WELCOME!!

Evidence-Based Evaluation and Treatment of Rotator Cuff Pathology

Presented by:
Christian Coulon, PT, PhD(c), OCS, CSCS, Cert. MDT

Outline

• Lecture
  – Exercise Physiology
  – Shoulder anatomy/Normal Shoulder Kinematics/Scapular Biomechanics
  – RTC pathology and Scapular Pathology
  – Evaluation of the Shoulder
  – Rehabilitation of the shoulder

Instructor

• Christian L. Coulon, PT, PhD(c), OCS, CSCS, Cert. MDT
  – Education
  – Clinical Background
  – Instructional Background
Levels of Evidence

<table>
<thead>
<tr>
<th>Grade of recommendation</th>
<th>Level of evidence</th>
<th>Type of study</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1a</td>
<td>Systematic review of (homogeneous) randomized controlled trials</td>
</tr>
<tr>
<td></td>
<td>1b</td>
<td>Individual randomized controlled trials (with narrow confidence intervals)</td>
</tr>
<tr>
<td>B</td>
<td>2a</td>
<td>Systematic review of (homogeneous) cohort studies of “exposed” and “unexposed” subjects</td>
</tr>
<tr>
<td></td>
<td>2b</td>
<td>Individual cohort study / Low-quality randomized controlled trials</td>
</tr>
<tr>
<td></td>
<td>3a</td>
<td>Systematic review of (homogeneous) case-control studies</td>
</tr>
<tr>
<td></td>
<td>3b</td>
<td>Individual case-control studies</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>Case-series, low-quality cohort or case-control studies</td>
</tr>
<tr>
<td>D</td>
<td>5</td>
<td>Expert opinion based on non-systematic reviews of results of mechanistic studies</td>
</tr>
</tbody>
</table>

Exercise Physiology in Shoulder Pathology

16-24 muscles

Practical Question of muscle physiology
- What is physiologically changing in rehab?
  - Endurance and Strength
    - Injured vs Healthy
    - "Weekend warriors"
    - Athletes
Practical Question of muscle physiology

- What is physiologically changing in rehab?
  - Endurance and Strength
    - "Weekend warriors"
    - athletes

Individuals and Fiber Types

Gollnick et al., 1972; Johnson et al., 1973

- Muscles heterogeneous
- FT/ST distribution varies between/within

Shoulder ST Fiber Type

Lovering & Russ, 2008: JOSPT
- 54% Supraspinatus
- 41% Infraspinatus
- 49% Teres Minor
- Older Population (65±12 years), Cadavers (6)
Shoulder ST Fiber Type

• Srinivasan et al., 2007: Clinical Anatomy
  – 50%-65%
• Deltoid ranges between 50-60%
  – Johnson et al., 1973

Individuals and fiber types

• Power athletes
  – Sprinters
  – higher % fast fibers

Individuals and fiber types

• Endurance athletes
  – Distance runners
  – higher % slow fibers

Individuals and fiber types

• Others
  – Weight lifters and non-athletes
  – 50% slow, 50% fast
Physiological Adaptations to Exercise

- Hyperplasia - increase in fiber number
- Hypertrophy - individual muscle fibers get larger
- Neural adaptation - ability of nervous system to appropriately activate muscle
- Increase oxidative capacity - changes in mitochondrial and capillary density

Endurance Training Adaptations

- Endurance Resistance training (Type I vs Type II?)
  - Type IIa vs IIx fibers
    - More oxidative properties
    - Doesn’t improve size or strength

Endurance Training Adaptations

- Capillary to Fiber Ratio ↑ by 5-20% (8-12 weeks)
- Mitochondrial number ↑

Strength and Power Training Adaptations
Strength/Power training adaptation

- Type I -> Type II?
  - Strength training ↑
    - muscle size
    - force production
- Hypertrophy: enlargement of fibers
- Small increase in fiber #?

