**Elbow Injuries in Sports**

*Introduction*

- Number of elbow injuries appear to be increasing
- Repetitive high forces – overhead athlete
  - 22% of all baseball injuries
- Macrotraumatic forces – dislocation / fractures / tears
- Thrower’s “not all or none”

Rehabilitation Program Must Be Specific For Each Type of Athlete

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**UCL Rehabilitation**

*Rehab Plan*

- THINK
  - Do it right the first time!
  - Plan ahead

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**Rehabilitation following UCL Surgery in the Overhead Throwing Athlete**

*Kevin E. Wilk, PT, DPT, FAPTA*

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**Coaching My Video Mobile**
Beckett et al: AJSM ‘14

- Assessment of scapular & hip joint in preadolescent (7-12 yrs) & adolescent (13-18 yrs) in baseball players
  - High rate of scapular dyskinesis in adolescent players compared to pre-adolescent
  - Also poor single leg squat test
  - Higher coracoid process distance – correlated to dyskinesis

UCL Reconstructive Rehabilitation

Lower Extremity Strengthening

Linking UE & LE

Outcome of Ulnar Collateral Ligament Reconstruction of the Elbow in 1291 Athletes

AJSM 2010

- 1281 UCL procedures, 1265 reconstructions
- Follow-up on 79% (743 patients)
- 95% baseball players (89% pitchers)
- Average follow-up: 49.1 months
  - 83% returned to same level (recon)
- 63% of repairs returned to same level competition
- Return to competition: 11.6 months
- ITP initiated – 4.4 months

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

AJSM 2014

- 179 UCL reconstructions included in study
  - 148 returned to play 83% returned to same level
  - Only 5 pitchers were not able to return to play
  - Return to competition: 20 months
  - Length of career 3.9 months
  - Pitchers performance improved after surgery
• 80 active minor league pitchers
• 40 UCLr compared to 40 normal
• PROM, radar gun ball velocity, & biomechanics were analyzed

Conclusions: no sign stat diff in any area tested

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

Oshbar, Cain, Dugas et al: AJSM ’13
• UCL reconstruction in throwing athletes – a minimal 10 year follow-up
• 256 of 313 (82%) available for F/U
• Average follow up 12.6 yrs ± 4.5 yrs
• 90% were pitchers
• 83.5% of overhead throwers RTP
• Longevity of career after UCLr 3.6 yrs for all levels
• 86% retired due to something else than UCL
• 98% still throwing

AJSM 2015

Injury Epidemic In Youth Baseball

Elbow Injuries in Baseball

UCJ Surgeries: Conte, Wilk: AJSM ’15

Surveyed all Major League Baseball Players
1,036 respondents
30/30 teams responded
100% responses in 30 teams
166 players had UCLr (16%)
Pitchers: 25%
Position players: 5%
49% UCLr received concomitant surgery

Elbow Injuries in Baseball

UCJ Surgeries – Conte, Wilk: AJSM ’15

Surveyed all Minor League Baseball Players
4,052 respondents (2,145 pitchers)
29/30 teams responded
100% responses in 29 teams
331 players had UCLr (8%)
Pitchers: 300/2145 (14%)
Position players: 31/1907 (2%)
Avg age at time of surgery 21
UCLr in the State of NY from 2002 to 2011
- UCLr increased by 193%
- UCLr mean age 17-18 & 19-20 yrs of age
- Private insurance patients were 25% more likely to undergo a UCLr than those with Medicaid
- The number of institutions performing UCLr doubled

Risk Factors for Injuries Overview
- Pitching when fatigued
- Pitching too many innings/year
- Not enough rest from throwing at end season
- Too many pitches in game, week, year
- Pitching consecutive days
- Poor pitching or throwing mechanics
- Playing on multiple teams, leagues

Youth Baseball Pitchers
- Excessive throwing when not pitching
- Throwing curveballs or sliders
- Improper conditioning
- Not following proper conditioning guidelines
- Not following safe practice guidelines at showcases
- Too much throwing with not enough rest!

