Rotator Cuff Lesions

Kevin E. Wilk, PT,DPT,FAPTA

Introduction

- Commonly seen pathology
- Wide spectrum of severity:
  - mild impingement
  - progressive failure
  - full thickness tears
- Rotator cuff failure is usually progressive process
- Numerous contributing factors
- Rehabilitation programs must vary significantly

The treatment plan – non-operative

ROTATOR CUFF PATHOLOGY

Classification

- Primary compressive cuff
- Primary tensile overload
- Primary internal impingement
- Rotator cuff failure / tear
- Calcific tendinitis
- PASTA lesions
- PAINT lesions
- Secondary compressive primary hypermobility
- Secondary internal impingement primary hypermobility
- Secondary tensile overload primary hypermobility
**ROTATOR CUFF PATHOLOGY**

**Classification**
- Primary compressive cuff
- Primary tensile overload
- Primary internal impingement
- Rotator cuff failure / tear
- Calcific tendonitis
- PASTA lesions
- PAINT lesions
- Secondary compressive primary hypermobility
- Secondary internal impingement primary hypermobility
- Secondary tensile overload primary hypermobility

**Tendonopathy**
- Increased T1-signal; thickened/attritional changes (thinned)
- Intermediate T2-signal (No Fluid Signal)

**Partial Thickness Tear (Articular)**
- T2 Fluid Signal extending into black tendon
- Partial Thickness Undersurface Tear

**Partial Thickness Tear (Bursal)**
- Fluid Signal Extending into the Bursal Surface of the Supraspinatus Tendon

**Partial Tear Classification**

**Partial Rotator Cuff Tears**

**Depth & Location**

- **Articular**
- **Bursal**

*Ellman 1987*
**Pasta Lesions**

- **P** - partial
- **A** – articular sided
- **S** - supraspinatus
- **T** - tendon
- **A** - avulsion

**Paint Lesions**

- **P** - partial
- **A** – articular side
- **IN** - interstitial
- **T** - tear

**ROTATOR CUFF**

**FAILURE**

- Wide spectrum of severity
  - full thickness
  - partial thickness
- 70% of tears occur in sedentary individuals
  - *Neer: Clin Orthop '83*
- Tears occur > 40 yo (50-60)
- Gradual weakening → failure
  - *Hawkins: JBJS '87*

**Causes of Failure**

- Tendon weakened by combination of factors
  - Age
  - Repeated microtrauma
  - Disuse - attrition
  - Steroid injection (repeated)
  - Impingement
  - Hypovascularity
  - Tendons poor oxygen uptake \(7.5\) lower than muscles
  - Major trauma

- Usually gradual weakening - failure

**ROTATOR CUFF VASCULARITY**

- RTC vascularity, position dependent
- Shoulder adduction less BF
- Shoulder abduction less BF
- "Winging out of cuff"
- BF & shoulder position

*Rathbun, MacNab: JBJS 1966*
Rotator Cuff Anatomy

Microvasculature

- Codman ‘34 – avascular region of cuff "critical zone"
- Lindbloom et al. ‘39 – hypovascularity "critical zone"
- Rothman CORR: ‘65 – undervascular in critical zone
- Rathbun: JBJS ’66 - decreased vascularity "position dependent"
- Moseley et al: JBJS ’63 – not less blood flow “rich in anastomoses”
- Swiontkowski CORR: ‘87 – utilized laser doppler substantial blood flow in zone position no effect on BF
- Iannotti: JBJS ‘89 - laser doppler study “significant BF in the critical area”
- Brewer: AJSM ’79 - hypovascularity “effects of age on vascularity”

Platelet Rich Plasma

Overview - PRP

- Autologous blood therapy
- Uses patient’s own blood components to stimulate healing response
- PRP – enhance body’s own healing response
- Uses platelets which have growth factors
- Used to treat "injured tissues"

Overview - PRP

- Withdraw autologous blood sample
- Add anticoagulant
- Centrifugation twice
  » 1st remove RBC’s
  » 2nd separate platelet poor plasma from platelet rich plasma
- Extract PRP
  » 4-8x whole blood concentration
- Add calcium & thrombin to activate platelets
- Relatively quick & easy
Platelet Rich Plasma Overview - PRP

