Nonoperative Treatment of Ulnar Collateral Ligament Injuries in the Throwing Athlete

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Head Team Physician, Philadelphia Phillies
Faculty Disclosure

- Consultant – Stryker Endoscopy
- Consultant – Venture MD
- Research Support – Arthrex
- Board/Committee Membership –
  - Orthopaedic Learning Center BOD
  - MLB Medical Advisory Committee
  - MLB Elbow Research Study Group
  - AOSSM Fellowship Committee
History

- 17 y.o. RHD elite high school pitcher
- Acute R medial elbow pain while throwing one pitch
- Unable to throw
History

- 19 y.o. RHD elite collegiate pitcher
- Progressive right medial elbow pain and stiffness for 6 months
History

- 25 y.o. RHD pro pitcher
- Right medial elbow pain and stiffness after 6 plus innings
- Able to recover by next start
Elbow Injury

... Injury to the Ulnar Collateral Ligament
WHAT’S the **BIG DEAL**?  

...Epidemiology
HOW BIG IS THE PROBLEM?

$1 BILLION$

- ANKLE $50 MILLION
- BACK $140 MILLION
- SHOULDER $250 MILLION
- ELBOW $200 MILLION
- KNEE $160 MILLION
- HAMSTRING $110 MILLION
- WRIST/HAND $80 MILLION

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Elbow Injuries in Professional Baseball: Epidemiology from the Major League Baseball Injury Surveillance System

Michael G. Ciccotti MD
Keisha Pollock PhD
Michael C. Ciccotti MD
John D’Angelo BA
Christopher Ahmad MD
Dave Altchek MD
James Andrews MD
Frank Curriero PhD
## Epidemiology of Professional Baseball Elbow Injuries

### Table 1:

<table>
<thead>
<tr>
<th>Level of Play</th>
<th>N (%)</th>
<th>Age Mean (Std)</th>
<th>Days Missed Mean (Median)</th>
<th>Required Surgery</th>
<th>Re-Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>2,753 (81.2%)</td>
<td>22.8 (3.2)</td>
<td>27.9 (13)</td>
<td>487 (17.7%)*</td>
<td>61 (2.2%)*</td>
</tr>
<tr>
<td>Major</td>
<td>637 (18.8%)</td>
<td>28.9 (3.9)</td>
<td>27.8 (12)</td>
<td>122 (19.2%)*</td>
<td>19 (3.0%)*</td>
</tr>
<tr>
<td>Total</td>
<td>3,390</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Percent calculated within Level of Play
## Epidemiology of Professional Baseball Elbow Injuries

<table>
<thead>
<tr>
<th>Minor &amp; Major League</th>
<th>Frequency</th>
<th>Requiring Surgery</th>
<th>Days Missed Non-Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Event Position</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitcher (Defense)</td>
<td>N (33.3%)</td>
<td>N (34.2%)</td>
<td>32.0 (20.5)</td>
</tr>
<tr>
<td>Position Player (Defense)</td>
<td>316 (9.3%)</td>
<td>64 (20.3%)</td>
<td>17.1 (9.0)</td>
</tr>
<tr>
<td>Base Runner (Offense)</td>
<td>24 (0.7%)</td>
<td>3 (12.5%)</td>
<td>13.5 (4.0)</td>
</tr>
<tr>
<td>Batter (Offense)</td>
<td>437 (12.9%)</td>
<td>8 (1.8%)</td>
<td>4.1 (2.0)</td>
</tr>
<tr>
<td>Not Classified</td>
<td>1,484 (43.8%)</td>
<td>148 (10.0%)</td>
<td>27.6 (15.0)</td>
</tr>
</tbody>
</table>
# Epidemiology of Professional Baseball Elbow Injuries

## Table 3:

<table>
<thead>
<tr>
<th>SMDCS</th>
<th>Diagnosis Type</th>
<th>Ligament</th>
<th>Tendon</th>
<th>Nerve</th>
<th>Bone</th>
<th>Misc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ligament</td>
<td>-UCL</td>
<td>730</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>-Other</td>
<td>116</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Tendon</td>
<td>-Medial</td>
<td>0</td>
<td>272</td>
<td>0</td>
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<tr>
<td></td>
<td>-Lateral</td>
<td>0</td>
<td>98</td>
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<tr>
<td></td>
<td>-Other</td>
<td>0</td>
<td>255</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Nerve</td>
<td>-Ulnar</td>
<td>0</td>
<td>0</td>
<td>224</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>-Other</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bone</td>
<td>-Post Imping</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>93</td>
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<tr>
<td></td>
<td>-Fracture</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>38</td>
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<tr>
<td>Cartilage</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Loose Body</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>89</td>
<td>0</td>
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<tr>
<td>Misc</td>
<td>-Bursitis</td>
<td>0</td>
<td>43</td>
<td>0</td>
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<td>0</td>
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<td></td>
<td>-Contusion</td>
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<td>0</td>
<td>724</td>
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<tr>
<td></td>
<td>-Infection</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>-Other</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>654</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>851</td>
<td>666</td>
<td>248</td>
<td>128</td>
<td>1,497</td>
</tr>
</tbody>
</table>