Neural Adaptation vs. Hypertrophy

Moritani & DeVries, 1979

  - adaptation distal motor neuron
  - neuromuscular junction
  - synaptic efficacy
  - motor unit synchronized firing
- Repeated voluntary activation

Neural Adaptation vs. Hypertrophy

Moritani & DeVries, 1979

- Week 2:
  - 80% neural
  - 20% hypertrophy
- Week 8:
  - 5% neural
  - 95% hypertrophy

Detraining

- Partial or complete loss of training adaptations in response to cessation/decrement of training
- Within 7 days!
Detraining Due To Immobilization

- Immobilization Causes (Booth, 1982)
- ↓ in protein synthesis rate in first 6 h (role initiating muscular atrophy)
- After weeks of immobilization:
  - muscles composed predominately of slow-twitch fibers took on properties characteristic of fast twitch muscles
  - EMG activity was reduced 5-15% of control levels
  - Insulin responsiveness for 2-deoxyglucose uptake decreased
  - no change or a decrease in resting membrane potential
  - an increase in extra junctional acetylcholine

Detraining Due To Immobilization

- Immobilization
  - neutral position less severe atrophy than shortened position (Baker and Matsumoto, 1988)
  - Immobilized cat soleus at 4 weeks (Tabary et al., 1972):
    - Shortened=decreased sarcomeres by 40%
    - Lengthened=added 20% more sarcomeres in series

What is VO\textsubscript{2} max?

- Maximum rate of oxygen consumption during exercise
- Reflects aerobic physical fitness of individual
- Important determinant of endurance capacity during aerobic exercise
- Average young untrained male 45 ml/min/kg
  - 84.0 Lance Armstrong (cycling)
  - 78.6 Joan Benoit (distance running)
  - 97.5 Oskar Svendsen (Cycling 18 year old)
What is VO$_2$ max?

Muscle Decline with Aging

- Sarcopenia: loss of muscle mass
  - Rate ↑ after 50 y.o.
  - By age 80,
    - $\frac{1}{2}$ total muscle mass lost
- Greater loss of fast fibers compared to slow
- 8% Decline per decade
- THE GOOD NEWS
  - Regular exercise training can improve strength and endurance
  - Cannot completely eliminate the age-related loss in muscle mass

Myoplasticity Due to Exercise

- Ability of the muscle to alter the quantity and the type of its proteins in response to stimulations
- Endurance exercise increases the oxidative metabolism of the muscle
- Resistance training increases the cross-sectional area due to true hypertrophy of the single cells

Train Specific Systems
Systems that restore ATP

• **Phosphagen system** (anaerobic), occurs without oxygen.

• **Glycolysis** is the breakdown of carbohydrates, either glycogen stored in the muscle or delivered in the blood to produce ATP.

• **Oxidative system** is the primary source of ATP at rest and low-intensity, it uses primarily carbohydrates and fats as substrates.

All three energy systems are active at a given time; the extent to which each is used depends on the intensity of the activity and its duration.

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Effect of Event Duration on Primary Energy System Used

<table>
<thead>
<tr>
<th>Duration</th>
<th>Intensity</th>
<th>Primary Energy System Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 s</td>
<td>Very intense</td>
<td>Phosphagen</td>
</tr>
<tr>
<td>6-30 s</td>
<td>Intense</td>
<td>Phosphagen and fast glycolysis</td>
</tr>
<tr>
<td>30 s-2 min</td>
<td>Heavy</td>
<td>Fast glycolysis</td>
</tr>
<tr>
<td>2-3 min</td>
<td>Moderate</td>
<td>Fast glycolysis and oxidative system</td>
</tr>
<tr>
<td>&gt; 3 min</td>
<td>Light</td>
<td>Oxidative system</td>
</tr>
</tbody>
</table>

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What system is he using?

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Patient May HAVE Next Day Soreness!!

• Concentrations of lactate in blood and muscle:
  - Rest=0.5 – 2.2 mmol/L
  - High intensity exercise=20 – 25 mmol/L

• Accumulation greater following high-intensity intermittent exercise
  - Lactic acid returns to normal levels within one hour of after exercise

• For athlete:
  - adjust training to this point to maximize training benefits

• Blood lactate systematically increase over baseline and associated with changes in CO2 production, blood pH, bicarbonate, [H+], RER.
Lactate Threshold

The breaks in LA accumulation may be due to recruitment of FOG & FT motor units.

