Elbow Injuries in the Throwing Athlete
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Disclosures

• None with respect to the material I will present today
Learning Objectives

• Discuss the etiology of injuries in young athletes
• Review common elbow injuries in young throwing athletes
• Discuss ways to prevent injuries in young throwing athletes
The Good

- 55% HS students participate in sports
- 60 million children between 6-18 participate in some form of organized athletics
- An emphasis on competitive success has become widespread, resulting in increased pressure to begin high-intensity training at young ages

Driven by parental goals of having their child selected for high-level travel teams, collegiate scholarships, and professional contracts.

Trend towards a concentration on a single sport in an attempt to improve a child’s chances of elite team selection and exposure to the college recruiting process.

Children’s sports are becoming a big business - coaches, personal trainers, club organizations, sporting goods manufacturers, and tournament directors, all have a financial stake in youth sports participation.
The Ugly

- 2.6 million annual sports injuries in patients 24 or younger
- At least 50% reporting to an ER due to overuse
- Early sports specialization:
  - Playing and training in a single sport > 8 mo/y
  - Playing to the exclusion of participation in others
  - Commitment prior to 12 y/o

Early Specialization is Child Abuse

• In addition to overuse injuries:
  – Burnout
  – Decreased satisfaction
• 235 athletes
• Mean age 13.8
• Specialized by 8.1
  – 31% single sports, 58% multiple but preferred
  – >70% collegiate or professional aspirations
  – 60% played primary sport > 9 mo/y
  – Those with an injury history are significantly more likely to play year-round
  – 1/3 told by a coach not to participate in other sports
  – 50% reported sports interfered with academic performance, with older players stating more frequently

Anatomy - Bones

• Ginglymus joint (hinge)
  – F/E
  – Sup/Pro

• Congruent – articular cartilage over a 300° arc of the trochlea

• Bony anatomy provides primary stability at opposite ends of terminal motion: < 20° and > 120°

• Radial head provides secondary restraint to valgus stress at 30°
Anatomy – Soft Tissue

- Soft tissue structures that provide static valgus elbow stability vital to overhead throwing:
  - Anterior joint capsule
  - UCL complex
  - Radial collateral ligament complex
• Functionally stabilize against valgus stress during active motion

• Flexor-pronator mass - originates off medial epicondyle
  – Pronator teres
  – FCR
  – PL
  – FDS
  – FCU
Anatomy – Nerves

- Radial
- Median
- Ulna Nerve
  - Passes just posterior to the medial epicondyle
- Superficial cutaneous nerves
Anatomy – UCL

- 3 bundles
  - Anterior
    - Provides valgus stability throughout entire ROM
    - Anterior band – full extension to 90°
    - Posterior band – isometric, 60° to full flexion
  - Transverse – does not cross elbow joint
  - Posterior – secondary stability > 90°
- Load to failure ~ 34 Nm
Thickening

- Coordinated motion that progresses from the toes to the fingertips consisting of 6 phases, ~2s
- Wind up (I) – elbow flexed, FA pronated
- Early cocking (II) ends when stride foot plants – mostly shoulder
- Late cocking (III) - elbow flexes 90-120°, FA pronated 90° arm reaches maximum ER
• Acceleration* (IV) – elbow rapidly extended up to 600,000°/s, 40-50ms
• Ball release/Deceleration (V) – 500,000°/s over 50ms as excess kinetic energy is dissipated
• Follow through (VI)– elbow reaches maximum extension
Throwing

Acceleration (IV)*

- When most elbow injuries occur
- Valgus forces approach 64 Nm
- Primarily concentrates on the anterior band of the anterior bundle of the UCL
- 300 N of shear
- 500 N of compression at the radiocapitellar joint
- Even with perfect mechanics the stresses from repetitive throwing may be the driving force to injury
Developmental Changes

- Repetitive stresses from throwing can lead to changes, and, eventually, injury in young athletes.
- Changes proximally in the kinetic chain may affect the elbow.
  - Deficits in total ROM of the shoulder have been associated with UCL tears in HS and collegiate baseball players.
    

- Inc ER due inc retroversion of humerus, capsular laxity and dec IR from bony adaptations.
Developmental Changes

- Mean dominant humeral torsion in professional pitchers: 38.5° vs 27.6°
- May be protective – higher incidence of severe injuries in players with lower deg

Developmental Changes

- 94% of competitive young baseball players have medial epicondyle apophyseal hypertrophy

Pathophysiology of Elbow Injuries

• Valgus Extension Overload (VEO)
• During the overhead throw:
  – Large valgus force
  – Humeral torque
  – Rapid elbow extension
  – Medial tensile stress
  – Posterior shear stress
  – Lateral compressive stress
First question

- What sport do you play?
History

• Most sports related injuries are caused by repetitive microtrauma
• And the underlying mechanism of injury is directly related to the biomechanics of the sport
Second question

• Where does it hurt?
• Anterior
• Medial Posteromedial
• Posterior
• Lateral
History

• Symptoms
  – Pain
  – Decreased ROM
  – Mechanical symptoms
    • Clicking, locking, popping
  – Instability
  – Paresthesias
Throwing-Specific Symptoms