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# Epidemiology of Professional Baseball Elbow Injuries

**Table 5:**

<table>
<thead>
<tr>
<th>Diagnosis Type</th>
<th>Minor League</th>
<th>Major League</th>
<th>Minor &amp; Major League</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>%Yes*</td>
</tr>
<tr>
<td>Ligament</td>
<td>430</td>
<td>290</td>
<td>59.5%</td>
</tr>
<tr>
<td>Tendon</td>
<td>474</td>
<td>25</td>
<td>5.1%</td>
</tr>
<tr>
<td>Nerve</td>
<td>177</td>
<td>21</td>
<td>4.3%</td>
</tr>
<tr>
<td>Bone</td>
<td>38</td>
<td>60</td>
<td>12.3%</td>
</tr>
<tr>
<td>Misc</td>
<td>1,147</td>
<td>91</td>
<td>18.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,266</td>
<td>487</td>
<td></td>
</tr>
</tbody>
</table>
Predictable Series of Events in Throwers

- Progressive osseous changes
- Peri-elbow muscle weakness
- Peri-elbow Soft Tissue contracture
- Flexor-Pronator Strain in Late Cocking/Acceleration/Follow-thru phases of throwing
- **UCL** injury can occur
- Ulnar Nerve Irritation/symptomatic subluxation

General population is not routinely exposed to this “cascade of events”... but throwers are!
WHAT’S THE BIG DEAL?

... Epidemiology confirms UCL injury importance

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HOW BAD IS IT?

... Spectrum of Injury
Anatomic Stabilizers

- **Anterior Band** is primary valgus restraint (30-120 deg)
UCL Injury in the Overhead Athlete

Spectrum of Injury

- Injury in-continuity
- Partial Tear
  - Proximal
  - Mid-Substance
  - Distal
- Full Tear

Extremely difficult to determine degree of injury by physical exam . . . but perhaps imaging can help?
Stress Ultrasound Evaluation of Medial Elbow Instability in a Cadaveric Model

Michael C. Ciccotti MD
Sommer Hammoud MD
Christopher Dodson MD
Steven Cohen MD
Levon Nazarian MD
Michael G. Ciccotti MD
Methods

- 12 cadaveric elbows
- Baseline stress ultrasound (SUS) of the medial elbow at 30 degrees of flexion both at rest and with applied Telos valgus force (15lbs)
- Sequential sectioning of medial elbow structures was then carried out
- SUS with Telos valgus stress (15lbs) performed at each step of sectioning
## Results

<table>
<thead>
<tr>
<th>Delta’s (Combined Sectioning Sequences)</th>
<th>Mean Increase in Laxity</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition of Stress</td>
<td>1.1 mm</td>
<td>0.5-1.8 mm</td>
</tr>
<tr>
<td>Transverse Band Cut (1st seq)</td>
<td>0.7 mm</td>
<td>0.2-1.3 mm</td>
</tr>
<tr>
<td>Posterior Band Cut</td>
<td>0.9 mm</td>
<td>0.3-1.3 mm</td>
</tr>
<tr>
<td>Ant. Portion of Ant. Band Cut (1st Seq)</td>
<td>2.0 mm</td>
<td>1.1-2.8 mm</td>
</tr>
<tr>
<td>Post. Portion of Ant. Band Cut (2nd Seq)</td>
<td>1.4 mm</td>
<td>0.6-2.2 mm</td>
</tr>
<tr>
<td>Entire Anterior Band</td>
<td>3.4 mm</td>
<td>2.4-4.3 mm</td>
</tr>
<tr>
<td>Flexor-Pronator Mass Cut (2nd seq)</td>
<td>0.5 mm</td>
<td>0.0-0.9 mm</td>
</tr>
</tbody>
</table>
MR CLASSIFICATION of UCL INJURY

- **MRA (Joyner et al, 2016)**
  - Type 1 – Low-grade partial UCL tear; edema in UCL only
  - Type 2 – High-grade partial UCL tear; no extravasation of contrast
  - Type 3 – Complete, full-thickness UCL tear; extravasation of contrast
  - Type 4 – Tear/pathology in >1 location (i.e.-ulna & humerus)

---

Joyner et al, JSES, 2016
Potential Utility of a Combined Ultrasound and MR Arthrography in Imaging of Medial Elbow Pain in Baseball Players

JB Roedl, MD
FM Gonzalez, MD
Adam Zoga, MD
William Morrison, MD
MT Nevalainen, MD
Michael G. Ciccotti MD
Levon Nazarian, MD

