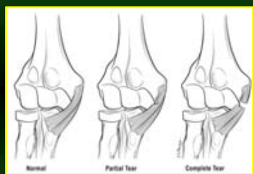
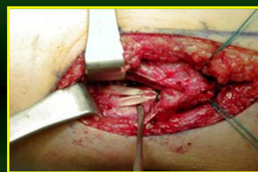
Pitching Flaws & UCL Injuries

Pitching Flaws and UCL Injuries





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Pitching Flaws and UCL Injuries

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

Detailed disclosure information is available via:

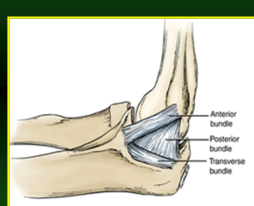
The course syllabus, or

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

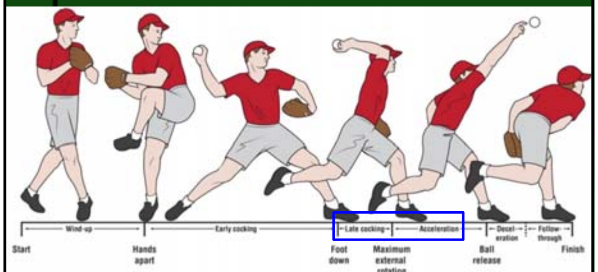
What is the UCL?

Pitching Flaws and UCL Injuries

- Primary restraint to valgus force at 30°-120°
- 3 Bundles
  - Anterior Bundle
    - Ant/Post Bands
  - Posterior Bundle
  - Transverse Bundle
- Hypertrophy in MLB Pitchers



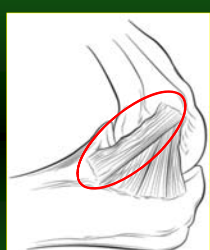
Pitch Cycle



Pitc

Anterior Bundle

Pitching Flaws and UCL Injuries

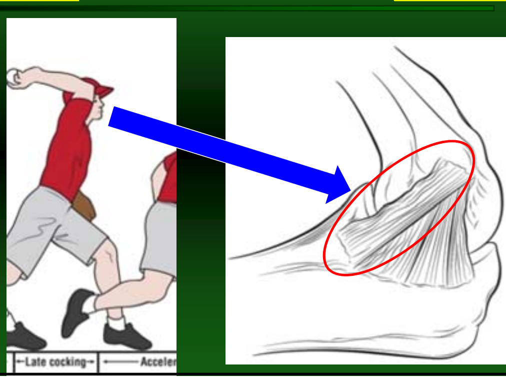


100° Elbow Flexion

15° Elbow Flexion

Anterior Bundle

Pitching Flaws and UCL Injuries



Midwest Orthopaedics at RUSH
Team Physicians Chicago Bulls & Chicago White Sox

Midwest Orthopaedics at RUSH
Hand, Wrist & Elbow Institute

Pitching Flaws and UCL Injuries

Scope of the Problem

Trends in Medial Ulnar Collateral Ligament Reconstruction in the United States: A Retrospective Review of a Large Private-Payer Database From 2007 to 2011

Brandon J. Erickson, Benedict U. Nwachukwu, Sam Rosas, William W. Schairer, Frank M. McCormick, Bernard R. Bach, Jr, Charles A. Bush-Joseph and Anthony A. Romeo

Am J Sports Med 2015 43: 1770

DOI: 10.1177/0363546515580304

Pitching Flaws and UCL Injuries

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)

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Brandon J. Erickson, Benedict U. Nwachukwu, Sam Rosas, William W. Schairer, Frank M. McCormick, Bernard R. Bach, Jr, Charles A. Bush-Joseph and Anthony A. Romeo

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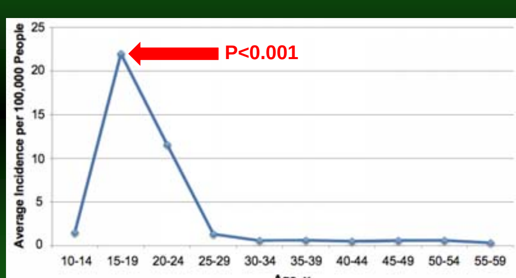
Pitching Flaws and UCL Injuries



