I (and/or my co-authors) have something to disclose.

Detailed disclosure information is available via:

The course syllabus, or

AAOS Disclosure Program on the AAOS website at http://www.aaos.org/disclosure

What is the UCL?

Primary restraint to valgus force at 30°-120°

3 Bundles

- Anterior Bundle
- Anti/Post Bands
- Posterior Bundle
- Transverse Bundle

Hypertrophy in MLB Pitchers
Scope of the Problem

- Affects athletes of any age engaged in overhand throwing sports.
  - Since 2000 there has been a 5-fold increase in shoulder/elbow injuries in youth baseball players.
  - Similar increase in the numbers of operative reconstructions required.

Professional Athlete

- 1 in 3 MLB Pitchers have required surgery for elbow.
- Over 200 - 500 Million $ in cumulative salaries miss time on the DL each year.

PearlDiver Database Study

2007 – 2011
790 patients underwent UCLR
695 males, 95 females

Avg annual incidence:
3.96 per 100,000 for the overall population
22 per 100,000 for patients aged 15 to 19 years.

Overall average annual growth was 4.2%.

Incidence of UCLR in the 15- to 19-year-old group increased at an average rate of 9.12% per year ($P = .009$)
Pitching Flaws and UCL Injuries

However, could not report on:

- Graft choice
- Surgical technique
- Management of ulnar nerve
- Concomitant Arthroscopy

Public Data

No central location to access all data
Has to be created by an individual

Many recent studies using public data:

- RTS following ACLR in NHL Players (Erickson 2014)
- RTS following ACLR in NFL QB (Erickson 2014)
- RTS following ACLR in NBA Players (Harris 2013)
- RTS following MFx in NBA Players (Harris 2013)
Created a database of all UCLR in MLB players from 1974 until 2013

179 MLB Pitchers underwent UCLR

83% RTS in MLB

97.2% RTS in MLB minors

1 in 3 MLB Players will undergo UCL reconstruction at a cost of $200-$500 million in lost salary with time on DL.
Outcomes in revision Tommy John surgery in Major League Baseball pitchers

Joseph M. Liu, MD," Grant N. Szarka, MD, Stan Conte, PT, DPT, ATC, Neil ElAttrache, MD, David W. Elush, MD, Joshua C. DiMe, MD

235 MLB pitchers underwent UCLR

- 31 pitchers (13.2%) underwent revision UCLR
- 37% underwent revision within 3 years of index UCLR
- 26 revisions had more than 2 years of follow-up

- 17 pitchers (65.4%) returned to pitch at least 1 MLB game
- 11 (42.3%) returned to pitch 10 or more games

Average length of recovery: 20.76 months for players who RTS in MLB

MLB pitchers undergoing revision surgery had a statistically shorter career after revision surgery, pitched fewer innings, and had fewer total pitches per season compared to controls.

UCL Epidemic

Can We Identify Players at Risk for UCL Injury?

Can we apply Modifications to reduce injury risk?

Are Pitching Mechanics Modifiable by the time athletes reach an elite level or have they been self-selected?

Risk Factors

Risk factors for UCL injuries in pitchers

- Potential Modifiable Factors
  - Shoulder Motion
  - Mechanics (?)
- Other Injuries
- Pitch Type
- Number of Pitches

- Non-Modifiable Factors
  - Height
  - Weight (?)
  - Velocity
505 examinations on 296 pitchers for 8 consecutive years (2008-2005)
Measured pROM of throwing/non-throwing shoulder
49 elbow injuries and 8 elbow surgeries in 38 players
Missed 2551 days

Pitchers w/ deficits of >5° in total rotation had a 2.6 times greater risk for injury
Pitchers w/ deficit of >5° in flexion had a 2.8 times greater risk for injury
No Difference with regard to GIRD

Supine shoulder pROM was assessed in 115 pitchers
Two trials of ROM were measured preseason
Arm injuries were prospectively tracked

33 injured and 82 uninjured pitchers
Side-to-side differences of:
- Horizontal adduction >15° - 4x more likely to be injured
- Internal rotation >13° - 6x more likely to be injured
Increased Volume of Throwing May be required to achieve Dominant HRT in the injury group.
Pitching Flaws and UCL Injuries

Pitch Type

Differences among fastball, curveball, and change-up pitching biomechanics across various levels of baseball

American Sports Medicine Institute, Birmingham, AL, USA

No difference in elbow varus torque between curveball and fastball at any level

Difference in torque noted between fastball and change up (velocity)

No difference in kinematics between normal group and players after UCL

Current Data:

Total arc of motion deficits and flexion deficits associated with increased risk of UCL tear

Horizontal adduction deficits (posterior capsular tightness) associated with increased risk of injury (UCL tear)

Decreased torsion in the ND arm may predispose risk for UCL tear: volume of throwing...
Pitching Motion and Influence of Fatigue

- 28 males between 13-16 threw a simulated game
- Pitches were videotaped
- The experimental model functioned properly
- Pitchers became fatigued with increasing pitch counts

No upper extremity kinematics changed with fatigue
- Hip to shoulder separation significantly increased with increasing pitch counts
Does Workload Influence Injury Risk in Starting Pitchers?