Radiology, 2016
Methods

- 144 throwers with medial elbow pain underwent both US and MRA
- 191 Medial Elbow diagnoses included:
  - UCL tear (53)
  - Flexor-Pronator Injury (59)
  - Osteochondral Injury (48)
  - Ulnar Neuritis (31)
- Sensitivity, specificity and accuracy for each diagnosis assessed for US and MRA individually and combined
Conclusions

For UCL Injury:
- US alone = 96% (Sen), 81% (Spec), 87% (Accu)
- MRA alone = 81%, 91%, 88%
- Combined US + MRA = 96%, 99%, 98%

For Ulnar Neuritis:
- MRA alone = 74%, 92%, 88%
- Combined US + MRA = 90%, 100%, 98%

For Flex-Pron and Osteochondral Injuries:
- MRA alone = 93%, 93%, 93%
- Combined US + MRA = 94%, 98%, 97%
Biomechanical Analysis of Elbow Medial UCL Tear Location and It’s Effect on Rotational Stability
Shickendanz et al, MLB TPA 2016 (Unpublished)

- 8 intact cadaveric elbows tested on simulator
- Valgus torques of 2.5Nm and 5.0Nm applied
- Resulting valgus angles applied to:
  - intact
  - partial tears (prox & distal)
  - complete tears (prox & distal)
- Posterior-Distal tears resulted in greatest instability
- Proximal tears may be more amenable to nonop tx
Stress Ultrasound Evaluation of Clinically Relevant Injury Patterns of the Ulnar Collateral Ligament in a Cadaveric Model

Michael C. Ciccotti MD
Sommer Hammoud MD
Christopher Dodson MD
Steven Cohen MD
Levon Nazarian MD
Michael G. Ciccotti MD

In Progress
Stress Ultrasonography of the Ulnar Collateral Ligament in Elite Baseball Players: A 10 Year Experience

Alfred Atanda MD
Steven B. Cohen MD
Levon N. Nazarian MD
Christopher Dodson MD
Lauren Holmes BA
Michael G. Ciccotti MD
Purpose

- To longitudinally evaluate MLB players over a 10 year period with Stress US to determine if it can be predictive of possible UCL injury and guide treatment

AJR, 2003
AJSM, 2014
Methods & Materials

- Stress US on 348 professional pitchers at each Spring Training over a 10 year period
- Mean age = 22.8 yrs
- Mean time as pro = 2.5 yrs
- Dominant and non-dominant arms

AJR, 2003
AJSM, 2014
UCL evaluated for:

- Thickness
- Hypoechoic focii
- Calcifications
- Joint space width at rest and stressed (30°)

AJR, 2003
AJSM, 2014

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Methods & Materials

- Baseline SUS data on all players
- Longitudinal comparison in players with multiple SUS during study
- Players who subsequently incurred UCL injury had pre-injury SUS findings compared to asymptomatic players

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**Phillies**

**AJR, 2003**
**AJSM, 2014**
Conclusions

Those players with:

- Dom – Non-Dom Joint Space Gapping > 1.5-2.0mm
- Dom UCL hypoechoic foci

... may be at higher risk for UCL injury and more likely to require operative treatment.
... close monitoring of ROM, strength, endurance, technique and exposure should be carried out.

AJR, 2003
AJSM, 2014
HOW BAD IS IT?

... the goal is to identify the degree of UCL injury ...

... partial tears may be most amenable to nonop treatment
HOW DO YOU FIX THAT?

... Techniques of Nonop Treatment

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Nonoperative Principles

- Multidisciplinary Approach
  - Athletic Trainers
  - Strength/Conditioning Coach
  - Skills Coach
  - Team Physicians

Reinold et al, J Ortho Sports Phy Ther 2002
Fleisig et al, J Ortho Sports Phy Ther 2011
Ciccotti & Sheridan, Orthopaedic Rehabilitation of the Athlete 2014

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Nonoperative Principles

General Protocol

- Rest for 3-6 weeks
- Heat/Ice/NSAID
- Modalities
- Continued cardio, core, lower extremity
Nonoperative Principles

SCAPULA

CORE

Hip and Legs

...Kinetic Chain...