- Gosens et al: AJSM '11
  - PRP vs corticosteroid injection
  - DBRCT: lateral epicondylitis (2 yrs follow)
  - PRP group better: pain & function
- Peerbooms et al: AJSM '10
  - PRP vs corticosteroid injection
  - DBRCT: lateral epicondylitis (1 yr follow)
  - PRP group better
- Mishra et al: AJSM '06
- Thanas et al: AJSM '11
- Hechtman et al: Orthopaedics '11

Does PRP work?

- Significantly different
  - Peerbooms, AJSM, 2010
  - Koo, KOSTA, 2010
  - Filardo, KOSTA, 2010
  - Robert, Arthroscopy, 2016
  - Wang, Sangeux, AOTL, 2011
  - Thanas, AJSM, 2011
  - Geiger, AJSM, 2011

- No difference
  - Selis, KJTA, 2009
  - De Vos, JAMA, 2010
  - Vigor, EJR, 2016
  - Cnarey, AJSM, 2011
  - De Jonge, AJSM, 2011
  - Sekerpi, AJSM, 2011

Scenario 2: PRP for Tendinopathy

- Significant difference
- No difference

- Dragoo J: 2014

Dragoo J: 2014

Dragoo J: 2014
Platelet Rich Plasma

**Literature - PRP**

- **Yamaguchi et al.** JSES ’01
  - Natural history of asymptomatic rotator cuff tears over a 5 year period (sonogram)
  - 45 patients (22 males), unilateral symptoms & contralateral asymptomatic cuff tear
  - Mean age 69 yrs (52-85)
  - 13 (18%) previously asymptomatic became symptomatic - within (3 yrs)
  - 9/45 had progression of tear (20%)
  - None had a decrease in tear size

- **Pettersson: ASES ’89
  - Natural history of asymptomatic rotator cuff tears over a 5 year period (sonogram)
  - 71 healthy, asymptomatic shoulders
  - Age 18 -85, arthrography
  - 13 (18%) + Arthrogram
  - Symptom free & no previous history

**FAST Procedure**

**Overview**

- **FAST Procedure**
- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique

**FAST Procedure**

- **Focused Aspiration Soft Tissue**
- Precutaneous removal of diseased soft tissue
- Tenex Health
- Ultrasound guided, 18 gauge needle technique
Kuhn et al: JSES '13

- Effectiveness of physical therapy in the Rx of atraumatic full thickness rotator cuff tears: a multi center study
- 452 patients – evaluated at 6 & 12 weeks & then phone interview at 1 & 2 yrs post
- Assessed ASES score, Western Ontario, single
  ✓ PT successful in 75% of cases
  ✓ 25% patients went on to have surgery – if elected to have surgery occurred 6-12 wks

Rotator Cuff

Rotator Cuff Tears

Age Related Prevalence

- Rotator Cuff Tears in Asymptomatic Shoulders
  Tempelhof, Rupp, Seil: JSES '99
  ✓ Overall incidence 23% (n=411)
  ✓ 50-59 yr old: 13%
  ✓ 60-69 yr old: 20%
  ✓ 70-79 yr old: 31%
  ✓ 80+: 51%
  ✓ “normal” degenerative attrition

- Rotator Cuff Tears in Asymptomatic Shoulders
  ✓ Overall incidence 22% (n=664)
  ✓ 20-40 yr old: 0%
  ✓ 50-59 yr old: 10%
  ✓ 60-69 yr old: 15%
  ✓ 70-79 yr old: 26%
  ✓ 80+: 36%
  ✓ Asymptomatic tears: 65% & symptomatic tears: 34%
  ✓ More tears in males than females
Shoulder Impingement
Compressive Cuff Disease - Neer

- Failure under "compressive loads" as cuff impinges upon coracoacromial arch
- Hallmark: "extra-articular" superior surface tears (outside-in lesion)
  - Subacromial erosion
  - Gradual cuff rotator failure
  - Progressive cuff failure