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Brandon J. Erickson, Benedict U. Nwachukwu, Sam Rosas, William W. Schairer, Frank M. McCormick, Bernard R. Bach, Jr, Charles A. Bush-Joseph and Anthony A. Romeo
Am J Sports Med 2015 43: 1770
DOI: 10.1177/0363546515580304

Pitching Flaws and UCL Injuries

However, could not report on:

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

Public Data

Pitching Flaws and UCL Injuries

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)

Rate of Return to Pitching and Performance After Tommy John Surgery in Major League Baseball Pitchers
Brandon J. Erickson, Anil K. Gupta, Joshua D. Harris, Charles Bush-Joseph, Bernard R. Bach, Geoffrey D. Abrams, Angielyn M. San Juan, Brian J. Cole and Anthony A. Romeo
Am J Sports Med 2014 42: 536 originally published online December 18, 2013
DOI: 10.1177/0363546513510890

Pitching Flaws and UCL Injuries

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

Rate of Return to Pitching and Performance After Tommy John Surgery in Major League Baseball Pitchers

Brandon J. Erickson, Anil K. Gupta, Joshua D. Harris, Charles Bush-Joseph, Bernard R. Bach, Geoffrey D. Abrams, Angielyn M. San Juan, Brian J. Cole and Anthony A. Romeo

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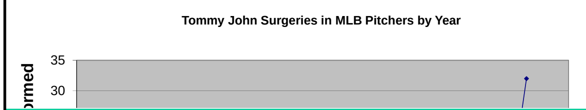
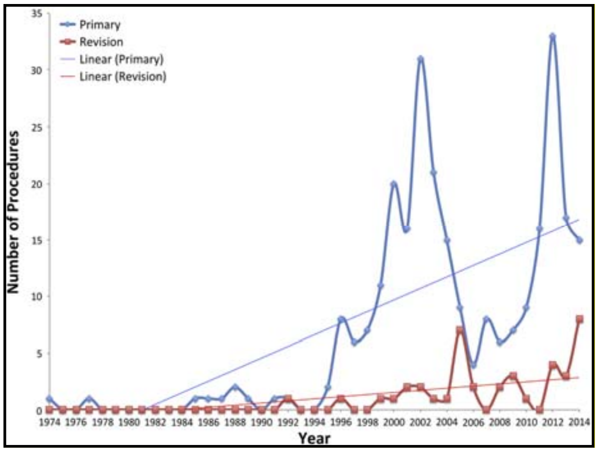


1 in 3 MLB Players will undergo UCL reconstruction at a cost of $200 million in lost salary with time on DL.



Outcomes in revision Tommy John surgery in Major League Baseball pitchers

Joseph N. Liu, MD[a,*], Grant H. Garcia, MD[a], Stan Conte, PT, DPT, ATC[b], Neal ElAttrache, MD[c], David W. Altchek, MD[d], Joshua S. Dines, MD[d]

Pitching Flaws and UCL Injuries

- 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

UCL Injuries

Can We Identify Players at Risk for UCL Injury?

Can we apply Modifications to reduce

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

Risk Factors

Pitching Flaws and UCL Injuries

Risk factors for UCL injuries in pitchers

- Modifiable Factors
  - Shoulder Motion
  - Mechanics
  - Other Injuries
  - Pitch Type
  - Number of Pitches
- Non-Modifiable Factors
  - Height
  - Weight
  - Velocity

Deficits in Glenohumeral Passive Range of Motion Increase Risk of Elbow Injury in Professional Baseball Pitchers: A Prospective Study

Kevin E. Wilk, Leonard C. Macrina, Glenn S. Fleisig, Kyle T. Aune, Ron A. Porterfield, Paul Harker, Timothy J. Evans and James R. Andrews

Am J Sports Med 2014 42: 2075 originally published online June 18, 2014
DOI: 10.1177/0363546514538391

Pitching Flaws and UCL Injuries

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

Deficits in Glenohumeral Passive Range of Motion Increase Risk of Elbow Injury in Professional Baseball Pitchers: A Prospective Study

Kevin E. Wilk, Leonard C. Macrina, Glenn S. Fleisig, Kyle T. Aune, Ron A. Porterfield, Paul Harker, Timothy J. Evans and James R. Andrews