Takes 8-12 Weeks to \( \uparrow \) \( LT \)
- Lactate Threshold (LT) - intensity at which blood lactate begins an abrupt increase above baseline - represents an increasing reliance on anaerobic metabolism
- The second point of inflection Onset of Blood Lactate Accumulation (OBLA) - lactate begins to accumulate in the blood - the point where an athlete begins to use anaerobic mechanisms for performance

Muscle Soreness Post-Exercise

Delayed Onset Muscle Soreness
- Soreness is felt most strongly 24-72 hours post-exercise
- Due to:
  - microscopic lesions at the Z-line of the muscle sarcomere
  - Inflammation and pain due to the accumulation of histamines, prostaglandins, and potassium
- Worse with Eccentric training
- Treatment: Prevention (design appropriate program), initially decrease inflammation then increase blood flow and allow to heal

Set and Repetition continuum

Using Interval Training to Train Specific Energy Systems

<table>
<thead>
<tr>
<th>% of maximum power</th>
<th>Primary system stressed</th>
<th>Typical exercise time</th>
<th>Range of exercise-to-rest period ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>Phosphagen</td>
<td>5-10 s</td>
<td>1:12 to 1:20</td>
</tr>
<tr>
<td>75-90</td>
<td>Fast glycolysis</td>
<td>15-30 s</td>
<td>1:3 to 1:5</td>
</tr>
<tr>
<td>30-75</td>
<td>Fast glycolysis and oxidative</td>
<td>1-3 min</td>
<td>1:3 to 1:4</td>
</tr>
<tr>
<td>20-35</td>
<td>Oxidative</td>
<td>&gt; 3 min</td>
<td>1:1 to 1:3</td>
</tr>
</tbody>
</table>
Set and Repetition continuum

• Dependent on Patient
• Appropriate exercise intensities (sets, reps) and rest intervals allows for the “selection” of specific energy systems during training

Exercise Based on End Goal

- Best therapeutic exercises=knowledge of exercise physiology

<table>
<thead>
<tr>
<th>Exercise Based on End Goal</th>
<th>RM 3</th>
<th>6</th>
<th>10</th>
<th>12</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength/power</td>
<td></td>
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<tr>
<td>High-intensity endurance</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Low-intensity endurance</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal power</td>
<td>Low power output</td>
<td>Maximal power endarnce</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What’s your end goal!?!?
Shoulder Therapeutic Exercise Considerations

• Position

• Movement
  – Isometric
  • Muscle exerts force without changing length
  – Isotonic (dynamic)
  • Concentric
    – Muscle shortens during force production
  • Eccentric
    – Muscle produces force but length increases

• Speed

Shoulder Therapeutic Exercise Considerations

• Resistance
  – Low to moderate resistance
  – 15-25RM progressing to 8-12RM

• Shoulder considerations:
  – Stable base
    • Proximal Stability=Distal mobility
    • Specific Exercise

Shoulder Anatomy

• Subacromial Space
  – 10mm area below the acromial arch (Petersson & Redlund-Johnell, 1984)
  – 1-2 mm deviation=pain
    • Allmann et al., 1997
    • Michener, McClure, & Karduna, 2003
Important Structures in Subacromial Space

- Rotator cuff tendons
- Coracoacromial ligament
- Long head of the biceps tendon
- Bursa
  - Subacromial bursa
  - Repetitive overhead activity

Rotator cuff anatomy

- Musculature
  - Rotator cuff
  - Deltoid

Rotator Cuff Orientation

- Musculature
  - Scapular stabilizers
Rotator Cuff Multiple, Confluent Layers
Matava et al., 2005: AJSM

- Histologic studies determined rotator cuff tissue layers functioning in concert
- 5 distinct layers through the supraspinatus and infraspinatus

- Superficial layer (layer 1, 1mm)
  - contains large arterioles and coracohumeral ligament fibers
- Layer 2 (3-5 mm)
  - direct tendinous insertions
- Layer 3 (3mm)
  - Smaller bundles of interdigitating collagen less uniform orientation
- Layer 4
  - loose connective tissue and collagen bands merge with coracohumeral ligament at anterior border of the supraspinatus
- Layer 5 (2mm)
  - shoulder capsule comprised of interwoven collagen