Subacromial Space
Subacromial Impingement
Overview

Factors contributing to impingement

Structural

Functional

ACROMIAL SHAPE
Bigliani, Orthop Trans 1986

Type I: Flat
Type II: Curved
Type III: Hooked

Table I  Acromial morphologic condition by age groups

<table>
<thead>
<tr>
<th>Decade</th>
<th>Type I (%)</th>
<th>Type II (%)</th>
<th>Type III (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-30</td>
<td>32</td>
<td>37</td>
<td>31</td>
</tr>
<tr>
<td>31-40</td>
<td>27</td>
<td>44</td>
<td>29</td>
</tr>
<tr>
<td>41-50</td>
<td>37</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>51-60</td>
<td>31</td>
<td>52</td>
<td>17</td>
</tr>
<tr>
<td>61-70</td>
<td>33</td>
<td>44</td>
<td>23</td>
</tr>
<tr>
<td>Total population</td>
<td>32</td>
<td>42</td>
<td>26</td>
</tr>
</tbody>
</table>

Nicholson et al: JSES ‘96
Compressive Cuff Disease
Structural Factors

- Bursae:
  - Inflammation
  - Thickening

- Rotator cuff tendon:
  - Tendinitis
  - Thickening
  - Partial thickness tears

- Humeral Head:
  - Congenital abnormalities
  - Fracture malunion

- Acromioclavicular Joint:
  - Joint abnormalities
  - Sprains
  - Degenerative spurs

- Acromion:
  - Abnormal shape
  - Spurs
  - Os Acromiale - unfused
  - Malunion of fracture
  - Nonunion of fracture

Compressive Cuff Disease
Functional Factors

- Rotator Cuff:
  - Weakness
  - Inflammation
  - Imbalance
  - Poor dynamic stab

- Capsular:
  - Hypomobility
  - Hypermobility

- Scapular Factors:
  - Postural adaptations
  - Position
  - Restriction in motion
  - Neuromuscular control
  - Paralysis
  - Fascroscapularhumeral Muscular Dystrophy

IMPINGEMENT TREATMENT
Overview – Possible Pathomechanics

- Glenohumeral capsular hypomobility
  - Capsular tightness
  - Asymmetrical tightness

- Glenohumeral joint hypermobility
  - Rotator cuff weakness (ER/IR)
  - Muscular imbalance

- Scapular abnormalities
  - Scapular position, posture
  - Scapular hypermobility
  - Anterior scapular tilting

Stages of Subacromial Impingement

- Acute Onset
- Chronic Lesion

Same Rx
Approach??

Subacromial Impingement
Functional Factors-Secondary

- Capsular Hypomobility
- Capsular Hypermobility
- Inadequate rotator cuff strength
  - Poor dynamic stabilization
- Scapular position

Treatment Variations

Acute Onset  ➔  Chronic Lesion
Rehab Compressive Cuff Disease

Treatment Philosophy

- Accurate & differential diagnosis
- Identify all causative factors
- Identity all involved structures
- Treatment sequentially & systematically – prioritize
- Progressive & functional rehab
- Caution against overaggressive activities early in rehab progress

Rehab Compressive Cuff Disease

Treatment Formula

- Acute Phase:
  - Postural corrections
  - Activation exercises
  - Calm inflamed tissue down
  - GH joint stability/mobility – “balance”
- Subacute Phase:
  - Restoring balance (muscle, capsule)
  - Improving strength with proper activation
  - Maintaining posture during activities
- Chronic Phase:
  - Endurance
  - Maximizing functional activities

Rehab Compressive Cuff Disease

Acute Episode

- Diminish inflammation & pain
- Restore or maintain ROM
- Improve or maintain proper posture
- Emphasize cuff & scapular strengthening
- Gradual restoration of activities
- Avoidance of specific activities

Rehab Compressive Cuff Disease

Acute Phase - Goals

- Normalize motion
- Diminish pain - inflammation
- Re-establish baseline dynamic stability
- Patient education, activity modification
- Correct postural adaptations

Rehab Compressive Cuff Disease

Normalizing Motion

“Reverse capsular pattern”
Wilk & Andrews Orthop 1994
- Inferior capsular tightness
  - Possibly posterior capsular tightness
- Joint mobilization
- Physiologic stretching
- CR, HR stretches
- AAROM, PROM, capsular stretches

Assess postural adaptations to improve motion
Always Supine ??

