UCL Injury: Treatment

- **UCL Reconstruction: Results**
  - Systematic Review (AJSM 2008 Vitale et al.)
    - 8 (Level III) retro, cohort studies
    - Athletes underwent recon w/ min 1 yr f/u
  - Muscle splitting > flexor takedown
    - 87% vs. 70% excellent results
    - 7% vs. 23% complications
    - 6% vs 20% ulnar neuropathy
  - Docking procedure > figure-8
    - 90-95% versus 76% excellent outcomes
    - 8% vs. 4% ulnar neuropathy

No transposition > transposition
89% versus 75% excellent outcomes
6% versus 14% complications
2 fold decrease in neuropathy
UCL Injury: Treatment

- UCL Reconstruction: Results
Flexor-Pronator Tendinosis/ Medial Epicondylitis

- Common flexor-pronator tendon at medial epicondyle
- Dynamic stabilizers to valgus stress in throwing elbow
- Wide spectrum of injuries
  - Mild overuse to acute tears
Flexor-Pronator Tendinosis/
Medial Epicondylitis

- **Presentation**
  - Insidious onset of medial elbow pain
  - Late cocking/acceleration

- **Exam**
  - TTP medial epi, over muscle distal/anterior
  - Pain with wrist flexion/pronation
  - No pain w/ valgus stress

**Concomitant valgus instability, may be underlying cause of sx & must be addressed at time of Rx**
Flexor-Pronator Tendinosis/Medial Epicondylitis

- Treatment
  - Non-Op
    - Main stay of Rx (90% success)
      - Phase I - Rest, NSAIDS, +/- Injection
      - Phase II - Stretching, pain free strengthening, counterforce brace
      - Phase III - Interval Throwing program, mechanics
      - Cortisone? PRP?
  - Operative Debridement/Repair
    - Refractory sx, muscle tears
    - 86-97% Good/Excellent Results in athletes (Jobe 1991, Morrey 1995)
Ulnar Neuropathy

- **Ulnar Nerve Sx Common**
  - 40% of athletes w/ valgus instability develop ulnar neuritis
  - 60% of throwers w/ medial epicondylitis have ulnar nerve sx

- **Susceptible to injury**
  - Tight path it follows
  - Subcutaneous location
  - Considerable excursion required
Ulnar Neuropathy

- Ulnar Nerve Irritation:
  - Traction-
    - Valgus Stress
  - Compression
    - Adhesions
    - Osteophytes
    - Muscle hypertrophy
    - Inflamed UCL (floor cubital tunnel)
  - Friction
    - Subluxation
Exacerbation of Ulnar Nerve Compression w/ Throwing

- Elbow flexion, wrist extension and shoulder abduction → 6x increase in intraneural pressure compared to resting level

- Made worse by chronic changes of valgus overload

- Prolonged and repeated pressure elevations lead to nerve fibrosis and ischemia
Evaluation of Ulnar Neuropathy

- Elbow pain w/ radiation down medial aspect of forearm into hand
- Clumsiness, heaviness, paresthesias, loss control
- Painful snapping w/ recurrent subluxations
- + Tinel's, Flexion Test

** R/O Concomitant UCL Instability/ Flexor Tendinosis
## Treatment of Isolated Ulnar Neuropathy

<table>
<thead>
<tr>
<th>Nonoperative</th>
<th>Operative</th>
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<tbody>
<tr>
<td>Rest, ice, NSAIDs</td>
<td>Decompression*</td>
</tr>
<tr>
<td>Brief immobilization/Night splints</td>
<td>Medial epicondylectomy*</td>
</tr>
<tr>
<td>Injections not recommended</td>
<td>Subcutaneous vs Submuscular Transposition</td>
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<tr>
<td>85% Success Rate</td>
<td>* Poor results in throwers</td>
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Operative Management
Ulnar Neuropathy

- **Submuscular Transposition**
  - Protects from trauma (Contact Athletes)
  - Longer rehab secondary to healing of flexor-pronator origin

- **Subcutaneous Transposition**
  - Minimizes disruption of flexor-pronator musculature (Throwers)
  - More vulnerable to direct trauma