Footprint Anatomy
Dugas et al., 2002: JSES

- Footprint=insertion site of the RTC tendon at the greater tuberosity
- Examined 20 normal cadaveric RTC
- Mapped the footprint using a 3-space digitizer

<table>
<thead>
<tr>
<th>Tendons</th>
<th>Mean medial-to-lateral insertion width</th>
</tr>
</thead>
<tbody>
<tr>
<td>supraspinatus</td>
<td>12.7mm</td>
</tr>
<tr>
<td>infraspinatus</td>
<td>13.4mm</td>
</tr>
<tr>
<td>teres minor</td>
<td>11.4mm</td>
</tr>
<tr>
<td>subscapularis</td>
<td>17.9mm</td>
</tr>
</tbody>
</table>
Acromion Types

- Acromia studies multiple imaging types
  - Poor-moderate intraobserver reliability & interobserver repeatability
    - Burkhead, Burkhart, & Gerber, 1995; Bright et al., 1997

Type I: 17%
Type II: 43%
Type III: 40%

Acromial Type and RTC tears

- partial RTC tears = SIS consequence
  - expect bursal side RTC tear
  - BUT majority intra-tendinous or on articular side of RTC
    - Wilk, Reinold, & Andrews, 2009
- Despite discrepancies, the extrinsic mechanism forms rationale for acromioplasty surgical procedure
  - Most commonly performed shoulder procedure

Type III Hook vs Spur

- 1/3 of population (Nicholson et al. JSES 1996)
- Difference between hook and spur

Type III Hook vs Spur

- Arthroscopic Acromioplasty
Normal Posture Orientation

- **Anterior**: Dominant side lower than non-dominant
  - Step deformity: AC joint
  - Fountain sign: swelling anterior to AC due to SA bursa communicating with AC (Rudert & Wulker, 2001)
  - Sulcus sign
- **Posterior**: Scapula position
  - Capsular pattern
  - Resting position: extends from T2-T7 or T9
  - Spine of scapula =~ T3

Normal GH Joint Orientation

- **Humerus**
  - Angle between humeral neck and shaft = 130°
  - Humeral head is retroverted 30°-40° relative to line joint epicondyle
- **Glenoid**
  - Resting position = 5° superior tilt/inclination, 7° retroversion (slight medial rotation)

Normal Shoulder Kinematics/Biomechanics

- Normal kinematics have been studied with or without EMG during:
  - ROM
  - Cadaver studies
  - Nerve injuries
  - Predictive biomechanical modeling
- “Scapulohumeral rhythm”
  - “2:1” glenohumeral joint to scapulothoracic joint range of motion during AROM

Normal Shoulder Kinematics

(Ludewig & Cook, 2000; Kibler & McMullen, 2003; Bagg & Forrest, 1986)
Scapulohumeral Rhythm

- Discrepancies
  - due to different measuring techniques and methods
- Generally considered
  - occur in 60 to 120 degrees with 1 degree of scapular movement occurring for every 2 degrees of elevation movement
  - until 120 degrees and thereafter 1 degree of scapular movement for every 1 degree of elevation movement

Table 2: Scapulohumeral ratio during shoulder elevation

<table>
<thead>
<tr>
<th>Study Year</th>
<th>Scapulohumeral ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fung et al. 2001</td>
<td>2.1/1</td>
</tr>
<tr>
<td>Ludewig et al. 2009</td>
<td>2.2/1</td>
</tr>
<tr>
<td>McClure et al. 2001</td>
<td>1.7/1</td>
</tr>
<tr>
<td>Inman et al. 1944</td>
<td>2:1</td>
</tr>
<tr>
<td>Freedman &amp; Monro 1966</td>
<td>1:2</td>
</tr>
<tr>
<td>Poppen &amp; Walker 1976</td>
<td>1.24:1 or 5:4</td>
</tr>
<tr>
<td>McQuade &amp; Smit 1998</td>
<td>7.9:1 to 2.1:1 (PROM) 1.9:1 to 4.5:1 (loaded)</td>
</tr>
</tbody>
</table>

Scapulohumeral Rhythm

- Differences:
  - Gender
    - Increased motion in females
  - Morphological
- Addition of resistance
  - 4-6lbs=completed setting before 30°