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Kibler et al, AJSM 2003
Nonoperative Principles

**General Protocol**

- Elbow ROM as player comfort allows
- Upper extremity strengthening follows
- Swinging at 4-6 weeks
- Throwing Program at 6-12 weeks
Nonoperative Principles

**Biologic Treatments**

- PRP/Stem Cells/Combinations
- Minimal data available
- Platelet Rich Plasma mostly
- Various PRP Regimens (Leukocyte-rich/-poor)
- Spectrum of post-PRP protocols

References:
- Mishra et al, 2009
- Rodeo et al, 2009
- Peerbooms et al, AJSM, 2010
- Podesta et al, AJSM, 2013
- Dines et al, AJO, 2016
Nonoperative Principles

**Short Toss/Long Toss/Mound Programs**

- **Tossing** – progressive from 30’ to 180’
- **Mound** – fastballs first with increasing effort; then off-speed pitches
- **Focus on technique throughout**

Fleisig et al, J Ortho Sports Phy Ther 2011
Reinold et al, J Ortho Sports Phy Ther 2002
Slenker et al, AJSM 2014
Nonoperative Principles

- Monitoring After Return
  - Batting Practice
  - Simulated Games
  - Rehab Starts – Minor Leagues
  - Pitch Counts with progression

Reinold et al, J Ortho Sports Phy Ther 2002
Fleisig et al, J Ortho Sports Phy Ther 2011
Ciccotti & Sheridan, Orthopaedic Rehabilitation of the Athlete 2014
Slenker et al, AJSM 2014

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HOW DO YOU FIX THAT?

... Techniques of Nonoperative Treatment continue to evolve

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COACH, WHEN CAN I GO BACK IN?

... Outcomes & Return to Play with Nonoperative Treatment
UCL Injury in the Overhead Athlete

Nonoperative Treatment is an appropriate option . . .

“A trial of nonoperative treatment should be considered in patients with a UCL tear”

Podesta et al, PRP for Partial UCL Tear  AJSM, 2013
Ciccotti, Sheridan et al, Ortho Rehab of the Athlete, 2014
Noonan et al, Return-to-Play in Pro Baseball, AJSM, 2016
43 UCL tears evaluated for RTP and RTSP

MRI graded:
- I=intact; IIA=partial; IIB=chronic, healed; III=complete

8 complete tears
- All had UCL Recon; 75% RTP; 63% RTSP

35 incomplete tears
- 7 had UCL Recon; 100% RTP + 86% RTSP
- 28 with Nonop; 93% RTP + 93% RTSP
UCL Injury in the Overhead Athlete

Treatment of Partial UCL Tears in the Elbow with Platelet-Rich Plasma
Podesta, Crow, Yocum et al, AJSM 2013

- 34 MRI documented Partial UCL Tears
- All failed minimum of 2 months nonop tx
- Prospective Baseline and Follow-up Measures:
  - KJOC Score, DASH and Stress Ultrasound (SUS)
- All had single, US guided PRP injection + PT
- 88% RTSP
- Avg Time to RTP = 12 weeks (range: 10-15wks)
- KJOC, DASH and SUS statistically improved
Platelet-Rich Plasma Can be Used Successfully to Treat UCL Tears in Elite Throwers

Dines, ElAttrache, Conte, Osbahr, Bradley, Ahmad et al, AJO 2016

- 44 Partial UCL Tears
- # of PRP injections:
  - 16 (one); 6 (two); 22 (three)
- Interval Throwing Program when asymptomatic
- Outcome:
  - 32 (73%) Excellent/Good; 2 (4%) Fair; 10 (23%) Poor
- Mean time to Throw = 5 weeks
- Mean time to RTP = 12 weeks
MLB Elbow Study Group
I - Epidemiology of Elbow Injuries in Professional Baseball

II - Epidemiology of UCL Injury in Professional Baseball

III - Risk Factors for UCL Injuries in the Professional Pitcher: A Prospective Study

IV – Nonoperative Treatment of UCL Injuries in Professional Baseball
Leave it alone if . . .

- Clinically low grade injury
- MR evidence of:
  - Partial Tear
  - Proximal/Mid-substance
  - No attritional/degenerative changes
- SUS evidence of:
  - Partial Tear
  - <2mm difference stressed-unstressed injured elbow
  - <1-1.5mm difference stressed from injured to uninjured elbow
- Non-throwing, recreational athlete
Summary

- UCL injury is epidemiologically a big deal . . . particularly in baseball
- There is certainly a spectrum of injury . . . partial to complete and imaging may help determine
- Nonop treatment should be considered . . . particularly for proximal partial injury
- Outcomes, Return-to-Play and Return-to-Prior Level must all be determined . . . for optimal care
Future Directions

- Evaluation of all levels of baseball players (professional, collegiate, high school and youth)
- Consider other factors that may lead to apparent “epidemic” of UCL injuries
- Identify methods of precisely determining the degree of UCL injury
- Determine long term outcomes of nonoperative treatment using sports specific metrics
THANK YOU.
The current study indicates that:

- SUS can identify progressive laxity of medial elbow structures
- Anterior Band is the greatest contributor to medial elbow stability
- This data allows correlation of SUS findings in the injured athlete with anatomic damage to specific medial structures
Conclusions

- Statistically significant added diagnostic value was noted with combined ultrasound and MR arthrography for medial elbow pain in the throwing athlete
- Most especially for UCL injury

Radiology, 2016