Internal Impingement in the Overhead Thrower: Recognition & Treatment
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Faculty Disclosure:

- Theralase Laser – Medical Advisory Board
- LiteCure Laser – Consultant
- AlterG – Medical Advisory Board
- Intelliskin USA – Medical Advisory Board
- Zetroz Medical – Medical Advisory Brd
- Throw Like A Pro – Co-Owner
- Dr PRP – Rehab Advisor
- Educational Grants:
  » Performance Health
  » Joint Active System
  » ERMI
  » Bauerfeind Brace
- Book Royalties:
  » CV Mosby, Lippincott, Human Kinetics
The Overhead Thrower

Introduction

• Highly skilled athlete
• Requires flexibility, muscle strength, coordination, synchronicity & NM efficiency
• Proper throwing mechanics
• Proper training program

Injuries Are Common to the Throwers Shoulder & Elbow

Tremendous stresses & velocities

The Thrower’s Shoulder

Overview

• Excessive Motion especially External Rotation
• Requires stability
• Inherent hyper-laxity
• Allows tremendous mobility

Fine line:
Too loose & just right !!!

Paradox of the Thrower’s Shoulder

“Loose enough to throw, but stable enough to prevent symptoms”

Wilk: AJSM ‘02
**Internal Impingement**

**Introduction**

- Occurs during abduction & excessive external rotation
- Late cocking during pitching
- Supraspinatus &/or Infraspinatus rubs on the posterosuperior glenoid rim & glenoid labrum
- Results in fraying of cuff and glenoid labrum & inflammation

Andrews: Op Tech Orthop’88
Walch: JSES '91
Jobe et al: JSES ’93
Internal Impingement

Proposed Causes

- Anatomic factors
- Excessive rotation (ER)
  - “Over-rotation”
- GIRD
- Subtle anterior hyperlaxity
- Muscular weakness
  - Lack of dynamic stability
- Faulty biomechanics

Internal Impingement

Introduction – Overlapping Pathology

- Eccentric overload
  - deceleration phase of throwing
  - large eccentric forces (1x BW)
  - resulting in rotator cuff partial tears
- Rotator Cuff Pathology
  - partial thickness tears
  - symptomatic late cocking & deceleration phase pain
  - rotator cuff wear
Is Internal Impingement **normal** in the overhead thrower???

**Internal Impingement**  
*Proposed Mechanism* #1

- Anatomic theory  
  *Jobe & Sidles: JSES '93*  
  - cadaveric study  
  - max ER at 90° ABD  
  - produced internal impingement  
  - greater tuberosity forces RTC & labrum into glenoid rim

**Halbrecht et al Arthroscopy 1999**

- Examined 10 college pitchers (asymptomatic)  
- Bilateral MRI performed  
- Shoulder placed in throwing position (ABD / ER)  
  - 10/10 physical contact between rotator cuff and posterior superior glenoid  
  - 0/10 physical contact on non-throwing side  
- 3/10 superior labral tear, 4/10 rotator cuff changes
Internal Impingement
Proposed Mechanism - # 2

- Anterior laxity / posterior tightness theory
- Unidirectional laxity
- “Over-rotation” – JRA theory
- Thrower’s ROM (excessive ER, limited IR
- Tightness of posterior capsule causing anterior humeral head migration
- Causing rubbing posterosuperior

Rehab of the Thrower
GIRD Theory

GIRD Theory
Glenohumeral Joint
Internal Rotation Deficit

Burkhart, Morgan, Kibler:
Arthroscopy ’03

Loss of Internal Rotation
GIRD Concept - Morgan

✓ GIRD: GH Internal Rotation Deficit
✓ Loss of IR compared to non-throwing shoulder
✓ Shoulder at risk = GIRD > 20 degrees
✓ Treatment: stretching posterior capsule
  Non-responders – capsular release
  Posterior Inferior Capsulotomy
  Morgan CD: Unpub ’05
  Burkhart et al: Arthroscopy ’03
Internal Impingement