- Improvement depends on stage of symptoms
- 4-6 months to return to full activity
Isolated Ulnar Neuropathy: Op Results

- Del Pizzo
  - 60% return to play with submuscular
- Rettig and Ebben
  - 95% return to play after subcutaneous transfer
- Andrews
  - 7 of 8 pro players returned after subcutaneous transposition

Current Recs: subcut ulnar nerve transposition in throwers
# Differential Diagnosis

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<th>Lateral</th>
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Differential Diagnosis

**Posterior**

Olecranon osteophytes

Loose bodies

Olecranon stress fractures
Differential Diagnosis

Posterior

Olecranon osteophytes

Loose bodies

Olecranon stress fractures

Posterior Impingement
Posterior Impingement

- **Cause:** Valgus Extension Overload
  - Repetitive combo of hyperextension, valgus & supination
  - Causes abutment of medial olecranon against fossa

- **Result:** Posterior Impingement
  - Synovitis, osteophyte and/or loose body formation in the posteromedial elbow of throwers
Posterior Impingement

- **Evaluation**
  - Posterior pain, effusion, locking, crepitus, loss of extension
  - TTP posteromedially, pain forced extension
  - Xrays - osteophytes/loose bodies
  - MRI - most sensitive test
  - Must r/o/address medial instability

- **Initial Rx: Conservative**
  - RICE
  - NSAIDS/ Cortisone
  - PT, Interval Throwing
Posterior Impingement

Operative Treatment

- Arthroscopic Debridement
  - Debridement of olecranon osteophytes
  - Removal loose bodies
  - Chondroplasty

- Must address concomitant instability if present

- Avoid excessive osteophyte removal; overzealous removal may expose UCL to increased stresses
Results

• Andrews et al. 1995
  - 56 pro players
  - posterior osteophyte excision +/- UCL or ulnar nerve transposition
  - 70% returned to play at 24 months
  - 41% required re operation for repeat debridement

• Reddy et al. 2000
  - 187 patients with elbow arthroscopy
  - 104 for posterior impingement
  - 92% good to excellent results at avg 42 months
  - 85% Baseball players RTP

• Current Recs- Arthroscopic debridement +/- UCL stabilization procedure, may improve sx but caution pt, may require additional procedures
Olecranon Stress Fractures

- Repetitive microtrauma by olecranon impingement or excessive triceps tensile stress
- Posterior elbow pain
- TTP over olecranon
- MRI, CT diagnostic
Olecranon Stress Fractures

- Treatment
  - Initial treatment w/ rest
  - May require ORIF in competitive thrower w/ 6.5 or 7.3 mm cannulated screw
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Differential Diagnosis

- Lateral
- OCD of the capitellum
- Radiocapitellar plica
Osteochondritis Dissecans of the Capitellum

- OCD
  - injury to subchondral bone that results in loss of structural support for cartilage

- Etiology
  - Unclear, repetitive microtrauma
Osteochondritis Dissecans of the Capitellum

- **Presentation**
  - Insidious onset, poorly localized lateral pain
  - Worse w/ activity
  - +/- mechanical sx
  - May experience loss extension

- **Imaging**
  - Xrays
    - Radiolucency lesion
  - MRI
Osteochondritis Dissecans of the Capitellum

- **Treatment**
  - Still evolving, no consensus
  - Natural hx not understood
    - Lesion progression

- **Conservative Rx**
  - Stable lesions, younger pts
  - Activity modification, Rest

- **Operative Rx (Arthroscopy)**
  - Unstable lesions, Loose bodies
  - Debridement +/- abrasion chondroplasty
  - OATS
Osteochondritis Dissecans of the Capitellum

- **Panner’s Disease**
  - Self-limited osteochondrosis of capitellum
  - Children < 10
  - Resolves with rest
Radiocapitellar plica

- Tenderness to palpation
- Pain with flexion-extension of pronated forearm
Summary

- Overhead throwing - Large valgus and extension moments
- Medial tensile, lateral compression and posterior shear
- Common pathologic mechanism for elbow conditions
- Many of the pathologic conditions in throwers are related to elbow instability
- Dx and treating elbow instability, key for successful outcomes; regardless of presenting condition