Am J Sports Med 2014 42: 2075 originally published online June 18, 2014
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Variable	Overall	Elbow Injury	No Elbow Injury	P
Age, y	24.7 ± 4.1	25.0 ± 4.2	24.7 ± 4.1	.70
Height, cm	188.6 ± 5.6	189.1 ± 6.3	188.5 ± 5.4	.55
Mass, kg	90.8 ± 10.1	93.4 ± 8.6	90.4 ± 10.3	.07
Follow-up time, mo	49.1 ± 28.9	55.7 ± 26.6	47.3 ± 28.6	.08
Cumulative elbow injury duration, d[b]		65.6 ± 74.8		

Shoulder PROM	Mean			
	Throwing	Nonthrowing	Mean Difference[b] ± SE	P
Internal rotation, deg	52.3	62.8	10.5 ± 0.7	<.001
External rotation, deg	131.2	124.9	–6.3 ± 0.6	<.001
Total rotation, deg	183.4	187.7	4.2 ± 0.7	<.001
Flexion, deg	177.7	179.0	1.3 ± 0.2	<.001

Risk Factor	Pitchers Who Sustained Injuries, % (No./Total)				
	With Risk Factor	Without Risk Factor	Odds Ratio	95% CI	P
GIRD	14 (7/52)	13 (31/236)	1.0	0.4-2.4	.55
Insufficient external rotation	14 (26/183)	11 (12/105)	1.3	0.6-2.8	.32
Total rotation deficit	19 (25/132)	8 (13/156)	2.6	1.3-5.4	.007
Flexion deficit	25 (13/52)	11 (25/235)	2.8	1.3-5.9	.008

Preseason shoulder range of motion screening as a predictor of injury among youth and adolescent baseball pitchers

Ellen Shanley PhD, PT, OCS, CSCS, Micheal J. Kissenberth MD, Charles A. Thigpen PhD, PT, ATC, Lane B. Bailey PhD, PT, CSCS, Richard J. Hawkins MD, Lori A. Michener PhD, PT, ATC, John M. Tokish MD and Mitchell J. Rauh PhD, PT, MPH, FACSM

Get rights and content

Journal of Shoulder and Elbow Surgery, 2015-07-01, Volume 24, Issue 7, Pages 1005-1013,

Pitching Flaws and UCL Injuries

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

Pitching Flaws and UCL Injuries

Table II Injury proportions by body site and diagnosis by age group

	Youth		Adolescent	
	n	%	n	%
Body site				
Shoulder	9	19	8	12
Elbow	10	21	8	12
Diagnosis				
Strain/tendinosis				
Rotator cuff	2	4	2	3
Biceps (shoulder)	1	2	2	3
Biceps (elbow)	1	2	0	0
Flexor/pronator	5	11	2	3
Labral/internal impingement	1	2	3	4
Ulnar collateral ligament strain	1	2	2	3
Epiphyseal (shoulder)	4	8	1	2
Apophyseal (elbow)	3	6	2	3
Other musculoskeletal injury	1	2	2	3
Total	19		16	

CL Injuries

Baseball Players With an Ulnar Collateral Ligament Tear Display Increased Nondominant Arm Humeral Torsion Compared With Healthy Baseball Players

Casey J. Meyer,* MS, ATC, J. Craig Garrison,†‡ PhD, PT, SCS, ATC, and John E. Conway,† MD
Investigation performed at Texas Health Ben Hogan Sports Medicine, Fort Worth, Texas, USA

Increased Volume of Throwing May be required to achieve Dominant HRT in the injury group.

Pitch Type

Pitching Flaws and UCL Injuries

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

Glenn S. Fleisig, Walter A. Laughlin, Kyle T. Aune, E. Lyle Cain, Jeffrey R. Dugas and James R. Andrews

American Sports Medicine Institute, Birmingham, AL, USA

Elbow varus torque (Nm)[a]				
Youth	37	33.9	31.6	4.7
High school	62.6	58.3	55.8	5.2
College	69.2	63.9	60.8	5.4
Minor league	83.1	79.5	73.6	4.5
Major league	105.8	101.6	93.9	6.2

No Difference in Elbow Varus Torque between Curveball and Fastball at any level

Difference in torque noted between Fastball and Change Up (Velocity)

UCL Injuries

Biomechanical Performance of Baseball Pitchers With a History of Ulnar Collateral Ligament Reconstruction