Proposed Mechanism- # 3

- Hyperangulation Jobe C. ‘93
- Throwing mechanics
- Throwing: Humerus in plane of scapula
- Fatigue occurs - improper mechanics
- Arm lags behind scapula
- Shoulder joint subjected to increased torques & strains

Proposed Mechanism- # 4

- Muscular weakness / fatigue
- Muscular imbalance ER/IR
- Loss of dynamic stabilization
- Increased anterior humeral head displacement
- Weakness, poor stabilization & loss of proprioception & NM control

Fatigue/Weakness

Increased Humeral Head Displacement
Rehabilitation of the Thrower

Keys to Successful Rx - Internal Impingement

- Accurate & differential diagnosis
- Assess ROM
  » total motion concept, GIRD, retroversion, scapula
  » muscular flexibility
- Assess laxity
- Examine muscular strength (ratios)
- Review conditioning & throwing program
- Analyze throwing mechanics

Internal Impingement

Clinical Signs & Symptoms

- Pain with excessive ER
- Positive internal impingement sign Meister AJSM '98
- Excessive ER (130-155°)
- Limited IR (35-45°)
- Posterior shoulder tightness
- Posterior tenderness
- Muscular weakness (ER, full can, scapula)
- History of recurrent symptoms (decreased velocity, pain, “inability to get loose”)
Internal Impingement
Clinical Examination

- Subtle anterior hyperlaxity
- Excessive anterior capsular laxity
- Humeral head displaces anteriorly
- Results in rubbing anteriorly
- Internal impingement sign
  Meister et al: AJSM ’98

Andrews, Wilk, Reed et al: Spring Trn ’00

- 31 asymptomatic professional baseball pitchers tested at onset spring training
- MRI of glenohumeral joint (ABDER view)
- 28/31 (90%) abnormal glenoid labrum
- 27/31 (87%) abnormal rotator cuff appearance
- 12/31 (39%) humeral head changes
- All pitchers were pain-free at time of study
- All MRI scans assessed by radiologist

Glennchumeral Internal Rotation Measurements Differ Depending on Stabilization Techniques
\[ ER + IR = \text{Total Motion} \]

"Envelope of Motion"

Total Rotational Motion is equal bilaterally (within ±5° degrees)

Wilk AJSM '02

Non-Throwing Shoulder

Throwing Shoulder

Wilk, Macrina, Porterfield et al: 2015

Pitchers Shoulder ROM ('05-'14)

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<thead>
<tr>
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<th>ND</th>
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<tbody>
<tr>
<td>ER at 90° abduction</td>
<td>131.1</td>
<td>125.1</td>
</tr>
<tr>
<td>IR at 90° abduction</td>
<td>53.3</td>
<td>63.2</td>
</tr>
<tr>
<td>Total Rotational ROM</td>
<td>184.3</td>
<td>187.4</td>
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<tr>
<td>Horizontal adduction</td>
<td>42.9</td>
<td>45.2</td>
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<tr>
<td>ER Horz Adduction</td>
<td>32.5</td>
<td>28.1</td>
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Loss of IR Due to Several Factors:

1. Osseous adaptations
   1° Cause of the IR loss
   superimposed other factors:
   2° Contributing Factors
   - Scapular posture – anterior tilt
   - Posterior muscular tightness
   - Shoulder fatigue
   - Posterior capsular thickness/thickness
Osseous Adaptation and Range of Motion at the Glenohumeral Joint in Professional Baseball Pitchers*

Helen C. Crockett, MD, London B. Gross, MD, PhD, Janet E. Wilk, PT, MS, Michelle T. Plybois, PT, MS, Jeffrey A. Douglas, MD, Keith Blaueter, MD, Stephen Lyman, PhD, and James E. Andrews, MD

From the Sports Medicine Institute, Birmingham, Alabama, the Texas A&M Sports Medicine Institute, College Station, Texas, and the University of Florida Shands Clinic, Gainesville, Florida.

