Evaluation and Management of Common Orthopaedic Injuries: Elbow

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Goals of this Presentation

• Review the relevant anatomy and biomechanics of the elbow
• Review the common injuries and pathologic conditions seen in the elbows of athletes
• Review On-Field Management and treatment options
• Follow the Sideline Emergencies App
Anatomy

- Modified hinge with three articulations
  - Ulnotrochlear
  - Radiocapitellar
  - Proximal radioulnar

- All contained within a single synovial lining
Ligament Anatomy

- Radial Collateral Ligament
- Annular Ligament
- Accessory Collateral Ligament
- Lateral Ulnar Collateral Ligament
- Anterior band (nonisometric bundle)
- Isometric bundle
- Area of attachment of muscle fibers
- Intermediate area
- Posterior band
- Transverse band

Aggressively Pursuing Victory Over Injury
Anatomic Stability

- 2/3 of valgus elbow stability in full extension is provided by the ulnohumeral articulation and the anterior joint capsule.

- Only in flexion does the anterior band of the UCL become the main stabilizer to valgus stress.
Anatomic Stability

• The radial head is a secondary stabilizer to resist valgus stress

Anatomy

- Dynamic Stabilizers

- Flexor Pronator muscle group
- Anconeus
- Biceps
- Triceps
- Extensors (mobile wad)
Elbow Traumatic Injuries
Elbow Dislocation
History

- FOOSH (Fall Onto OutStretched Hand)
- Varus/Valgus, supination, and axial load
- Direct Blow to extended elbow
Aggressively Pursuing Victory Over Injury
Elbow Dislocations - Evaluation

• Straightforward in acute setting
  – pain, swelling, deformity, painful motion
• Palpation will demonstrate abnormal position of radial head/olecranon relative to humerus
• NEUROVASCULAR EXAM
  – pre and post-reduction (ulnar/median)
• Wrist and shoulder must be examined
  – 10-15% associated injury
  – interosseous membrane of forearm (DRUJ)
Elbow Dislocations
On Field Management

• Generally Posterior
• Attempt Reduction ASAP (on field, medical tent, locker room)
• Longitudinal Traction of Forearm with assistant stabilizing humerus
• Check NV status pre- and post-reduction
Evaluation
Radiographs

• Associated fractures (25%):
  1) Radial head
  2) Coronoid
  3) Epicondyles
  4) Osteochondral fractures in nearly 100%

Classification

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Elbow Dislocation

**Treatment**

- Evaluate stability after reduction
- Early Range Of Motion
- Never immobilize > 2 weeks
- Unacceptable loss of ROM if immobilization > 3 weeks
  - Mehlhoff et al, 1988
  - Broberg and Morrey, 1987
- Follow up x-rays to confirm maintenance of reduction
Elbow Dislocation

Treatment

• Indications for operative treatment
  – Cannot obtain concentric reduction
  – Gross instability (requires flexion >50-60 degrees to remain reduced)
  – Entrapped osteochondral fracture
  – Unstable fractures
Elbow Dislocation

Complications

- Residual Pain - 45%
- Loss of extension - 30%
- Pain with valgus stress - 35%
- Heterotopic ossification - 75%
- Arthrofibrosis
- Recurrent dislocation (posterolateral)
- Persistent neurologic deficit
Elbow Dislocation

Return to Play

• Current Game: NO!
• Estimated RTP: 1-2 weeks with Brace/protection - depends on sport/position
• Key Points:
  – Don’t Splint >2 weeks (stiffness)
  – Allow early active ROM within the “Stable Arc of Motion”
Radial Head Fracture
History

- FOOSH (Fall Onto OutStretched Hand)
- Valgus, supination, and axial load
Radial Head Fracture

Concerns in Athletes

• Very Uncommon
• Generally seen with elbow subluxation & Medial (UCL) injury
• Treat like Complex Elbow Dislocation
• Displacement requiring reduction
• Loose bodies/ chondral fragments
• RTP: same game NO
  – Depends on position/ stability
  – Usually 6-8 weeks
Medial Epicondyle Injuries
Medial Epicondylar Fracture

- 2 Types seen on-field (Traumatic Valgus Stress vs Overhead athlete)
- Both generally need to be fixed if displaced
  - Traumatic Valgus Stress/ elbow subluxation in adolescents- fracture through medial apophysis- treat like elbow dislocation
  - Overhead thrower- Acute Apophyseal avulsion- ORIF if ANY displacement
Thrower’s Elbow
Why does the Elbow Hurt?