Asymmetrical Capsular Tightness
Proper Glides

Bang, Deyle: JOSPT ‘00

- Compared two PT treatment approaches for the treatment of shoulder impingement – prospective randomized clinical trial
- 50 patients (30 male) with diagnosis of shoulder impingement syndrome were prospective randomized into 2 groups
  - Group I: exercise grp: (flexibility & strengthening exercises
  - Group II: manual Rx grp: (same program but addition of manual therapy
- Intervention was 6 times over 3 weeks
- Testers were blinded, assessed on strength, ROM, pain (VAS), functional assessment questionnaire
- Results: both groups improved
  - However, manual Rx group stat sign improvement over other group regarding pain and strength

McClure, Bialker, Neff et al: PT ‘04

- Shoulder function in people with shoulder impingement before & after 6 week exercise program
- 59 patients with impingement syndrome
- 39 patients Rx with 6 week program @ 6wks & 6 mos.
- Pain, satisfaction, function, strength, ROM & 3D scapular kinematics were assessed
  - Improvement in all areas (ROM, strength, pain & function)
  - No difference in scapular kinematics
  - “relatively simple exercise program with pt education”

Kuhn: JSES ‘09

- Effectiveness of exercise in the treatment of rotator cuff impingement
- Systematic review of 11 randomized controlled trials & studies
  - Data demonstrated exercise has statistical & clinically significant effects on pain & improving function but not ROM or strength
  - Manual therapy augmented the effects of exercise
  - No difference b/t home & supervised program

Rehab Compressive Cuff Disease

Baseline Dynamic Stability

- Emphasis: posterior rotator cuff & scapular muscles
- Initially, co-contraction (RS) “balance of forces”
- Isometrics if painful - Isotonics if not painful
Rehab Compressive Cuff Disease

Baseline Dynamic Stability

- Initial strengthening program – focus on posterior shoulder structures
- Posterior shoulder dominant program
  - ER strengthening
  - Scapular muscles
  - Retractors
  - Depressors
  - Protractors (?)

Stackhouse et al: JSES ’12

- 17 healthy adults asymptomatic were tested
- Isolated ER force HHD
- Tested pre injection then after painful injection (1.5mL 5% hypertonic saline) into subacromial space
  - After painful injection ER force decreased by 32% and EMG by 23%

Rehab Compressive Cuff

Diminish Pain / Inflammation

- Pain = Inflammation
- Modalities, ice, heat, ultrasound, iontophoresis (patch)
- Biomechanical factors
- Avoidance program
- NSAID’s (?)
Iontophoresis

Hybresis

The IontoPatch

Anderson et al.: Physical Therapy 83(2) 2003

Supraspinatus Tendonitis

Tendonosis

- Similar subjective complaints
- Pain present at rest
- Often associated with biceps tendonosis
- Treatment significantly different than paratendinositis
- Tendon degeneration—arthritic tear
- Tendon failure—poor healing response

Localised Area

Diffuse Area

Supraspinatus Tendonitis

Tendonosis Rx

- Promote tendon healing—circulation
- Heat & ultrasound: No ice
- Stretch musculotendinitis unit
- No NSAIDs
- Eccentric muscle training
- Transverse massage, soft tissue
- Cuff strengthening program
- Gradually increased applied loads

Key: stimulus for collagen synthesis

Deep Tissue Laser Therapy

Supraspinatus Tendonitis

Peritendinitis Rx

- Treatment of rotator cuff tendinitis
- Active rest
- Ice, modalities
  - Iontophoresis “patch”
  - NSAID
  - Injection
- Avoidance
- Enhance posterior flexibility
- Improve dynamic stabilization
- Gradually increase applied loads