Pro Baseball Pitchers
- Excessive throwing when not pitching
- Throwing curveballs or sliders
- Improper conditioning
- Not following proper conditioning guidelines
- Not following safe practice guidelines at showcases
- Too much throwing with not enough rest!
**Elite Baseball Pitcher**

**Risk Factors for Injury**

- Pitching at maximum effort
  - “too many pitches at 100% effort”
- Pitching too many innings
  - “over utilization”
- Pitching when fatigued
  - “alteration in normal throwing mechanics”
- Pitching beyond the player’s capabilities
  - “types of pitches, velocity, innings, reliever vs”

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**Chalmers, Erickson, Romeo: AJSM ’16**

- Fast ball pitch velocity helps predict UCLr in MLB pitchers
- Data base study design using Pitch Fx
- MLB pitchers from 4/2/07 – 4/14/15
- 1327 pitchers included
  - 309 (26.8%) underwent UCLr (145 had pre injury velocity recorded)
  - Peak pitch velocity independent predictor (p<.001)
  - Mean velocity, body mass & age 2nd predictors

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**Glenohumeral Passive Range of Motion**

& the Correlation to Elbow Injuries in Professional Baseball Players: An 8 year Prospective Study (AJSM 2014)

Kevin E. Wilk, DPT
Leonard C. Macrina, MSPT
Glenn S. Fleisig, PhD
Kyle Aune, MPH
Ronald Porterfield, ATC
Paul Harker, ATC
James Andrews, MD
Conclusions & Clinical Relevance

- Based on the results of this study:
  - Pitchers with a throwing shoulder deficit in TRM had a 2.3x risk of sustaining an elbow injury
  - Pitchers with a dominant shoulder loss of Flexion exhibited a greater risk (2.8x) risk of an elbow inj
  - GIRD did not correlate with elbow injuries
  - Strong trend for increase ER incr risk UCL inj
- Clinicians need to be aware of this and plan a preventative & rehabilitation program that addresses these findings – this to prevent &/or treat elbow injuries in the overhead pitcher


- Humeral torsion risk factor for shoulder/elbow injuries in professional baseball pitchers
- Protective or Harmful
- 255 pitchers prospective study ROM, Retro US
- 60 injuries were recorded (24%) 30 shldr 30 elb
- Players who sustained shoulder injuries exhibited less retro torsion compared uninj (4°)
- Players who sustained elbow injuries exhibited an increase in humeral retro torsion by 5°

Sports Illustrated

- How many MLB stars came from warm-weather and cold-weather states?

MLB Hitters > 300 Home Runs

MLB Pitchers > 200 Wins

OJSM ‘14
Physical Characteristics of the Thrower’s Elbow

The Elbow Joint in Throwers

Range of Motion

Wilk, Macrina, Reinold, Porterfield Unpublished: ’15

- Extension: 7 ± 7°
- Flexion: 147 ± 4°
- Pronation: 98 ± 4°
- Supination: 93 ± 4°

n = 732

Elbow Injuries in Sports

Overview

Common elbow injuries in the overhead athletes
- Vagrus extension overload
- Flexor/pronator tendonitis
- Extensor tendonitis
- Ulnar collateral ligament sprains
- Degeneration of elbow joint
- Ulnar neuritis

Elbow Injuries in Sports

Overview

Common elbow injuries in the overhead athletes
- Vagrus extension overload
- Flexor/pronator tendonitis
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- Ulnar collateral ligament sprains
- Degeneration of elbow joint
- Ulnar neuritis
Rehabilitation Following UCL Surgery (Repair & Recon)
Our Current Program (2018)

Rehabilitation Following UCL Repair with Augmentation

UCL Surgery Repair
- 2 x 3.5 mm corkscrew PEEK anchors
- Collagen-coated Fiber Tape
- Size 0 suppsuture (Ticron)
  - One limb of FiberTape and suture placed through the eyelet of the first anchor
  - First anchor placed at the site of avulsion
  - Suture used to repair avulsed ligament
  - Both limbs of tape placed through eyelet of the second anchor
  - Second anchor placed at other insertion UCL
  - Caution on tension of tape