Normal shoulder Biomechanics

- initial arm elevation:
  - deltoid exerts an upward and outward force on humerus
  - If unopposed:
    - superior migration of humerus
    - 60% pressure \( \uparrow \) on subacromial soft tissue (Ludewig & Cook, 2002)
  - AAOS elevation=scaption
Normal Shoulder AROM

• Abduction 170°-180°
• Flexion=160°-180°
• Scaption= 170°-180°
• External rotation=80°-90°
• Internal rotation=60°-100°
• Extension=50°-60°
• Adduction=50°-75°

Normal shoulder Biomechanics

• Disagreement in direction of RTC force vector:
  — parallel to axillary border (Inman, Saunders, & Abbott, 1944)
  — perpendicular to glenoid (Freedman, & Munro, 1966)
  — overall effect= RTC counteracts the deltoid

Remember Force Couples

Deltoid-Rotator cuff Force couple

• Fluoroscopic images demonstrate (Matsuki, et al. 2012):
  — 2.1mm humeral head superior migration 0-105°
  — .9mm inferior translation 105-180°
• Force couple exists:
  — superior directed force counteracted by inferior and medially directed force
  — supraspinatus serves approximating role
    • neutralize upward shear force
    • ↓ workload on deltoid (improving mechanical advantage)

Deltoid-Rotator cuff Force couple
Upper Trapezius-Serratus Anterior Force Couple

- Synergistic relationship produces scapula upward rotation during elevation
  - servers 4 functions:
    - allows scapula rotation
    - maintain efficient deltoid length tension relationship
    - prevent RTC impingement
    - provide stable base
      - enable recruitment of scapulothoracic muscles

Anterior-Posterior RTC force couple

- Subscapularis and teres minor/infraspinatus
  - Creates inferior dynamic stability (depressing the humeral head)
  - Concavity-compression mechanism (compress humeral head in glenoid)
- Imbalances in SIS
  - overdeveloped IR and underdeveloped ER
Anterior-Posterior RTC force couple

Shoulder kinematics in scapular plane

- Scapular plane
  - supraspinatus and deltoid are advantageously aligned
  - functional activity plane
  - Resting position: 30-45 anterior to coronal plane
- Optimal plane for shoulder strengthening exercises

Scapular Plane

- Unwanted RTC passive tension at lowest point
  - much lower than in flexion and/or abduction (Wilk, Reinold, & Andrews, 2009)
- Scapular upward rotation is greater in the scapular plane
  - allow for “clearance in the subacromial space”
  - ↓ impingement risk

Shoulder kinematics loaded vs unloaded

- The effect of load during elevation remains unclear
  EMG activity
- .5kg (1.1lb) load while performing scaption (Antony & Keir, 2010)(n=16)
  - ↑ EMG activity of shoulder musculature (4%)
  - firmer grip: ↓ 2% (anterior and middle deltoid), ↑ 2% (posterior deltoid, infraspinatus, and trapezius)
  - Gives some evidence for dumbbells while performing rehabilitation
Normal Scapular Biomechanics

• Normal scapular movement help:
  – length tension relationships
  – prevent “impingement”

• Overhead athletes have increased scapular upward rotation, internal rotation, and retraction during elevation
  – hypothesized adaptation to clear subacromial structures during throwing (Wilk, Reinold, & Andrews, 2009)

Normal Scapular Biomechanics

• Generally accepted normal ranges during elevation:
  – upward rotation (45-55 degrees)
  – posterior tilting (20-40 degrees)
  – external rotation (15-35 degrees)
  – internal rotation has shown variability across investigations
  • ↑ scapular IR during elevation (McClure, Michener, Sennett, & Karduna, 2001)

Normal shoulder EMG activity

Table 3: Mean glenohumeral EMG normalized by MVIC during scaption with neutral rotation (Adapted from Alpert, Pink, Jobe, McMahon, & Mathiyakom, 2000).