• Accuracy
• Velocity
• Stamina
• Strength
• Timing of symptoms may not always be clear
  – But it is important to know when, how and whether there were any antecedent symptoms
• Changes in a throwing or training regimen should be noted
Physical

- Posture
- Arm position
  - Kept at around 70° due to an effusion
  - Flexion at lesser angles can be sign of mechanical block
- Muscle mass
- Skin – ecchymosis or incisions
- Symmetry
Palpation

• Olecranon
  – Lateral – stress fracture
  – Medial - impingment

• Medial and lateral epicondyle
  – Fracture, stress fracture, tendonitis
  – Skeletally immature athletes – apophysis or physis injuries

• Radial head
  – OCD, fracture, joint incongruency

• Soft spot - effusion
Palpation

- **Flexor-pronator mass**
  - Just distal to medial epicondyle with elbow flexed 90°
  - Wrist flexion/forearm pronation helps identify tendinous mass, accentuate pain and differentiate from UCL pathology

- **Cubital tunnel encloses ulnar nerve**
  - Posterior to medial epicondyle
  - Subluxation – full extension to flexion w/o pressure to assess
Stability Tests

• Valgus instability
  – Patient seated or supine (if supine, then maximum ER)
  – Flex 30°
  – Forearm fully pronated
  – Valgus stress
  – Always compare to contralateral side
  – Increased opening or reproduction of pain and think UCL injury
Stability Tests

• Milking maneuver
  – Posterior band of UCL
  – Forearm supinated fully
  – Elbow flexed > 90°
  – Humerus at side
  – Thumb may be pulled laterally by athlete or examiner
  – Pain, instability or apprehension is indicative of UCL injury
Stability Tests

• Moving valgus stress test
  – Athlete seated
  – Forearm supinated
  – Elbow slightly flexed
  – One hand on posterior humerus and the other on volar forearm
  – Rapid extension with valgus stress
  – Pain indicates impingement of the posteromedial tip of the olecranon on the medial wall of the olecranon fossa
Imaging

- X-ray – trauma
- CT – stress fractures
- MRI – soft tissues
4 Zones of Injury

Anterior
• Biceps tendonitis

Medial
• UCL
• Ulnar neuropathy
• Flexor-pronator injury
• Epicondyle avulsion or apophysitis
• VEO

Lateral
• Olecranon stress fracture
• Panner’s/OCD
• Tennis elbow

Posterior
• Olecranon apophysitis
• Avulsion fracture
• Osteophytes
• Triceps tendonitis
UCL Injury

- Treatment is based upon the extent of damage
  - Partial tears may be managed non-op in lower demand athletes
  - Overhand athletes more likely to fail non-op
- In general, 3 choices of treatment:
  1. Non-op
  2. Repair with internal brace
  3. Free tendon reconstruction (Tommy John)
UCL Non-op

- Majority of cases (non-throwers)
- If thrower, then in hinged brace to prevent valgus stress with extension block
- 2 weeks of active rest
- Re-evaluate
- If still tender, then 4 more weeks of rest from throwing
UCL Non-op

• First phase:
  – Cryotherapy
  – E-stim
  – I generally avoid NSAID’s (may delay healing)
  – ROM of elbow AND shoulder
  – Shoulder strengthening exercises that do not put valgus stress on elbow
  – Scapular-based exercises
  – Core and LE strengthening as long as no gripping heavy weights or resistance bands
  – Wrist and FA isometrics as tolerated
UCL Non-op

• Second phase:
  – Increase ROM
  – Begin isotonics
    • Medial dynamic stabilizers, b/c function decreased in face of UCL injury
      – Pronator teres
      – FCU
      – FDS


  – Advance shoulder strengthening (may begin shoulder IR strengthening if no pain)
UCL Non-op

• Third phase:
  – Continue to regain ROM
  – Isokinetics
  – Thrower’s 10
  – Begin plyo’s
  – Interval Throwing Program (no sooner than 6 weeks)
    • Normal functional patterns
    • Pain-free
    • Full ROM
    • Valgus stress test is negative
UCL Non-op

- **Platelet Rich Plasma (PRP)**
  - 34 athletes with confirmed PT (Grade II) UCL tears
  - Failed 2 months non-op
  - 1 injection
  - PT
  - 30/34 (88%) RTP by avg. of 12 weeks
  - 2 injections
  - 22/23 (96%) RTP and showed reconstitution on MRI


UCL Reconstruction

- UCL Reconstruction (Tommy John) first described by Dr. Jobe in 1986 (although performed in 1974) and is still the Gold Standard for treatment of overhead athletes that want to RTP
- Many modifications since
- Results encouraging with RTP 66.7% - 97%
UCL Reconstruction

- Jobe Technique
  - Harvest Ipsilateral Palmaris Longus
  - Bone tunnels
  - Reflect F-P mass**
  - Transpose nerve**
  - **Later modified to split muscle and leave nerve
UCL Reconstruction

- Docking Technique
- DANE
- Cortical Buttons
UCL Surgery

• Rehabilitation is lengthy process
  – Posterior splint in gentle flexion for 7 days
  – Functional brace at 7 days with motion stops
  – Gradual increase ROM 4-8 weeks
  – Protected strengthening and conditioning (no shoulder ER or valgus stress before 6 weeks)
  – Rehab holiday 8-14 weeks
  – Interval Throwing Program by week 17
  – 7 Months – mound progression
  – 10 Months – live batters
  – 12 – 18 Months - RTP
If reconstructions do so well, then why should we repair?