Key—Diminish soft tissue inflammation
Deep Tissue Laser Therapy

Then & Now

**Laser Therapy**

*How does it work - Benefits*

- Light from laser penetrates into tissue, where light energy is converted into chemical energy (First law of Photo Chemistry)
- Mitochondrion stimulated to produce more energy (ATP) and repair damaged tissue (Kreb’s Cycle / Electron Transport Chain)
- Production of up to 700% more nitrous oxide for vasodilation of capillaries compared to 0% from placebo or continuous wave lasers
- Decreases / eliminates pain
- Reduces inflammation
- Promotes new blood vessels and tissue growth
- Faster wound healing and closure
- Stimulation of osteoblasts

- Decreases / eliminates pain
- Reduces inflammation
- Promotes new blood vessels and tissue growth
- Faster wound healing and closure
- Stimulation of osteoblasts
Shock Wave Therapy

**Piezo Wave**

- Shock waves are single-impulse with high-amplitude and short-length sound waves from
- a transient pressure disturbance that propagate
- In 3D space, with a sudden rise from ambient pressure to its maximum pressure at the wave front.

**Mechanisms of Action**

- MyACT employs the natural mechanisms, by which cells "convert" mechanical forces into cellular biochemical events
- Compression exerts a mechanical stress on cells resulting in heightened expression of proangiogenic genes such as eNOS (endothelial nitric oxide synthase), VEGF (Vascular Endothelial Growth Factor), CXCL5, CCL2, CCR2 (Chemokines and receptors), and proangiogenic proteins of VEGF and vWF
- Promotes increased circulation and pain relief
Shock Wave Therapy
Piezo Wave

Physiological effects of ultrasound
- Optimizing ultrasound-based bio-modification—It's physics
- Sustained Deep
- Terrestrial Effects
- On Tissue Due to Absorption
- Increased Circulation
- Temperature and Mitochondrial Activity
- Increased Wound Healing
- Increased Extracellular Matrix
- Compression and Remodeling
- Improved Microcirculation

Ultrasound Therapeutic Effects
- Physiological Effects:
  - Thermal Effects:
    - Decreased pain perception
    - Increased blood flow
    - Reduced muscle spasm
    - Improved joint mobility
    - Reduced pain levels
    - Increased Extensibility of collagen
  - Non-Thermal Physiological Effects:
    - Increased skin elasticity
    - Reduced pain levels
    - Increased bone density
    - Increased bone growth
    - Decreased inflammation
    - Wound healing

Low Intensity Therapeutic UltraSound (LITUS)
Rehab Compressive Cuff Disease

Patient Education - Posture

Postural adaptations
- Posture modification
- Activity modification
- Don’t smoke – promote healing...
- Pathomechanics of impingement
- Compliance

Postural Correction

- Scapular angular position assessment at end range internal rotation
- 3-dimensional scapular assessment
- 23 subjects were analyzed
- IR ROM deficit group exhibited significantly greater scapular anterior tilt (9 deg) compared to control group

---

**Lukasiewicz et al: JOSPT ’99**

- Analyze scapular position and orientation in subject w/ impingement & normals
- 3D electromechanical devices in 3 planes
- During arm elevation: posterior tilting, upward rotation, protraction
- Impingement subjects: greater scapula elevation & less posterior tilting*
Scapular Assistance & Retraction Maneuver

Kibler: AJSM '06
McClure: JOSPT '12

IntelliSkin
The benefits
- Maximizing your surgical outcomes
- Enhancing your patients' experience

www.intelliskin.com
Seitz, McClure, Finucane et al: JOSPT ’12

- Scapular assistance test
- 42 Subjects: 21 with SAIS & 21 controls
- 3D motion analysis at 0, 45 & 90 deg elevation
- Increase in posterior tilt at all angles
- Acromiohumeral distance improved at 45 & 90
t “more subacromial space”
- No change in isometric strength

Best Stretch for Pectoralis Minor

Pectoralis Minor Muscle Stretching
Factors affecting stretch

- Ability to relax
- Humeral abduction
- Humeral ER
- Position of scapula
- Posterior tilted
- ER