<table>
<thead>
<tr>
<th>Interval</th>
<th>Anterior Delto</th>
<th>Middle Delto</th>
<th>Posterior Delto</th>
<th>Supraspinatus</th>
<th>Infraspinatus</th>
<th>Teres Minor</th>
<th>Subscapular</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30°</td>
<td>22±10</td>
<td>30±18</td>
<td>2±2</td>
<td>36±21</td>
<td>16±7</td>
<td>9±9</td>
<td>6±7</td>
</tr>
<tr>
<td>30-60°</td>
<td>53±22</td>
<td>60±27</td>
<td>2±3</td>
<td>49±25</td>
<td>34±14</td>
<td>11±10</td>
<td>14±13</td>
</tr>
<tr>
<td>60-90°</td>
<td>68±24</td>
<td>69±29</td>
<td>2±3</td>
<td>47±19</td>
<td>37±15</td>
<td>15±14</td>
<td>18±15</td>
</tr>
<tr>
<td>90-120°</td>
<td>78±27</td>
<td>74±33</td>
<td>2±3</td>
<td>42±14</td>
<td>39±20</td>
<td>19±17</td>
<td>21±19</td>
</tr>
<tr>
<td>120-150°</td>
<td>90±31</td>
<td>77±35</td>
<td>4±4</td>
<td>40±20</td>
<td>39±29</td>
<td>25±25</td>
<td>23±19</td>
</tr>
</tbody>
</table>
Normal EMG activity

- Shoulder complex muscular activity correlated:
  - maintenance of scapulothoracic rhythm
  - maintenance of force couples
  - (1-2mm) superior translation
- Upper trapezius
  - progressive ↑ 0-60°, constant 60-120°, ↑ 120-180° during elevation
- Middle trapezius
  - high EMG activity during elevation at 90° and >120°, while other authors have shown low EMG activity in the same exercise
- Lower trapezius
  - low during elevation, flexion, and abduction below 90°, progressively ↑ 90°-180°
- Serratus Anterior
  - activity tends to ↑ as arm elevation ↑

Scapulothoracic translations

- Scapulothoracic “translations”:
- gaps in the literature:
  - normal values for:
    - protraction/retraction
    - elevation/depression
  - measure scapulothoracic “translations”? www.sports-medicine-institute.com

Scapulohumeral Motion
Kibler, 1991: Contemp Orthop

- Quantify bilateral scapular motion
- > 1.5cm asymmetry correlated to impingement
  - Glenoid faces up=increased movement humeral head

Lateral Scapular Glide Test

- Semi-dynamic test to evaluate scapular position and scapular stabilizer strength
- 3 positions measure (cm) from inferior angle to spinous process in direct horizontal line
  - Arms at side, hands-on-hips, 90° GH abd with full IR
- (+) greater that 1.5cm difference between sides
  - Indicates a deficit in dynamic stabilization or postural adaptations
- Test-retest reliability (Kibler, 1998)
  - ICC=0.84 intra-tester to 0.88 inter-tester

www.sports-medicine-institute.com 88
### Scapula & GH joint Pathology

**RTC lesions & Impingement**
- Scapular kinematic alterations & RTC disease/Impingement
  - Endo, 2001: J Orthop Sci
  - Laudner, 2001: JOSPT
  - Graichen, 2001: J Orthop Res
  - Ludewig, 2000: PTJ
  - Lukasiewicz, 1992: JOSPT
  - McClure, 2006: PTJ

### Rotator Cuff Pathology

**Classifications**
- Tendinopathy
- Primary tensile overload
- RTC tear/ failure
- Internal impingement
- Calcific tendonitis
- PASTA lesion
- PAINT lesion
- Primary compressive cuff disease

### Shoulder Impingement Pathophysiology

- Believed to contribute to the development of RTC disease
- Diagnostic criteria and etiology of impingement syndrome are debatable

#### Table 1: Neer classifications of lesions in impingement syndrome

<table>
<thead>
<tr>
<th>Stage</th>
<th>Characteristics</th>
<th>Typical Age of Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>Edema/hemorrhage of bursa and cuff, reversible conservative treatment</td>
<td>&lt; 25 y.o.</td>
</tr>
<tr>
<td>Stage II</td>
<td>Irreversible changes, fibrosis and tendinitis of RTC</td>
<td>25-40 y.o.</td>
</tr>
<tr>
<td>Stage III</td>
<td>Partial or complete RTC tear and/or biceps tendon; acromion and/or AC joint pathology</td>
<td>&gt;40 y.o.</td>
</tr>
</tbody>
</table>
Rotator Cuff Disease
(Andrews & Angelo, 1988; Wilk, et al., 2009)