Crockett, Gross, Wilk, et al: AJSM '02

• 25 professional baseball pitchers
• Compared to 25 subjects (never played baseball)
• Assessed laxity, ROM and CT scan
• Average ROM
  ➢ Throwers: ER 129º, IR 61º
  ➢ Non-throwers: ER 119º, IR 7º
• Total motion: NS side-to-side
• Laxity: NS side-to-side

CT scan: humeral retroversion:
  ➢ Throwing side: 40º
  ➢ Non-throwing side: 28º
  ➢ Control group (NT): 22º = bilateral

Humeral Retroversion Throwers

Bilateral Differences – 34 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, Pill, Shanley, et al: AJSM '12 (13 *)
Whiteley et al: JOSPT ’09 (Ultrasound 11.9 *)
Hibbard 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
Polster et al: AJSM '13 (correlation to injury in professional
Humeral Retroversion Throwers
Bilateral Differences

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 grip less retrov)

Overhead athletes osseous adaptations

Increase in Humeral Retroversion
Accounts for Age-Related Increase in
Glenohumeral Internal Rotation Deficit
in Youth and Adolescent Baseball Players

AJSM '14

- 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

ASSESS DON'T ASSUME!!
Treat the clinical findings

ASSESS DON’T ASSUME !!

Treat the clinical finding

Specific Rehabilitation Concepts
Internal Impingement
Rehabilitation Overview

- Reduce inflammation & pain
- Restore flexibility & ROM
- Enhance dynamic stabilization
- Enhance rotator cuff strength
- Normalize posture & scapular strength
- Improve muscular endurance, proprioception & NM control
- Endurance & body position
- Correct faulty mechanics
- Gradually return to throwing

New Rehabilitation Concepts

Rehabilitation of Overhead Athlete
Rehabilitation Program - Overview

- Reduce Pain &/or Inflammation
- Normalize Motion
- Postural Correction Exercises
- Stabilization Program
- Enhance Proprioception & NM control
- Kinetic Chain Effect
- Correct Throwing Biomechanics
- Enhance Tissue Regeneration
Rehabilitation of Overhead Athlete

Reduce Inflammation Program

- Reduce Pain &/or Inflammation
- Tendinitis program
- Anti-inflammatory treatment
  - NSAIDs, Iontophoresis, Laser
- Restore tendon health
- Flexibility (light program)
- Strengthening program
- Determine cause of onset
Rehabilitation of Overhead Athlete

**Motion Imbalance Program**

- Improve IR ROM
- Restore total rotational ROM balance

**Capsular Restriction**
- Supine Horizontal Adduct Stretch
- Sleeper’s stretch
- Joint mobilization

Treatment based on assessment

**Musculotendinous**

Rehabilitation of Overhead Athlete

**Postural Correction Program**

- Improve soft tissue flexibility
- Pectoralis minor stretches
- Strengthen Rhomboids/ Trapezius
- Neuromuscular control drills
- Scapular ↔ Pelvis Link
- Proprioception of scapular
- Scapular shirt

Rehabilitation of Overhead Athlete

**Stabilization Program**

- Emphasize dynamic stabilization drills
  - Neuromuscular control
  - Rhythmic stabilization
  - Proprioception drills
  - Perturbation activities
- Muscular balance
  - ER/IR
  - ER/Deltoid
  - Scapular ratios
- Entire body awareness
  (core, hips)
- Core stabilization drills - tone
Rehabilitation of Overhead Athlete

**Kinetic Chain Effect**

- Assess & treat deficiencies in the entire kinetic chain
- GH, ST, Core, Hips, Legs
- Pelvic girdle ↔ Shoulder girdle
- Hip abduction, ER, Extension
- ND & D Hip PROM
- Core position & stabilization

**Correct Biomechanics Program**

- Is athlete able to get into proper body position – to perform task
- Adequate/proper ROM
- Body awareness – proprioception
- Break it down into components
  - analyze each phase of the throw
  - proper body position?
- Biomechanical assessment

