What's New in The Rehabilitation of the Overhead Thrower: Criteria to RTP

Kevin E. Wilk, PT, DPT, FAPTA

GIRD assessment
Assessment of humeral retrotorsion
ROM & association with injuries
Stretching techniques
Thrower’s Ten Program
Advanced Thrower’s Ten Program
Lower Trapezius activation
Serratus anterior activation
Planking
Shoulder & Hips/Core activation
Endurance
Weighted Ball Throwing
BFR

Osseous Adaptation and Range of Motion at the Glenohumeral Joint in Professional Baseball Pitchers

AJSM '02

Michael C. Conklin MD, London S. Forry MD, PhD, Kevin E. Wilk, PT, ATC, John E. Gordon III MD, Michael T. Willy MD, J. Jeffrey Dugas MD, Keith Mader MD, Stephen Lyman PhD

From the Cleveland Sports Medicine Institute, Cleveland, Ohio, and the American Sports Medicine Institute, Birmingham, Alabama, Tampa Bay Devil Rays Baseball Club, Tampa, Florida, and the University of Florida Shands Clinic, Gainesville, Florida.
Humeral Retroversion Throwers
Bilateral Differences – 38 studies
Crockett, Gross, Wilk, Andrews et al: AJSM ’02 (17 *)
Reagan, Meister, Horodyski, Wilk et al: AJSM ’02 (10 *)
Osbahr, Cannon, Speer: AJSM ’02 (10 *)
Chart, Litchfield, et al: JOSPT ’07 (10.6 *)
Pieper: AJSM ’98 (9.4 * up to 29 *, painful grp less retrov)
Wyland, Pilla, Shanley et al: AJSM ’12 (13 *)
Whiteley et al: JOSPT ’09 (Ultrasound 11.9°)
Hibberd et al: AJSM ’14 (Ultrasound - age dependent+)
Myers et al: AJSM ’12 (validation study – ultrasound)
Myers et al: Sports Health ’11 (injury related – college age
Tokish et al: J Spots Sci Med ’08 (radiographs) (11.2°)

• Influence of age on GIRD, humeral retrotorsion, retrotorsion adjusted GIRD & TROM on healthy baseball players
  ✓ 52 youth aged (6-10 yrs of age)
  ✓ 52 junior high school (11-13 yrs)
  ✓ 70 junior varsity (14-15 yrs)
  ✓ 113 Varsity (16-18 yrs)
✓ GIRD & retrotorsion increased with age while retrotorsion adjusted GIRD & TROM remained unchanged –
✓ GIRD is primarily attributed to retrotorsion & not due to soft tissue tightness

Ultrasound Retroversion Corrected ROM

Ultrasound Evaluated PROM
Retrotorsion Adjusted ROM

Validation of measuring humeral torsion using palpation of bicipital tuberosities

Abstract
The magnitude of humeral torsion (HT) affects the internal and external rotation range of motion at the shoulder.
Converting angles is essential to quantify the HT, which varies between study and the availability of imaging.
In a study of 20 volunteers, palpation of the bicipital tuberosities was used to measure the humeral torsion.
A Bic平Combined Interobserver Reliability (BIC) was calculated for the interobserver agreement, the intraclass correlation coefficient (ICC), and the Bland-Altman analysis.
The results showed a high level of interobserver agreement (ICC = 0.92), and the Bland-Altman analysis indicated a small bias (−0.2°, 95% CI: −1.1° to 0.7°).
In conclusion, palpation of the bicipital tuberosities appears to be a practical alternative to US imaging for measuring HT.
Humeral Retrotorsion Palpation Technique

Dashattar: Physiother Theory Practice 2013

ER + IR = Total Motion
“Envelope of Motion”

Wilk AJSM ’02
Total Rotational Motion is equal bilaterally (within ±5 degrees)

Non-Throwing Shoulder

Throwing Shoulder

Total Rotational Motion Concept (TRM)

Relationship Between Humeral Torsion and Injury in Professional Baseball Pitchers

• Relationship between humeral torsion & UE injury in professional pitchers
• N=25 CT scan to determine humeral torsion
• Strong inverse relationship between (D) humeral torsion & injury severity
• The more retrotorsion less risk for injury
• Every 10° increase risk of inj 30%