- RTC tears caused by 3 mechanisms:
  - internal impingement
  - primary tensile cuff disease (PTCD)
  - primary compressive cuff disease (PCCD)
- Tear types:
  - Partial thickness
  - full thickness

Do tears Heal

- AAOS
  - "Many rotator cuff tears can be treated non-surgically. Anti-inflammatory medication, steroid injections, and physical therapy may all be of benefit in treating symptoms of a cuff tear. The goals of treatment are to relieve pain and restore strength to the involved shoulder. Even though most tears cannot heal on their own, satisfactory function can often be achieved without surgery. If, however, you are active and use your arm for overhead work or sports, then surgery is most often recommended because many tears will not heal without surgery."

Primary compressive cuff disease (PCCD)

- Failure under compressive loads
- Extra-articular superior surface tears (outside in lesion)
  - Subacromial erosion
  - Gradual cuff failure

Compressive cuff Disease Factors

- RTC: weakness, inflammation, imbalance, poor dynamic stability
- Capsular: hyper- or hypo-mobility
- Scapular factors: posture, position, restricted motion, neuromuscular control, paralysis, muscular dystrophy

- Bursae: inflammation or thickening
- RTC tendon: tendinitis, thickening, partial thickness tear
- Humeral Head: congenital abnormalities, fracture malunion
- AC Jt: abnormalities, sprains, degenerative spurs
- Acromion: shape, spurs, os acromiale-unfused, malunion or nonunion of fractures
**Angiofibroblastic hyperplasia**

- Present in degenerative tendinopathies
- Hyperplasia = excessive growth or proliferation
- Angiofibroblastic = growth occurring in capillaries (angio) and fibroblasts
  - Immature fibroblasts lay down disorganized collagen of poor quality and lay down smooth muscle to allow capillary wall formation within and between collagen fibers
  - Capillaries are not connected to a good blood supply (blind loops) = doesn’t deliver O2 rich blood

**Tendinopathy**

- Tendinitis or Peritendinitis
  - Active rest
  - Ice, Modalities
  - Iontophoresis “patch”
  - NSAID
  - Injection???
  - MRI beneficial
- Avoidance???
- Enhance flexibility (posterior)
- Improve dynamic stability
- Gradual progression of applied loads
- Key: diminish soft tissue inflammation

---

**Tendinitis vs. Tendinosis**

(Khan et al. 2000)

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Prevalence</th>
<th>Recovery time</th>
<th>Focus in Rehab</th>
<th>Likelihood of full recovery</th>
<th>Full recovery period</th>
<th>Histology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendinitis</td>
<td>rare</td>
<td>3-14 days</td>
<td>Decrease inflammation and pain</td>
<td>99%</td>
<td>4-wks</td>
<td>Local bleeding, inflammation, neutrophils &amp; macrophages present</td>
</tr>
<tr>
<td>Tendinosis</td>
<td>common</td>
<td>6-10 weeks</td>
<td>Promote collagen-synthesis and tissue strength</td>
<td>~80%</td>
<td>3-6m</td>
<td>Non-inflammatory, collagen degeneration, Angiofibroblastic hyperplasia</td>
</tr>
</tbody>
</table>

---

Angiofibroblastic hyperplasia

- Present in degenerative tendinopathies
- Hyperplasia = excessive growth or proliferation
- Angiofibroblastic = growth occurring in capillaries (angio) and fibroblasts
  - Immature fibroblasts lay down disorganized collagen of poor quality and lay down smooth muscle to allow capillary wall formation within and between collagen fibers
  - Capillaries are not connected to a good blood supply (blind loops) = doesn’t deliver O2 rich blood
Tendinopathy

- Tendinosis
  - Treatment significantly different
  - Promote tendon healing
  - Heat and ultrasound??
  - Stretching musculo-tendinous unit
  - NO NSAIDS
  - Eccentric muscle training
  - Transverse massage, soft tissue
  - RTC strengthening
  - Gradual increase of applied load
  - Key: stimulate healing response and collagen synthesis