Publicly available database
- All MLB starting pitchers with ≥5 starts in seasons 2010-2015
- Excluded players:
  - Previous surgery
  - Injury in a current year due to trauma or medical reason
  - If began season on DL due to injury from previous year
- 2010-2015 data collected on:
  - Annual pitching stats (starts, innings, pitches, pitches/gm)
  - Annual DL information
- Multiple logistic regression
  - Are pitching stats a risk factor for injury?

161 MLB starting pitchers included...

- Upper extremity responsible for most DL occurrences and DL days

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<th>Year/Type</th>
<th>Overall</th>
<th>LE</th>
<th>UE</th>
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<td>6.16</td>
</tr>
</tbody>
</table>

The Impact of Fatigue on Baseball Pitching Mechanics in Adolescent Male Pitchers

- The majority of velocity is generated from the pitcher's core and legs
- As the core and legs fatigue, the pitcher opens up more during their delivery
- The pitcher then places more stress across the shoulder and elbow, specifically the UCL, to generate force for the pitch
- Hence, trunk weakness may be a factor in UCL tears, and strengthening the core may prevent UCL injuries
161 MLB starting pitchers included...

- Upper extremity responsible for most DL occurrences and DL days
- No significant association between preceding years of cumulative stats with pitcher placement on DL for any musculoskeletal reason evaluating:
  - Starts
  - Pitch count
  - Innings
  - Pitches per start
  - Only exception: total innings pitched from 2010-2011 being significantly associated with DL placement in 2012 (No DL, 310.5 ± 97.5 innings, DL, 344.7 ± 85.9 innings)

Non-Modifiable Factors

Physics Problem:
UCL is operating at or near its failure load.

Kinetics of Baseball Pitching with Implications About Injury Mechanisms

Glenn S. Feltig, PhD, James R. Andrews, MD, Charles J. Dilman, PhD, and Rafael F. Eiscamilla, MS, CSCS

From the American Sports Medicine Institute, Birmingham, Alabama

247 MLB Pitchers Underwent UCLR as of June 1, 2014

State/country where MLB pitcher played
Baseball was used to determine warm vs. cold

Cold states were outside the 33rd parallel; warm states were within it
Risk Factors

- 139 MLB Pitchers from warm weather areas
- 108 MLB Pitchers from cold weather areas

A sig higher proportion of MLB pitchers undergoing UCLR are from warm weather areas (p<.0001)

1327 pitchers included
309 (26.8%) had undergone UCLR
145 had preinjury velocity data

Peak pitch velocity was significantly higher among preinjury pitchers than control pitchers: 93.3 mph vs. 92.1 (P < .001) as was mean pitch velocity (87.8 mph vs. 86.9 mph (P = .001)

Weight was significantly higher for preinjury pitchers than controls (P = .005). On multivariate regression, peak pitch velocity was the primary independent predictor of whether a pitcher underwent UCLR (P < .001),

Pitch counts were not significant predictors of whether pitchers underwent UCLR

RTS
- 154 pitchers were included
- MLB pitchers who pitched 1 full season after UCLR
- 135 pitchers did not require revision UCLR
- 19 underwent revision UCLR
Simple Physics…..

As r increases valgus load (torque) increases.

As F (velocity) increases, valgus load (torque) increases.

Predictors of UCLR based on this model:
1. fewer days between consecutive games
2. A smaller repertoire of pitches
3. a less pronounced horizontal release location
4. a smaller stature
5. greater mean pitch speed
6. greater mean pitch counts per game
Summary

Little data to suggest that modifiable factors are associated with UCL tear (Shoulder ROM).

Further work needed to determine if injury prevention programs may help.

No usable guidelines regarding innings limits.

Physics will likely give us the answer: Size, Velocity, Volume.

Factors associated with a smaller likelihood of UCLR:
1. Increase in mean days between consecutive games.
2. Number of unique pitch types thrown.

An increase in mean pitch speed or mean pitches per game was associated with significantly higher odds of UCL reconstruction surgery.
Revision UCLR

Trends in Revision Elbow Ulnar Collateral Ligament Reconstruction in Professional Baseball Pitchers

Analyzed professional Pitchers who had revision UCLR 1974-2014

271 underwent primary UCLR
40 (15%) had at least one revision UCLR
3 had a second revision UCLR

Avg time from primary UCLR to revision: 5.2 +/- 3.2 years

Avg career length:
After primary UCLR: 4.9 +/- 4.3 years
After revision UCLR: 2.5 +/- 2.4 years

No risk factors for revision UCLR were identified

Thank You