UCL Repair Augmentation Rehab
- Week 1: Elbow brace locked 90° 5-7 days
  - Shoulder isometric exercises
  - Scapular exercises (scapular NM ex)
- Week 2: ROM Brace (30-110°)
  - Continue shoulder exercises isotonics
  - Initiate elbow & wrist exercises
- Week 3-4:
  - Thrower’s Ten Program
  - Week 4-5 full PROM
- Week 5-6:
  - Advanced Thrower’s Ten Program

UCL Repair Augmentation Rehab
- Week 6:
  - Advanced Thrower’s Ten Program
  - Plyometrics 2 hand drills
- Week 8:
  - Plyometrics 1 hand drills
  - Hitting week 10
- Week 12-16:
  - ITP Phase I (week 10-11)
  - ITP Phase II (wk 14-15)
- Week 16-20:
  - Return to play

Wilk - Rehabilitation Following UCL Surgery
2018
Rehabilitation Following UCL Reconstruction

Recent Adaptations in Our Program

- Earlier restoration of motion
  - Previous: 7-8 wks FROM
  - Present: 4-6 wks FROM
  - More present: Full ext ASAP

Acute Injury → Chronic Injury

- Emphasis on wrist flexors, shoulder strength
- Preparation phase of throwing – plyometrics longer

Throwing programs – long toss (more time)...
delay hard throwing for longer – return to games delayed

Rehab Comparison UCLibrace v UCLr

- No motion first week
- Motion: begins week 2
- Full PROM: ibrace (week 4-6), recon (5-6)
- Plyometrics: ibrace (week 6), recon (week 12)
- ITP: ibrace (week 16), recon (week 16)
- RTP: ibrace (4-5 mos.), recon (9.6 mos.)

Rehabilitation Following UCLr in Throwers

Phase I: Acute Post-Op Phase:
- Phase II: Subacute Phase:
- Phase III: Advanced Phase:
- Phase IV: Return to Activity Phase:

Rehabilitation UCLr Throwers

Phase I: Post-Op Phase (weeks 0-8):
- Protect the healing tissue (UCL)
- Gradually restore motion
- Decrease inflammation & pain
- Prevent muscular atrophy
- Scapular, GH joint, leg, core program

Phase II: Subacute Phase (weeks 9-12)
- Continue ROM & stretching
- Isotonic strengthening program (Throw 10
  - Scapular & Glenohumeral joint
  - Fine tune muscular ratios
- Core & Leg program

Phase III: Advanced Phase (weeks 13-16)
- Advanced isotonic program
- Strength, power, & endurance
- Advanced thrower’s ten program
- Plyometrics
- Continue stretching & ROM program

Phase IV: Return to Activity Phase: 4 mos
- Thrower’s ten program
- Plyometrics
- Interval throwing program (ITP)
- Light stretching program
Reconstruction of the UCL
Surgical Overview

- Modification of Jobe procedure
  - Jobe: JBJS ’86
- Subcutaneous ulnar nerve transposition
  - fascial sling
- Graft source
  - Palmaris longus
  - Gracilis

Graft location:
- UCL reconstruction - 1586
  - Palmaris longus 62%
    - ipsilateral: (78%) contralateral: (22%)
  - Gracilis 38%

UCL RECONSTRUCTION REHAB
Range of Motion Progression

- Week one: splint at 90 degrees
- Week two: brace 30-100 degrees
- Week three: brace 15-115 degrees
- Progress program 5 degrees of extension and 10 degrees of flexion per week
- Full ROM at week 5-6
  More Aggressive with ROM

Rehab of Graft Site

- Palmaris tendon graft:
  - Ice & compression first 5-7 days
  - Immediate wrist motion, no aggressive stretching 2 weeks
  - Immediate hand gripping exercises
  - Soft tissue (scar) mobilization at 2 wks
  - If scars: US, stretch, tissue mobilization
  - Begin strengthening program for wrist flexors
    - Isometrics: immediate
  - Isotonics at 3 weeks
  - Progress to stretch with open hand & digits extended