• Throwing a baseball overhand is not a natural activity
• Until 1865 baseball was pitched underhand (like fast pitch softball)
• Pitchers routinely threw >400 innings/ season – Injury was uncommon
Why does the Elbow Hurt?

• High forces are generated during overhand throwing

• Rapid Elbow motion up to 7000 degrees/second
Biomechanics of Throwing
100 ‘Elite’ Professional Pitchers: evaluated in the past 5 years, averaged ≥88 mph during testing, healthy for ≥1 year

ASMI Biomechanical Evaluations: 1989-present

5000+ Pitchers

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Cy Young Winners Tested


1993 CY

2002 CY

2003, 2010 CY

2006 CY

2007 CY

2008 CY

2009 CY

2015 CY

2018 CY

Aggressively Pursuing Victory Over Injury
Windup

- Generate potential energy
- Ends at maximum knee height
- Low force/torque on elbow
Stride

- Elbow extends, then flexes
- Ends at lead foot contact
- Elbow flexion = 90°
Arm Cocking

- Elbow flexion = 90° throughout phase
- Ends at shoulder maximum external rotation (MaxER)
- Maximum varus torque occurs ~MaxER
Arm Acceleration

- Elbow extension velocity = 2300°/s
- Energy is delivered to the baseball
- Ends at ball release, elbow flexion = 20°
Deceleration and Follow-Through

- Eccentric forces decelerate arm
- Large body parts dissipate energy
- Balance necessary to field position
Pathomechanics
Critical time periods

Maximum External Rotation  
Ball Release

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UCL Injury Mechanism

- Valgus Torque = 100 Nm
- ~60 lbs pulling down on hand
- ~Five hanging bowling balls
- Equivalent varus torque needed
Biomechanics

• Varus torque = 100 N-m
• UCL resists 33 % = 33 N-m
• Estimated Failure load of UCL = 32 N-m

The UCL experiences Near-Failure Loads with Each Pitch
(Worse with High Velocity >90 mph)
Lateral Elbow

- Radiocapitellar = ~33% of varus torque
- 33% of 100 Nm = 33 Nm
- 33 Nm / 0.04 m = 825 N = 185 lbs of force
Valgus Extension Overload

- Elbow varus torque = 100 Nm
- Elbow extension velocity = 2300°/s

Aggressively Pursuing Victory Over Injury
Valgus Extension Overload
Cyclical relationship

Valgus Extension Overload

UCL Injury

Osteotomy

Aggressively Pursuing Victory Over Injury
Medial Injuries
Valgus Extension Overload

- Medial tensile stress
- Lateral compression
- Forced extension
UCL Surgery in MLB (Conte)
1974-2015

No. of Tommy Johns
1974-2015
Prevalence of UCLr (Conte)

- 1 in 4 Major League Pitchers have undergone UCLr
- 1 in 7 Minor League Pitchers have undergone UCLr.
- 16% Prevalence Rate for All Pitcher (Major + Minor)

<table>
<thead>
<tr>
<th>Level</th>
<th>UCL prevalence</th>
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<tr>
<td>Current level</td>
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<td>&lt;0.001</td>
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<tr>
<td>Major League</td>
<td>25% (96/382)</td>
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<tr>
<td>Minor League</td>
<td>15% (341/2324)</td>
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SAN DIEGO -- Padres right-hander Mike Clevinger underwent Tommy John surgery on his right elbow and will miss the 2021 season, delivering an early blow to an upstart team with serious hopes of contending next year.

The club made the announcement on Monday, simultaneously noting that Clevinger has agreed to a two-year, $11.5 million contract which buys out his two remaining arbitration seasons.
Medial Elbow Pathology

**UCL Injury**

- UCL is the main medial stabilizer of the elbow
- Anterior bundle is the primary structure involved in throwing
UCL Injury
Overhead Athlete

• History:
  - Acute medial pain (50%)
  - Unable to throw >75% without pain
  - Loss of control
  - “Pop” heard or felt (less than 50%)
  - Previous Hx of pain, steroid injection, treatment for tendinitis (common)
UCL Injury
Overhead Athlete

• Physical exam:
  - Medial elbow ecchymosis
  - Ulnar nerve symptoms
  - Tender at ant. bundle
  - Difficult exam:
    +/- instability (1-2mm),
    dynamic testing???
UCL Stress Test - Seated
UCL Stress Test - Supine
UCL Stress Test - Prone
Milking Maneuver
Arthrogram MRI (MRA)