Glenn S. Fleisig,*† PhD, Charles E. Leddon,† PhD, Walter A. Laughlin,† MS, Michael G. Ciccotti,§ MD, Bert R. Mandelbaum,‖ MD, Kyle T. Aune,† MPH, Rafael F. Escamilla,†¶ PhD, PT, Toran D. MacLeod,¶ PhD, PT, and James R. Andrews,†‡ MD
Investigation performed at the American Sports Medicine Institute, Birmingham, Alabama, USA

No Difference in Kinematics between Normal Group and Players after UCL

ROM and UCL

Pitching Flaws and UCL Injuries

Current Data:

Total Arc of Motion Deficits and Flexion Deficits Associated with Increased Risk of UCL Tear

Horizontal Adduction Deficits (Posterior Capsular Tightness) Potentially Associated with increased risk of UCL tear

Decreased Torsion in the ND arm may predispose risk for UCL Tear

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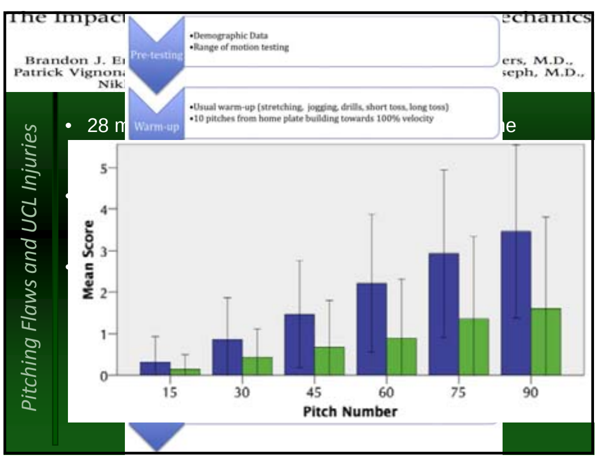
Pitching Flaws and UCL Injuries

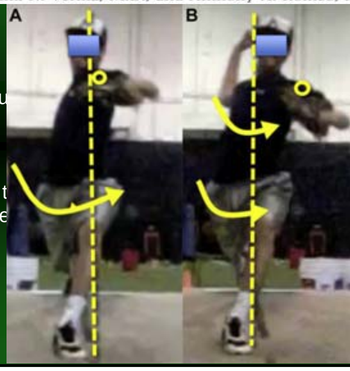
Pitching Motion and Influence of Fatigue



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

Brandon J. Erickson, M.D., Terrance Sgori, B.S., Peter N. Chalmers, M.D., Patrick Vignona, B.S., Matthew Lesniak, B.S., Charles A. Bush-Joseph, M.D., Nikhil N. Verma, M.D., and Anthony A. Romeo, M.D.

Pitching Flaws and UCL Injuries



- No u… fatigue
- Hip t… …ased with incre…

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

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Pitching Flaws and UCL Injuries

- 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

Non-Modifiable Factors

…CL Injuries

Physics Problem:

UCL is operating at or near its failure load.

Kinetics of Baseball Pitching with Implications About Injury Mechanisms

Glenn S. Fleisig,* PhD, James R. Andrews, MD, Charles J. Dillman, PhD, and Rafael F. Escamilla, MS, CSCS

From the American Sports Medicine Institute, Birmingham, Alabama

gone up.

Is Tommy John Surgery Performed More Frequently in Major League Baseball Pitchers From Warm Weather Areas?

Brandon J. Erickson, Joshua D. Harris, Matthew Tetreault, Charles Bush-Joseph, Mark Cohen and Anthony A. Romeo

Orthopaedic Journal of Sports Medicine 2014 2:
DOI: 10.1177/2325967114553916

Pitching Flaws and UCL Injuries

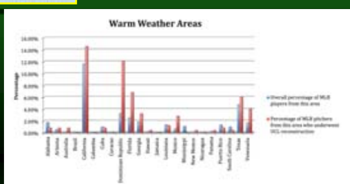
247 MLB Pitchers Underwent UCLR as of June 1, 2014

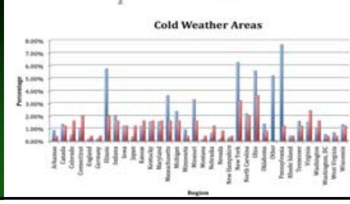
State/country where MLB pitcher played Baseball was used to determine warm vs. cold