Pectoralis Minor Muscle Stretching
Overview

Borstad & Ludewig: JSES ’06
- Comparison of 3 stretching techniques:
  - Each technique different
  - Unilateral self stretch (1st)
  - Supine manual stretch (2nd)
  - Seated manual stretch (3rd)

Muraki et al: Phys Ther ’09
- Comparison of 3 stretching techniques cadaveric study:
  - Scapular retraction at 30 deg flexion best
IMPINGEMENT TREATMENT

**Early Phase - Keys to Treatment**
- Normalize motion
- Capsular mobility (balance)
- Establish dynamic stability (ER/IR)
- Diminish pain &/or inflammation**
- Postural correction & patient education

IMPINGEMENT TREATMENT

**Intermediate Phase - Goals**
- Full non-painful ROM - capsular
- Improve strength, endurance
- Promote dynamic stability
- Maintain correct posture

IMPINGEMENT TREATMENT

**Intermediate Phase - Exercises**
- Continue stretching and flexibility exercises
- Initiate complete shoulder program
  - Deltoid, supraspinatus
  - ER & scapular muscle training
  - Adjust work levels
  - Emphasize eccentrics
  - Endurance program
  - Continue dynamic stabilization drills
Scapular Muscle Training
Train the Scapular Daily

- **Isotonic table days**
  - Heavier weights
  - Isolated movements
  - Hypertrophy
  - Neuromuscular drills

- **Stability Ball days**
  - Lighter weights
  - Bilateral movements
  - Combined movements
  - Trunk, core, ...

---

**Cools, et al: AJSM ’03**

- Scapular muscle recruitment patterns (timing)
- Compared 39 overhead athletes with shoulder pain (impingement) to 30 painfree overhead athletes
- Performed EMG to scapular & deltoid muscles – performed drop arm test
  - Significant slower muscle activation in MT, LT in painful grp. compared to control grp. (esp. LT)
  - Painful grp. slower recruitment from deltoid to trapezius

---

**Cools, Witvrouw, et al: AJSM ’07**

- Rehabilitation of scapular muscle balances
- Which exercises to prescribe
- EMG activity, analysis of muscle ratios
- Trapez EMG activity (UT, MT, LT)  UT:LT  MT:LT
- 4 exercises were best:
  - Sidelying ER
  - Prone extension
  - Prone horizontal abd
  - Sidelying forward flexion
  - “consider these exercises when selecting scapular muscle ratios…”

---

**DeMey, …Cools: JOSPT ’13**

- 30 asymptomatic overhead athletes with scapular dyskinesis
- EMG analysis: UT/LT, UT/MT ratios
- 4 selected exercises performed with & without scapular correction
- 4 selected exercises:
  - Prone extension
  - Sidelying ER
  - Prone horizontal abd
  - Sidelying forward flexion
  - Increased EMG ratios with side lying ER & prone extension
  - No difference with side fwd flexion or prone horz abd
Reinold, Macrina, Wilk: J Athl Train ‘07

- EMG activity of supraspinatus & deltoid muscles during 3 common exercises
- 22 asymptomatic subjects (15 men)
- Fine wire EMG dominant shoulder
- Full can, empty can & prone full can
- Results: no sign diff in supraspinatus EMG
- Middle Deltoid sign greater during FC & PFC
- Posterior Deltoid: sign greater PFC & FC

*Best exercise for supraspinatus – standing full can*

**Best Exercises for Supraspinatus**

- Standing full can
- Military press
- Prone full can
- Lateral raises
- Empty can ???

Supraspinatus muscle activity is important to normal shoulder function but not critical!!!