- Diagnostic test of choice for Thrower’s
- High rate of asymptomatic UCL tears

“If you want to operate on a baseball player, just get a MRI”  Dr. Andrews
Partial Tears

- Intact external layer
- Detached/frayed/torn inner layer

MRI Arthrography
- No contrast dye leak
- “T sign”
Partial UCL Tear

• Active rest:
  - Mild severity 6-8 weeks
  - Moderate severity 3-4 months

• Rehab exercise
  - Progressive elbow & shoulder program

• Interval throwing program
Operative Management

• Only after conservative failure
  – May operate acutely if completely ruptured or avulsed (more common in gymnasts)

• Consider goals of patient
  – If patient does not plan to throw, may not need to be fixed
UCL Reconstruction Surgery

“Tommy John” operation
UCL Reconstruction

- Free autogenous tendon graft
  - Palmaris Longus
  - Gracilis
- Bone tunnels
- Different fixation techniques
Augmented UCL Repair with Internal Brace
UCL Reconstruction

Operative Technique

• Lab Demo to come.........
Lateral Injuries
Osteochondritis Dissecans of the Elbow (capitellum)

• Young athletes ages 11-20 yrs
  – Not to be confused with Panner’s disease (osteochondrosis)
    • typically younger age < 10 yrs

• Males > Females

• Repetitive overhead and upper extremity weightbearing activities
  – Throwing athletes
  – Gymnasts
  – Tennis
  – Volleyball

• Usually affects dominant upper extremity
  – Bilateral involvement in up to 20%
Pathophysiology

- Repetitive microtrauma & Vascular insult theory
  - Repetitive loading of the lateral compartment
  - Capitellar epiphysis with tenuous blood supply
  - Leads to subchondral bone degeneration and cartilage fragmentation/shearing
Clinical Presentation

• Elbow pain and stiffness
  – Insidious & activity-related onset
• Decreased ROM
  – Typically mild loss of extension
• TTP over lateral elbow
• +/- mild elbow effusion
• +/- mechanical symptoms
  – Catching
  – Locking
  – Grinding
Imaging

- **Radiographs**
  - AP & Lateral initially to confirm diagnosis
  - Well-defined subchondral lesion

- **MRI**
  - Useful for assessing:
    - Size of the lesion
    - Extent of subchondral edema
    - Cartilage
    - Stable vs Unstable lesions
Treatment

• Non-operative
  – Indicated for symptomatic stable lesions
  – NSAIDs
  – Brief immobilization
  – Physical Therapy / Rehab
  – Shut’em down
    • 6-8 weeks of restricted activities until pain resolves
    • Slow gradual progression back to activities over next ~6-12 weeks
Treatment

• Operative
  – Indicated for unstable lesions
    • Arthroscopic debridement +/- MicroFx or drilling
    • *Open debridement w/ LBR*
    • Fixation of larger lesions
    • Osteochondral autograft or allograft transplantation
Our Experience at ASMI

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<th>Surgeon</th>
<th># Patients</th>
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<tr>
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<td>19</td>
<td>25.7%</td>
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<tr>
<td>Cain</td>
<td>36</td>
<td>48.6%</td>
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<tr>
<td>Dugas</td>
<td>13</td>
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<td>Emblom</td>
<td>6</td>
<td>8.1%</td>
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<td>58</td>
<td>78.4%</td>
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<tr>
<td>Left</td>
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<td>21.6%</td>
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<td>Yes</td>
<td>58</td>
<td>78.4%</td>
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<tr>
<td>No</td>
<td>15</td>
<td>20.3%</td>
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<tbody>
<tr>
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<td>50</td>
<td>71.4%</td>
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<tr>
<td>Female</td>
<td>20</td>
<td>28.6%</td>
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- Mean age at time of surgery = **14.8 yrs** (range, 11.4 - 21.9)
- Mean follow-up = **8.4 yrs** (range, 2.1 - 18.8)
OCD Capitellum

Our Results at ASMI

• Arthroscopic debridement +/- microfracture of capitellar OCD lesions yielded very good results with return to competition in 90% of patients at an average time of 5.5 months and satisfactory outcomes scores at mean f/u of 8.4 years.
Posterior Injuries
Valgus Extension Overload Syndrome

Late Cocking/Early Acceleration Phase
Valgus Stress
Posteromedial Impingement
Osteophyte Formation

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Valgus Extension Overload Syndrome