Early reports led us to believe that repair was inferior to reconstruction, but perhaps we were trying to repair the wrong patients.

For over a decade, repair was abandoned.

Repair probably best for younger patients with more robust tissue, avulsion type injuries.

Repair is typically augmented with think, braided suture and PRP.

Recovery may be half the time.

Dugas J, et al. AOSSM 2016 Specialty Day
• Repetitive, near-failure tensile stresses create microtrauma and attenuation of the anterior UCL → valgus instability

• Continued shear stress and impingement in the posterior compartment lead to olecranon tip osteophytes, loose bodies, and articular damage to the posteromedial trochlea
• Subtle laxity in the UCL also leads to stretch of the other medial structures, including the flexor-pronator mass and ulnar nerve.
• Extrinsic valgus stresses and intrinsic muscular contractions of the flexor-pronator mass lead to tendonitis
• Ulna neuropathy – susceptible to traction, compression, and irritation
• In setting of attenuated UCL or physiologic laxity
• Posteromedial pain during extension (late acceleration) or follow-through
• Inflammation of joint
• Loose bodies can cause locking or catching
• If trial of non-op management, then stress eccentric strengthening of elbow flexors
VEO – Surgical Management

• Most common diagnosis requiring surgery in baseball players


• Arthroscopic debridement and removal of loose bodies

• May address other issues – OCD’s, hypertrophied synovium, undersurface tears UCL

• DO NOT REMOVE > 3 mm of posteromedial olecranon ➞ will unmask attenuated UCL

Ulnar Neuropathy

- Second most common of the upper extremity
- Medial elbow pain, N/T into RF/SF
- Compression
  - Arcade of Struthers, intermuscular septum, medial triceps, cubital tunnel, FA muscles
- Traction
  - During acceleration phase
- Irritation, friction
  - F-P tendonitis, elbow synovitis, subluxation
Ulnar Neuropathy

• Non-op
  – Activity restriction, NSAIDs, elbow pad
  – However, in overhead athletes typically stems from an underlying cause that returns when throwing resumes

• Surgery
  – Subcutaneous transposition
Flexor-Pronator Injury

- Provides dynamic stability against valgus forces (acceleration phase)
- Acute rupture is rare
- Tendonitis and acute partial muscle tears
- Pain during late cocking and acceleration
- Always beware hidden UCL tear
Flexor-Pronator Injury

• Tender more anterior than UCL
• Pain with resisted wrist flexion, forearm pronation and elbow extension
• Active rest, ice, PT, gradual RTP
• Corticosteroid shots are generally avoided as so close to UCL
Little League Elbow

- Medial side stress injuries that occur in skeletally immature throwers
- Medial epicondylar center is last to fuse (17 y/o males)
- > 50% of Little League pitchers or older adolescents will develop medial elbow pain


- Both static and dynamic stabilizers of the medial elbow attach to the medial epicondyle
- Inadequate rest
Medial Epicondyle Avulsion

- Sudden pop while throwing
- Minimally displaced respond well to splint < 7 days, then early motion
- Displacement > 5mm may necessitate internal fixation

Olecranon Stress Fractures

• Combination of factors
  – Repetitive microtrauma from overhead throwing
  – Excessive tensile stresses from triceps
  – Posterior impingement of olecranon


• Pain may be posteromedial or – lateral

• Percussion may be indicative

Olecranon Stress Fractures

• Initial rest from throwing and immobilization
• ROM brace or orthosis blocking terminal 20° extension for 4 weeks
• Allow full ROM at 4 weeks if pain free
• Gradually increase resistance
• Avoid valgus stress for 6 weeks
• Interval throwing program by 8 weeks
Panner’s Disease

• Necrosis of the capitellum followed by recalcification
• 7-12 years old
• Typically present with pain, swelling and flexion contracture
• Rest from throwing and likely heal
OCD of the Capitellum

- Repetitive compressive forces upon the radiocapitellar joint
  - Subchondral changes of the capitellum
  - May lead to loose body formation
- 13-16 years old
- Complain of lateral elbow pain on palpation and with valgus stress
- Loss of extension of 5-20°
- Swelling
- Crepitus
OCD of Capitellum

• In younger athlete, non-op management may be successful

• Arthroscopic removal of loose body and debridement leads to fair results
  – ~ 50% RTP
  – Better outcomes in younger patients and lesions < 50% capitellar width
  – When larger or uncontained, then OATS
Preventing Injuries in Young Athletes

- Discourage single sport specialization
- Early recognition and treatment
- Correct biomechanics
- Pitch count limits
- 3 month break from throwing sports in particular
THANKS!

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