Wrist & hand ROM / gripping
• **Gracilis tendon graft**
  » Ice & compression first 5-7 days
  » No stretching of hamstrings for 2-3 weeks
  » Soft tissue (scar) mobilization on day 15
  » No isolated hamstrings for 3-4 weeks
  » May bicycle at 2-4 weeks
  » Begin strengthening program for hamstrings & calf
    • Isometrics at 4 weeks
    • Isotonics at 6 weeks

**Rehab of Graft Site**

**UCL RECONSTRUCTION REHAB**

**Muscular Strength Training**

• Wrist & hand isometrics day 1
• Isometrics UE week 1-2
• Active ROM week 2-3
• Isotonics program week 3-4
• Thrower’s Ten program week 4/5
• Weight lifting week 10-12
• Sports (golf) week 11
• Plyometrics
  » Two hand drills week 12
  » One hand drills week 14

**Thrower’s Ten Program**

**Bilateral Extremity Exercises**
**UCL RECONSTRUCTION REHAB**

Rotator Cuff Strengthening

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**Advanced Strengthening Phase: Week 12-16**

- **Progress strengthening program**
- **Initiate isotonic strengthening program**
  - Bench press (seated)
  - Pull-downs
  - Seated Rows
  - Biceps/Triceps
- **Advanced Throwers’ 10 Manual Resistance Techniques**

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**UCL RECONSTRUCTION REHAB**

Strengthening Drills - MR Elbow/Wrist Flex C/E

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**Elbow Rehabilitation in Athletes**

Dynamic Stabilization

*Davidson et al: AJSM ’95*
UCL RECONSTRUCTION REHAB

Strengthening Drills

Thrower’s Ten Program

D2 PNF Flexion

Standing Full Can

Prone Full Can

Sidelying ER

Prone Horz Abduct

Prone Row into ER

Advanced Thrower’s Ten Program

Prone rowing

Elbow Flex/Ext

Sup/Pron & Wrist Flex/Ext

Push-Ups

www.asmi.org

www.asmi.org
UCL RECONSTRUCTION REHAB
Advanced Thrower's Ten

Scapular NM Control Drills

Dynamic Stabilization Exercises
Dynamic Stabilization Exercises

UCL RECONSTRUCTION REHAB

Strengthening Drills

Lower Extremity Strengthening

UCL RECONSTRUCTION REHAB

Lower Extremity Strengthening

UCL RECONSTRUCTION REHAB

Advanced Strengthening Phase (Week 12-16)

• Plyometric Progression:
  » Week 12: 2 hand drills
  » Week 14: 1 hand drills
  » Week 15: plyoball throws
  » Wk: 15-16 wt ball

  
  Gradual Progression !!!!

- Compared 3 baseball specific training programs on maximum throwing velocity
- 68 high school players (aged 14-17)
- Randomly assigned to 1 of 4 groups:
  - Thrower’s Ten Program
  - Kaiser cable system
  - Plyometrics
  - Control group
- 3 x week for 6 weeks
- Throwing velocity assessed pre & post training
  - Compared to pre-test throwing sign increase in throwing velocity (p<0.05)
    - Throwers ten (1.7%)
    - Plyometrics (2.0%)
    - Kaiser (1.2%)

Criteria to return to throwing

- Full non-painful ROM
- Elbow stability
- Satisfactory isokinetic test
- Satisfactory clinical exam
  - Moving valgus stress test (-)
- Adequate healing time

How long is that? 6, 9 or 12 mos.
**Return to Play in Throwers**

- Specific Objective Criteria
- Objective Functional Testing
- Clinical Exam
- ROM
- Objective Muscle Strength Test
- Successful Completion of Rehab