“In the early phase of acceleration, excessive valgus stress causes a wedging effect on the olecranon into the fossa leading to osteophyte formation at the posteromedial olecranon tip”

Wilson and Andrews 1983
Valgus Extension Overload Syndrome

• Physical Exam:
  - Posterior elbow tenderness
  - + VEO test (valgus + rapid extension)

• X-ray: posteromedial olecranon osteophyte
Surgical Technique
Elbow Arthroscopy
“Thrower’s Stress Fracture of the Olecranon”

• Gradual onset

• Ill-defined pain

• Pain may be at proximal ulnar shaft
  – Medial or lateral
  – Usually Posterolateral Pain

• Diagnosis by exclusion and suspicion
“Thrower’s Stress Fracture of the Olecranon”

- X-ray (negative early, sclerosis later)
- Bone scan (frequently hot in thrower’s anyway)
- CT, Tomogram, MRI, definitive
Olecranon Stress Fracture
Olecranon Stress Fracture

Aggressively Pursuing Victory Over Injury
“Thrower’s Stress Fracture of the Olecranon”

• Conservative
  – Active rest
  – Gradual return when symptoms abate
  – Bone Stimulator
  – Prevention of terminal extension

• Surgical
  – Drilling and internal fixation
Olecranon Stress Fractures

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Delayed Union
Olecranon Apophysitis

• Early and continued stress from throwing from a young age
• Apophysis doesn’t close
• Normally begins closing around age 14, often delayed in throwing athletes
Other Elbow Pathologies
Flexor-Pronator Injuries

• Acute tear vs. chronic tendinosis
  – Bony or soft tissue avulsion from ME
  – Intrasubstance injury
Flexor-Pronator Injuries

• Active Rest
  – More shoulder than elbow exercise to avoid continuation of symptoms
  – Corticosteroid injection
  – Gradual return to elbow exercise

• Interval throwing program
• Mild - 3-6 weeks
• Severe - 4-6 months
Flexor-Pronator Injuries

• Failure of conservative measures is indication for surgical management

• Small medial incision to inspect flexor fascia
  – Open fascia in line with fibers

• Inspect insertion onto ME
  – If tear is present, direct repair
    • Tissue to bone if avulsed, tissue to tissue if intrasubstance

• If degenerative, debride diseased tissue, abraid bone to create bed for healing
  – Anchor to bone?
Pronator Syndrome
Median Nerve Neuropathy

Classic: Compression of the Median Nerve

1. Between 2 Heads of the Pronator Teres m.
2. Beneath the Lacertus Fibrosus
3. Ligament of Struthers
4. Fibrous Arch of the FDS
5. Accessory FPL (Gantzer m.)
Pronator Syndrome  
Median Nerve Neuropathy


**Primary myoses in the M. pronator teres as cause of lesion of the N. medianus (the pronator syndrome).**  
SEYFFARTH H.

1976 *Journal of Neurology*  
Morris and Peters  
Reported 7 cases  
*One of which was a Baseball Player*

San Francisco Giants Pitcher 2017  
Described as Pronator Syndrome  
But no mention of Median N. Sx

He underwent a Lacertus Release
Pronator Syndrome  Anatomy

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Lacertus Syndrome

- Biceps
- Brachial artery
- Median nerve
- Pronator teres
- Lactertus fibrosus
- Radial artery
- Pronator teres (superficial head)
- Pronator teres (deep head)
- FDS arch (sublimis bridge)
- FDS

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Physical Exam

After Throwing

- Reproduction of Discomfort
- “Cobra position”
- Distinct Fullness
- Indentation along the Lacertus

Aggressively Pursuing Victory Over Injury
Lacertus Syndrome

Physical exam

After Throwing
Lacertus Syndrome  Surgery

Aggressively Pursuing Victory Over Injury
Surgery  Simple Fasciotomy

Aggressively Pursuing Victory Over Injury
Lacertus Syndrome

- Awareness and Athletic Trainers
- Post Exertional “Compartment -Like”
- Exam After Throwing
- Traditional Work-up

- Simple Surgery
- Simple Recovery
Conclusions

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Conclusions

• Many types of Elbow Pathology in Athletes
• Different Pathology
  – Traumatic Injury vs
  – Overhead Athletes
• Early diagnosis and management is crucial
• Early Range of motion is one of the keys to success in any elbow pathology
  – Early management of pain, swelling
  – Minimal immobilization
  – Early Physical Therapy is key
THANK YOU

Aggressively Pursuing Victory Over Injury