Motion Analysis Study → Coach

**Tissue Regeneration Program**

- Rotator Cuff Partial Thickness Tears
- **Tendonosis - Tendinopathy**
- Restore musculotendinous flexibility
- Promote collagen synthesis & organization:
  - ↑ blood flow – heat, ultrasound, etc
  - Cold laser
  - Eccentric loading of muscle
  - Higher loads
  - Nutrition

Tissue Regeneration
Internal Impingement
Rehabilitation Overview

- Enhance rotator cuff strength
- Improve scapular muscular endurance
- Improve muscular endurance / proprioception
- Restore flexibility to posterior structures *(improve IR & Hz Add)*
- Do not further stretch anterior, inferior structures / capsule
- Correct faulty mechanics

Internal Impingement
Acute Phase

- Diminish pain and inflammation
- Normalize motion
- Re-establish dynamic stabilization
- Control stresses

Internal Impingement Rehab
Diminish Pain & Inflammation

- Active rest
- Motion, tolerance level
- Exercise at tolerance level
- Modalities
  » Ultrasound
  » Iontophorosis
  » Heat or ice
Posterior Impingement Rehab
Normalize Motion-Stretching

- Consider “total motion concept”
- Caution when stretching into ER
- Do stretch into IR & Horizontal Adduction
- Adjust intensity of stretch to player’s laxity !!!
Loss of Internal Rotation

• Cause(s) for limited IR
  » osseous adaptations
  » capsular hypomobility
  » muscular tightness
  » Or is it something else ??

Re-establish
Dynamic Humeral
Head Control
Internal Impingement

Establish Muscular balance

- Emphasize muscular balance
  - ER/IR ratio: 62-72%
  - ER/ABD ratio: 64-69%
  - ABD/ADD ratio: 66-72%
- Emphasize ER & scapular muscles

Wilk: AJSM '93
Wilk: AJSM '95
Towel roll increases infraspinatus, teres minor EMG activity by 18-20%.

Posterior Impingement Rehab
Subacute Phase

- Progress strengthening program
  » isotonic strength training
  » entire upper extremity
- Continue flexibility / stretching
  » maintain IR & horz adduction
- Gradually increase functional stresses
  » initiate plyos & throwing position drills
Internal Impingement Rehab
Progress Strengthening Program

• Emphasize muscular balance
• Manual resistance drills
• Rhythmic stabilization drills (@ end range)
• Isotonic strengthening
• Trunk and leg training
  » Core stabilization
Posterior Impingement Rehab
Gradually Increase Stresses

- Functional drills
- Initiate *plyometrics*
- Gradually increase plyometrics
  » *Continue stretching / flexibility*
- Continue stretching, maintain ROM
Posterior Impingement Rehab
Advanced Phase

- Aggressive & advanced strengthening program
- Functional drills - plyos
- Gradual return to throwing
Posterior Impingement Rehab
Advanced Strengthening

- Improve strength, power, endurance
- *Thrower’s ten program*
- Manual resistance program
- Endurance drills

Internal Impingement
Functional Drills

- Thrower’s ten program
- Plyometric drills
- Interval throwing program
  - long toss
  - interval mound throwing
  - competition
Internal Impingement

Functional Drills

• Interval Throwing Program
  » How far should a player throw??
  » Pitcher vs position player
  » Should pitchers throw further than 120 ft ??

Rehabilitation of Internal Impingement

Rehabilitation

• Utilize plyometric training as transition
  » Two hand drills one hand drills
• Gradual return to throwing
• Monitor throwing mechanics

Internal Impingement

Key Points

• Recognition of pathology
differential diagnosis
• Establish cause - treat cause
• Improve posterior flexibility, IR & Horz Adduction
• Establish muscular balance
• Scapular muscular strength
• Enhance proprioception & NM control
• Gradual return to throwing
Internal Impingement

• If non-operative treatment fails
• Surgical intervention may be required
  » Arthroscopic debridement
  » Open capsular shift
  » Arthroscopic plication
  » Arthroscopic TCS

Thank You!