AJSM ‘15

Wilk, Macrina, Fleisig, et al: AJSM ’15

• 8 year GIRD study – 1 professional team
• N=505 Pitcher/Seasons (n=296 pitchers)
• Correlation of spring training shoulder ROM to DL days & surgery (shoulder & elbow injuries)
  ✓ GIRD did not correlate (p=0.862)
  ✓ TROM did correlate (p=<0.05)
  ✓ >ER was protective
  ✓ 77 shoulder injuries
  ✓ Players who had surgery spent 3x more time on DL getting well, 208.3 days on DL

AJSM ’13

• Relationship between humeral torsion & UE injury in professional pitchers
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• The more retrotorsion less risk for injury
• Every 10° increase risk of inj 30%
Noonan, Thigpen, Bailey, et al: AJSM '16

- 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 retrotorsion compared uninj (4°)
  ✓ Players who sustained elbow injuries exhibited an increase in humeral retrotorsion by 5°

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
  ✓ ER & elbow injuries association (NS)
- 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
Modified Sleeper’s Stretch

Wilk et al: JOSPT ’13

McClure et al: JOSPT ’07

- Randomized controlled comparison for stretching posterior shoulder tightness
- 30 subjects with 10 deg loss of IR compared contralateral side
- Compared sleeper stretch (n=15) to cross body (n=15) to control group (n=24)
- Stretches 5 reps for 30 sec for 4 weeks
  ✓ Significant improvement in IR in cross body group (20°) compared to control (6°) – sleeper stretch (12°) no sign increase in IR compared to control

Cross Body Stretch

Moore, Laudner, McLoda et al: JOSPT ’11

- 61 Division I baseball players randomized into 1 of 3 groups:
  » muscle energy technique for horz abd
  » muscle energy technique for ER
  » control
  ✓ A single application of MET for the shldr horz abd provided immediate gain in IR & horizontal adduction

Modified Side-Lying Cross Body Stretch

Wilk et al: JOSPT ’13

Laudner, Sipes, Wilson: J Athl Trn ‘08

- Effects of sleeper stretch during a season
- 33 Division I baseball players were evaluated (15 pitchers, 18 position players)
- ROM assessed pre & post season
  ✓ 3 stretches of 30 sec stretch
  ✓ Stretching produced an increase in IR ROM – however not stat sign
Wilk - What's New in The Rehab of the Overhead Thrower 2017
Chicago Sports Medicine

Thrower’s Ten Program

- D2 PNF Flexion
- Standing Full Can
- Tubing ER/IR
- Lateral Raises

Thrower’s Ten Program

- Prone rowing
- Elbow Flex/Ext
- Sup/Pron & Wrist Flex/Ext
- Push-Ups

www.asmi.org

Thrower’s Ten Program

- Sidelying ER
- Prone Full Can
- Prone Horz Abduct
- Prone Row into ER

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Lower Trapezius Exercises

- Kibler et al: AJSM ’08

**TABLE 2**

<table>
<thead>
<tr>
<th>Muscle Group</th>
<th>Low Row</th>
<th>Lateral Row</th>
<th>Biomechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper trapezius</td>
<td>8.1 (6.0)</td>
<td>19.4 (8.3)</td>
<td>15.4 (6.7)</td>
</tr>
<tr>
<td>Lower trapezius</td>
<td>19.4 (28.2)</td>
<td>30.5 (23.4)</td>
<td>15.4 (8.1)</td>
</tr>
<tr>
<td>Sternocostal</td>
<td>31.4 (18.0)</td>
<td>25.5 (21.0)</td>
<td>19.4 (18.4)</td>
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<tr>
<td>Anterior deltoid</td>
<td>41.6 (25.2)</td>
<td>10.2 (10.8)</td>
<td>41.0 (12.4)</td>
</tr>
<tr>
<td>Posterior deltoid</td>
<td>8.0 (3.5)</td>
<td>12.0 (6.8)</td>
<td>14.0 (9.2)</td>
</tr>
<tr>
<td>Biceps</td>
<td>SA = UTT AD PD</td>
<td>FB = UTT LE AD</td>
<td>UT + LT + SA UT + LT + SA + AD</td>
</tr>
<tr>
<td>Triceps</td>
<td>SA = UTT LE PD</td>
<td>LT = AD PD</td>
<td>UTT + LT + SA + AD</td>
</tr>
</tbody>
</table>