MMT - Rotator Cuff
Kelly, et al AJSM 1996

- EMG analysis of shoulder muscles
- Supraspinatus, infraspinatus, subscapularis
- Tested 11 subjects, 29 isometric contractions
- Maximize neural activation of desired muscle
- Simultaneously minimize activation of synergists
- Optimal Position: “Full Can”
Solem - Bertoft: Clin Orthop '93
• Used MRI to determine effect of scapular retraction & protraction on acromial space
• Subjects supine & passively positional
• Protraction position sign reduced acromial angle, or anterior tilting of scapula

• Study scapular positions in 22 asymptomatic shoulders, 22 unstable & 7 impingement
• Analyze positions: arm at rest, elevated to 90°
• Impingement patients exhibited increased scapular elevation & winging

Greenfield, et al JOSPT ’95
• Measured head, thoracic spine, scapular resting posture & ROM
• Subjects asymptomatic vs. overuse injury
• Subjects with overuse injuries exhibited forward head posture & greater shoulder elevation
• No significant difference in scapular resting position

Lukasiewicz et al: JOSPT ’99
• Analyze scapular position and orientation in subject w/ impingement & normals
• 3D electromechanical devices in 3 planes
• During arm elevation: posterior tilting, upward rotation, protraction
• Impingement subjects: greater scapula elevation & less posterior tilting
Best Exercises for Scapular Muscles

Lower Trapezius

- Prone horz abd at 105°
  Ekstrom’93
  “prone full can”
  Blackburn JAT ’89
- Table press down
  Wilk: NAJSPT ’06
- Wall push downs
  Wilk: NAJSPT ’06
- Scapular ER w/ Shlder ER
  Kibler: AJSM ’08

Kibler, Sciascia, Uhl: AJSM ’08

- EMG analysis of specific scapular exercises in early phase rehab
- Studied: SA, UT, LT, Ant & Post Deltoid
- Performed: low row, inf glide, lawn mower, & robbery exercises
- Moderate EMG activity across all exercises
- SA highest during low row (30%)
- UT & LT were highest during lawn mower & robbery

Kibler et al: AJSM ’08

SA > UT, AD (23)
LT > UT, LT (42)
**TABLE 2**

<table>
<thead>
<tr>
<th>Exercise/Claw</th>
<th>Lever Row</th>
<th>Innerram</th>
<th>Shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper trapezius</td>
<td>4.4 (0.0)</td>
<td>14.6 (0.1)</td>
<td>23.5 (10.5)</td>
</tr>
<tr>
<td>Lower trapezius</td>
<td>17.0 (19.5)</td>
<td>35.4 (10.5)</td>
<td>21.5 (30.6)</td>
</tr>
<tr>
<td>Triceps anterior</td>
<td>22.4 (15.4)</td>
<td>21.2 (10.5)</td>
<td>34.5 (15.6)</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>34.4 (15.6)</td>
<td>23.4 (10.5)</td>
<td>23.4 (10.5)</td>
</tr>
<tr>
<td>Forearm flexor</td>
<td>42.4 (21.5)</td>
<td>45.4 (12.5)</td>
<td>48.4 (10.5)</td>
</tr>
<tr>
<td>Palmar flexor</td>
<td>5.4 (12.5)</td>
<td>12.4 (15.6)</td>
<td>13.4 (10.5)</td>
</tr>
</tbody>
</table>

*Note: Data are given in mean ± standard deviation. ERS: electromyography, HD: elbow, LA: lateral, IA: internal, TR: triceps, FR: forearm.
**Best Exercises for Scapular Muscles**

**Serratus Anterior**

- Push-up with a plus  
  *Moorey: AJSM '92*
- Punches  
  *Kendall: '79*
- Dynamic hug  
  *Dockey: AJSM '99*
- Wall slide  
  *Hardwick: JOSPT '06*
- Bench press  
  ???
IMPINGEMENT TREATMENT
Scapular Component

- Assess passive & active scapula mobility
- Examine scapular motion (active arm elevation & abduction)
- Analyze in phase of motion
- Analyze in force couples
- Pect minor flexibility / low trapez control
- Protraction / retraction strength
- *restore posterior scapular tilt* !!
IMPINGEMENT TREATMENT
Chronic Phase - Goals

- Maintain capsular / muscular flexibility
- Continue improvement in strength
- Improve muscular endurance
- Gradual return to sports / activities

FUNDAMENTAL SHOULDER EXERCISES

- ROM exercises (flexion, ER, IR)
- Stretching, horizontal adduction (stabilize)
- ER/IR strengthening
- Sidelying ER
- Shoulder abduction to 90 degrees
- Scaption “thumb up”
- Prone horizontal abduction
- Prone rowing
- Biceps curls