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**Rehab Overhead Athlete**

*Return to Play Criteria*

- Full sport specific non painful ROM
- Strength which meets the criteria
- Excellent stability and no painful special tests
- Demonstrates proper throwing mechanics
- Successfully has completed rehab program
- Appropriate rehab progression completed
- Satisfactory functional scoring

*An Objective Criteria is Important*

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**Assess Muscular Strength**

*Biodyex - Isokinetics*

- **ER / IR ratios**
  - 72 - 76%
- **ER / ABD ratios**
  - 68 - 73%
- **Torque / BW ratios**
  - ER: 18 - 23%
  - IR: 26 - 32%
- **Bilateral comparison**
  - ER: 95 - 100%; IR: 115%

*Wilk et al: AJSM '93, Wilk et al: AJSM '95*

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**Return to Play Criteria**

*Appropriate Rehab Progression*

- **Dynamic stabilization drills**
  - RS drills at 90/90 (P/F)
  - Prone ball drops

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**Return to Play Criteria**

*Ball Drop Test*

- **Dynamic stabilization tests**
  - Prone ball drops
    - 30 sec test
    - prone on plinth
    - number of releases/catches
    - compare Dom to Non Dom
    - score: %
    - Goal: 90%>
    - Expectation: 110%>
    - mean score: 115%
**Return to Play Criteria**

**Ball Throws into Wall Test**

- Dynamic stabilization tests
  - Ball Throws into wall
  - 30 sec test
  - standing
  - number of throws/catches
  - compare Dom to Non Dom
  - score: %
  - Goal: 90%>
  - Expectation: 110%>
  - Mean score: 110%

**Single Leg Squat Test**

- Single leg squat test
  - Floor or 8 in step
  - 10 reps on each leg
  - assess depth
  - assess valgus/varus
  - assess lateral trunk movt.
  - assess trunk flexion
  - looking for symmetrical motion with no pain &/or dysfunction
  - ability to maintain balance & perform the 10 reps

**Appropriate Rehab Progression**

- Throwing Activities:
  - painfree 1 hand throwing
  - 20 ft away
  - 1 lb plyoball

**Subjective Shoulder Questionnaire & Scoring System**

- ITP (I): long toss – wk 16-20
- ITP (II): mound - wk 26-30
- Competitive throwing – 9 mos (simulated game)
- RTP: 12-16 mos
- “Thrower’s Ten” program
  - Strengthening & Stretching
UCL RECONSTRUCTION REHAB

Return to Activity

- Interval Throwing Program:
- Caution with high intensity throwing!
- When is it safe to throw hard

UCL RECONSTRUCTION REHAB

Functional Drills

- Thrower’s ten program
- Plyometric drills
- Stretching
- Core & leg program
- Interval throwing program:
  - Long toss
  - Interval mound throwing
  - Gradual return to competition

Fleisig, Bolt, Fortenbaugh, Wilk: JOSPT ‘11

- 17 healthy college pitchers
- Biomechanical analysis of long & short throwing
- Threw 18.4m, 37m, 55m & maximal distance on a line
- Shoulder line was horizontal for mound distance but gradually went uphill as distance increased
  - Maximal throwing distance resulted in more ER, more Elb Flexion, more shoulder IR torque & more varus elbow torque
- Trunk tilt gradually increased with distance

Assess for contracture, loss of motion and joint stiffness

FLEXION CONTRACTURE

Treatment

- Active - passive warm-up
- Joint mobilization – posterior glides of humerus & radius
- Low load long duration stretch – (with heat)
- Modalities (ultrasound)
- CR, HR, passive stretching
- Progress program, repeat process
- Evaluate for splint, home program LLLD 3-4X
  TERT Treatment
Conclusions

- Common in the overhead thrower
- UCL injuries occur in several situations (throwers, macrotraumatic)
- Surgery often indicated for UCL injuries
- Rehab must match the surgery
  - Reconstruction - Repair
  - Gradual restoration through rehab
- Excellent outcomes: 85% ≥ return sport
- Stiffness occurs in less than >2%

Predictable & Reproducible Results