*Data are given in mean (standard deviation). KIB: electromyography. RIL: riblets. LM: Brachial plexus. SA, semitendinosus, UTT, upper trapezius, AD, anterior deltoid, PD, posterior deltoid, LT, lower trapezius*
Lower Trapezius Exercises

**Kibler et al: AJSM ‘08**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Low Rin</th>
<th>Lats rows</th>
<th>Robber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper trapezius</td>
<td>10.4 (6.1)</td>
<td>21.8 (15.7)</td>
<td>21.6 (15.7)</td>
</tr>
<tr>
<td>Lower trapezius</td>
<td>15.4 (11.6)</td>
<td>30.5 (22.2)</td>
<td>27.9 (20.8)</td>
</tr>
<tr>
<td>Serratus anterior</td>
<td>10.2 (8.6)</td>
<td>25.8 (20.0)</td>
<td>22.5 (18.6)</td>
</tr>
<tr>
<td>Anterior deltoid</td>
<td>4.4 (2.4)</td>
<td>10.4 (13.3)</td>
<td>7.4 (5.5)</td>
</tr>
<tr>
<td>Posterior deltoid</td>
<td>8.6 (1.6)</td>
<td>14.4 (22.2)</td>
<td>14.4 (10.6)</td>
</tr>
<tr>
<td>Biceps</td>
<td>SAD = UT AD, PD</td>
<td>PIP = UT LE AD UT = LT SAD</td>
<td>UT = LT SAD</td>
</tr>
</tbody>
</table>

**Advanced Throwers Ten Program**

*Data are given in means (standard deviations): EMD, electromyography; AD, adduction; SAD, serratus anterior; UT, upper trapezius; AD, adduction; PD, posterior deltoid; LT, lower trapezius.*
Advanced Thrower’s Ten Program

Plyometrics with Dynamic Stabilization

Serratus Anterior Activation Exercises

Lateral Slides w Theraband CLX

Plank Drills with Shoulder Exercises
Rehab Overhead Throwing Athlete

*Weighted Ball Programs*

- Popular form of training
- Proposed to increase throwing velo
- Program utilizes weighted baseballs
- 4-8 week program prior season
- Been using plyoball throws since ’86
  - Wilk, Gambetta, et al: JOSPT ’93
  - Literature review:
    - DeRenne: Athlet J ’85
    - DeRenne: J Appl Sp Sci R ’90
    - Escamilla et al: Spats Health ’00
    - Fleisig et al: JSH ’16
Rehab Overhead Throwing Athlete

Weighted Ball Programs

Rehab Overhead Throwing Athlete

Weighted Ball Programs

Rehab Overhead Throwing Athlete

Weighted Ball Programs

Rehab Overhead Throwing Athlete

Weighted Ball Programs – Plyoball 1#
Fleisig et al: JSH ‘16

- 25 high school & college baseball pitchers
- 3 trials of 10 different exercises:
  » 4, 5, 6 & 7 oz ball from mound
  » Flat ground holds with 14 & 32 oz baseballs
- Biomechanical analysis during throws
  ✔ Ball velocity with lesser ball mass
  ✔ Overweight throwing - arm torques & forces decreased
  ✔ Underweight throwing – kinematics & kinetics same
  ✔ Exception was elbow flexion torque which significantly increased with increase ball
  ✔ Body positions differences occurred with ball size

Reinold: Unpub 2016

- 34 male high school baseball players (age 15)
- 16 study, 16 control
- Measured strength HHD, ROM, FB velo, elbow stress (motus)
- 6 week training program (2-32 oz balls)
  ✔ Study group 4% (2.6mph) increase in velo, no diff strength, valgus stress
  ✔ ROM 5° increase in ER, TROM (no diff)
  ✔ 3 inj in study grp (2 UCL, 1 Olecranon stress fx)
  0 injuries control group
What is Blood Flow Restriction (BFR) Training

- Causes venous blood to pool distal to the occlusion
  - Creates Hypoxic environment
  - Metabolites accumulate
- Utilizes 20-30% IRM and provides similar gains in muscle hypertrophy & strength
  - Compared with standard ACSM guidelines
    - 70-85% IRM

What is Blood Flow Restriction (BFR) Training-How Does it Work?