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

Risk Factors

Pitching Flaws and UCL Injuries





139 MLB Pitchers from warm weather areas

108 MLB Pitchers from cold weather areas

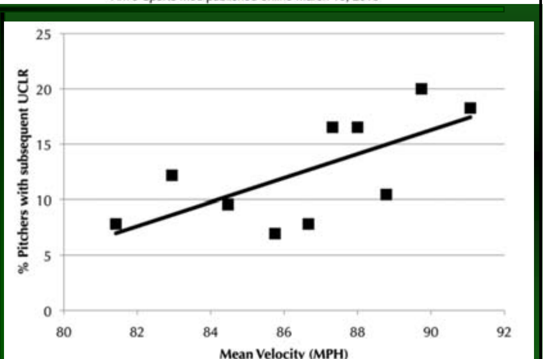
A sig higher proportion of MLB pitchers undergoing UCLR are from warm weather areas $p<.0001$

Fastball Pitch Velocity Helps Predict Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

Peter N. Chalmers, Brandon J. Erickson, Brian Ball, Anthony A. Romeo and Nikhil N. Verma

Am J Sports Med published online March 16, 2016

Pitching Flaws and UCL Injuries



Should We Limit Innings Pitched After Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers?

Brandon J. Erickson, Gregory L. Cvetanovich, Bernard R. Bach, Jr, Charles A. Bush-Joseph, Nikhil N. Verma and Anthony A. Romeo

Am J Sports Med published online July 11, 2016

Pitching Flaws and UCL Injuries

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

Innings Pitched and Number of Pitches Thrown for MLB Pitchers Who Did and Did Not Require a Revision UCLR[a]

	Pitchers Who Did Not Require a Revision UCLR	Pitchers Who Underwent a Revision UCLR	*P* Value
First season after UCLR			
Innings pitched	90.15 ± 58.6	79.4 ± 46.7	.9016
Pitches thrown	1449.2 ± 904.1	1233.2 ± 710.4	.7337
Career after UCLR			
Innings pitched	399.3 ± 446.4	357.4 ± 312.0	.6945
Pitches thrown	5674.7 ± 5755.4	5632.7 ± 4583.9	.4789

Should We Limit Innings Pitched After Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers?

Brandon J. Erickson, Gregory L. Cvetanovich, Bernard R. Bach, Jr, Charles A. Bush-Joseph, Nikhil N. Verma and Anthony A. Romeo

Am J Sports Med published online July 11, 2016

Pitching Flaws and UCL Injuries

Pitchers Who Pitched More/Less Than 180 Innings in Their First Season After UCLR Compared With Pitchers Who Did/Did Not Require Revision UCLR[a]

	Pitched >180 Innings in First Full Season	
Revision UCLR	Yes	No
Yes	0	19
No	16	119

Pitchers Who Pitched More/Less Than 150 Innings in Their First Season After UCLR Compared With Pitchers Who Did/Did Not Require Revision UCLR[a]

	Pitched >150 Innings in First Full Season	
Revision UCLR	Yes	No
Yes	0	19
No	17	118

Predictors of Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

David Whiteside, Douglas N. Martini, Adam S. Lepley, Ronald F. Zernicke and Grant C. Goulet

Am J Sports Med 2016 44: 2202 originally published online May 6, 2016

Pitching Flaws and UCL Injuries

Tried to identify performance factors that were risk factors for undergoing a UCLR

Their model explained 19.9% of the variance in UCL reconstruction surgery, and correctly classified 66.8% of cases

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

Pitching Flaws and UCL Injuries

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

Pitching Flaws and UCL Injuries


A Review Paper

Predicting and Preventing Injury in Major League Baseball

Predictors of Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

David Whiteside, Douglas N. Martini, Adam S. Lepley, Ronald F. Zernicke and Grant C. Goulet

Am J Sports Med 2016 44: 2202 originally published online May 6, 2016

Pitching Flaws and UCL Injuries

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

Pitching Flaws and UCL Injuries

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

Alexander T. Wilson, BS,* Tyler S. Pidgeon, MD,* Nathan T. Morrell, MD,* Manuel F. DaSilva, MD

Pitching Flaws and UCL Injuries

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

Pitching Flaws and UCL Injuries

Thank You