Always have add-ons, modifications. tweak it!!
Based on Type of Patient

THE OFFICE SHOULDER EXERCISES

- Move / change positions frequently
- Wall Stretches:
  - Pectoralis major stretch
  - Pectoralis minor stretch
- Scapular Muscle Training
  - Scapular retroversion
  - Lower trapezius
  - Shoulder extension
  - Shoulder ER
- Chin Tucks
- Neck Stretches
  Perform several times per day

Subacromial Impingement Treatment
Keys to Treatment

- Gradual return to sports
- Interval sport programs
- Stretch / strengthen prior to play
  “Fundamental shoulder exercise program”

SHOULDER IMPINGEMENT

- Glenohumeral hypomobility
  - capsular tightness
  - asymmetrical tightness
- Glenohumeral hypermobility
  - rotator cuff weakness
  - muscular imbalances(ER/IR)
- Scapular muscular abnormalities
  - Hypermobility
  - Postural - anterior tilt
IMPINGEMENT TREATMENT
Keys to Treatment
- Correct asymmetrical capsular tightness – balance the capsule
- Re-establish muscular balance
- Early avoidance of strenuous activities
- Normalize motion: especially capsular mobility
- Improve ER, scapular muscle strength – Dynamic stabilization
- Normalize posture, treat scapular control & position
- Watch out for empty can exercises
- “Balance the Shoulder”

SECONDARY IMPINGEMENT
Pathophysiology
- Primary instability or hypermobility
- Humeral head displaces anteriorly and superiorly causing impingement
- Seen in overhead athletes
- Key: differential diagnosis
- Rx: enhance dynamic stabilization

SECONDARY IMPINGEMENT
Due to Hypermobility
- Treatment plan:
  » Re-establish proper muscular ratios
  » Dynamic stabilization
  » Proprioception & neuromuscular control
  » Correct biomechanics
  » Functional Stability

Arthroscopic Subacromial Decompression
**Posterosuperior (Internal) Impingement**

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

---

**Internal Impingement**

*Overhead Athlete*

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

---

**Is Internal Impingement normal in the overhead thrower??**

---

**Rehabilitation Guidelines for Internal Impingement Syndrome**

Tomorrow !!!
Rehabilitation Internal Impingement
Differential Diagnosis – Clinical Exam

- Excessive ER
  Loss of IR GIRD
- Positive internal impingement sign Meister AJSM '00
- Pain posteriorly palpation
- Anterior hyperlaxity (?)
- Subjective: pain with late cocking & acceleration. Can’t get loose, loss of velocity, stiffness

TRAUMATIC IMPINGEMENT
Pathophysiology

- Fall onto outstretched arm
- Arm is abducted and rotated
- Humeral head forced into acromion
- Tissue injury varies (age, force, etc.)
  » Labrum, cuff tear, rotator cuff avulsion, &/or fracture

Traumatic Overload
Overview

- Forces on tissue exceed tissue strength
- Traumatic fall or during sports
- Accumulative trauma(throwing, etc.)
  then superimpose a fall or blow to shldr
- Associated lesions; SLAP tears, fractures, capsular injuries (dislocations), neurologic
- Tissue quality, age, extent of force determines pathology & degree of injury
Calcific Tendinitis
Overview

- Unknown etiology
- Reactive calcification followed by spontaneous absorption
- Usually occurs in supraspinatus &/or infraspinatus tendon (vascularity issues)
- Overall incidence 3-20%
- Phases to calcification – acute inflammation, calcification, absorption
- Treatment concepts – Rehab, burbotage

What’s his lesion/problem ???
Calcific Tendinitis

Overview

IMPINGEMENT

Summary

- Numerous types of impingement
  - subacromial (compressive)
  - internal (posterosuperior)
  - traumatic (overload)
- May be due to structural / functional factors (osseous — soft tissue)
- Humeral head forced into acromion
- Rehabilitation base on causative factors: tailor the program to patient

Evaluation — Treatment

"Kevin, may I be excused? My brain is full."

Thank You !!!