- Actual mechanism remains unclear
  - Localized hypoxic stimulus may play important role in BFR training with low load resistance
  - Hypoxic stimulus may cause greater accumulation of metabolites that increase muscle cell swelling, intramuscular anabolic/anti-catabolic signaling, and muscle fiber recruitment (Type-II)
  - All thought to be beneficial for muscular adaptation
  - Hypoxic environment may increase the activation and proliferation of myogenic stem cells leading to enhancing hypertrophic response

Sample: UE Rehab Routine with BFR

- Heat/PROM/Stretching/Dynamic Warm up
- Manually Resisted ER/IR
- BFR Application:
  - Tubing IR/ER bilaterally (3x25)
  - Full Can (3x25)
  - Sidelying ER (3x25)
- BFR Removed
- Total Time of Bands – 15 min

2015 Systematic Review and Meta-Analysis

- Cuff size considerations:
  - Wider cuff results in more occlusion
  - Narrow cuffs result in increased pressure to reach same level of occlusion
  - Increased limb size results in increased pressure to occlude
- Pressures:
  - Leonneke compared 40% to 90% and saw no difference
  - Make sure they can get prescribed sets and reps

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Rehab Overhead Athlete

Return to Play Criteria – ITP I

- Full sport specific non painful ROM
- Satisfactory Clinical Exam
- Strength which meets the criteria
- Appropriate rehab progression completed
- Functional Testing - satisfactory
- Successfully has completed rehab program
- Satisfactory subjective KJOC functional scoring

An Objective Criteria is Important

Criteria to Return to Throwing

Clinical Exam

- Physician Clinical Exam
- Satisfactory exam
- Special tests
- Shoulder Joint
  - SLAP tests
  - Rotator Cuff tests
  - Laxity exam
- Elbow Joint
  - UCL testing
  - Ulnar nerve testing
  - ...

Criteria to Return to Throwing

Shoulder Motion PROM

- Full Non-Painful ROM
- Shoulder ROM within 5° bilateral
- Horizontal adduction 40° >
- GIRD < 15°
- Elbow full non-painful ROM
- Wrist full non-painful ROM

Wilk et al: Corr ’12
Wilk et al: AJSM ’13

Return to Throwing Criteria

Biodex - 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

Criteria to Return to Throwing

Appropriate Rehab Progression

- Plyometrics
  - painfree 2 hand throwing
  - painfree 1 hand throwing
- Dynamic stabilization drills
  - RS drills at 90/90
  - prone ball drops
Return to Throw 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+%>

**Return to Throw Criteria**

**Ball Drop Test - Error**

**Return to Throw Criteria**

**Ball Drop Test (T Side)**

**Return to Throw Criteria**

**Ball Drop Test (NT Side)**

**One Hand Ball Throws Against Wall**

- Ball Wall Throws
  - Baseball Style Throws
    - 2 lb plyoball
    - baseball style throws
    - 30 sec duration
    - bilateral comparison
    - Successful Criteria:
      - no pain
      - proper mechanics
      - no change with fatigue
      - bilateral difference: depends level

**Return to Throw Criteria**

**One Hand Ball Throws Against Wall**
Return to Throw Criteria

Single Leg Squat

- Single leg squat test
- Floor or 8 in step – 30 sec
- 10 reps on each leg (want time)
- Bilateral comparison
- Assess depth
- Assess valgus/varus
- Assess lateral trunk movement
- Assess trunk flexion
- Looking for symmetrical motion with no pain &/or dysfunction

Appropriate Rehab Progression

- Subjective Shoulder Questionnaire & Scoring System

Rehab Overhead Athlete

Return to Play Criteria – ITP II

- Full non painful ROM which fulfills criteria
- Satisfactory Clinical Exam
- Strength which meets the criteria
- Appropriate rehab progression completed
- Completed ITP Phase I, & flat ground at 75% effort
- Functional Testing – satisfactory
- 20 feet throwing into plyoback w/ 1 lb at 66%
- Prone ball drop test – 2 lb: 115%>
- Ball wall throws for 30 sec
- Satisfactory subjective KJOC functional scoring

Criteria to Return to Throwing

Functional Testing

One Hand Ball Throws Against Plyoback 66%
**Rehab Overhead Thrower**  
**Conclusions & Key Points**

- Criteria to initiate ISP reduces re-injury rates by 84% (21/54 pts who didn’t pass – re-injury  
  Grindem et al: BJSM’16)
- Criteria Based vs Time Based Progression
  - Patients progress at different rates
  - Incentivies the patient to be comply & work
- New concepts in rehab
- Rehab continues to evolve & improve
- New is not always better – Evidence Based Rx

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**Thank You**