Platelet Rich Plasma

- Use patients own blood to stimulate a healing response
- PRP hypothesized to enhance body’s own healing response
- Platelets are used which have growth factors
- “Treat injured tissues”

Platelet Rich Plasma

- Withdraw autologous blood sample
- Addition of anticoagulant
- Centrifuge 2x
  - 1=remove red blood cells
  - 2=separate platelet poor plasma from platelet rich plasma
- Extraction of PRP
  - Between 4-8 times whole blood concentration levels
  - Normal concentration=200,000 per micro liter
  - Platelet Rich Plasma≥2 million platelets per micro liter
- Add Calcium and thrombin to activate platelets
- Inject
FAST Procedure

- Focused Aspiration Soft Tissue
- Percutaneous removal of diseased soft tissue
- Ultrasound Guided, 18 gauge needle technique
- Tenex Health

Calcific Tendinitis

- Unknown etiology
  - 3-20% incidence
  - Reactive calcification followed by reabsorption
  - More likely in 40 and 50 y.o. and females
- Occurs in supraspinatus/infraspinatus tendon
- Phases to calcification
  - Acute inflammation
  - Calcification
  - Absorption

Calcific Tendinitis

- Non-operative treatment
  - 70% of 159 patients had a good result
    - At 4 year and 8.5 year follow up
      - calcific deposits were no longer detectable by ultrasonography in 82% of cases (Wolk & Wittenberg, 1997)
  - Possible complications
    - adhesive capsulitis, intraosseous lesion, biceptial tendinitis (Wainer & Hasz, 1998:JOSPT)

Calcific tendinitis

- Treatment
  - Treatment of calcifying tendinitis varies with the clinical and radiologic phase of the calcification
  - Control inflammation
    - Modalities
      - NSAIDs
      - acetic acid iontophoresis
  - Maintain ROM and Flexibility
  - Maintain/restore strength
Impingement syndromes
(Neer, 1972)

• SIS two main mechanistic theories:
  – Neer’s impingement theory
    • Focuses on extrinsic mechanisms (primary) (PCCD)
    • Focuses on intrinsic mechanisms (secondary) (PTCD)
  – Two less classic forms:
    – internal impingement
    – coracoid impingement

Primary Shoulder Impingement

• Pathology:
  – mechanical abrasion/compression in SAS during elevation
  – Correlation between acromial shape
  – Hooked acromion is a pre-existing anatomic variation
    • repetitive humerus superior translation
      (Jacobson, et al., 1995:JSES)

Secondary Shoulder impingement

• 2nd theory based on degenerative intrinsic mechanisms
  – breakdown of RTC tendons
    • tension overload and ischemia
  – problems with muscular dynamics and instability
    (Wilk, Reinold, & Andrews, 2009)
  – enhanced by:
    • Overuse
      – leads to joint imbalances and altered shoulder kinematics

Internal impingement

• Thought to be caused by friction and mechanical abrasion of the undersurface of the supraspinatus and infraspinatus against the anterior or posterior glenoid rim or glenoid labrum
• Seen posteriorly when the arm is abducted to 90 degrees and ER
  – posterior shoulder pain during late cocking phase of throwing
• glenohumeral internal rotation deficit (GIRD) (Burkhart, Morgan, & Kibler, 2003: Arthroscopy)
• Posterior shoulder tightness (Tyler, Nicholas, Lee, Mullaney, & Mchugh, 2012)
**Internal impingement**

**GIRD=Glenohumeral Internal Rotation Deficit**

Post-Inf Capsule Contracture

Exists if total arc of motion=25°< contralateral shoulder

“Total Motion Concept”=ER+IR

**Coracoid impingement**

- Anterior shoulder pain
  - extreme ranges of GH IR
- Less commonly discussed
  - subscapularis tendon impinged between coracoid and lesser tuberosity

**GIRD=Glenohumeral Internal Rotation Deficit**

Post-Inf Capsule Contracture

<table>
<thead>
<tr>
<th>ER</th>
<th>IR</th>
<th>Total Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>52</td>
<td>184</td>
</tr>
<tr>
<td>126</td>
<td>53</td>
<td>179</td>
</tr>
<tr>
<td>143</td>
<td>35</td>
<td>176</td>
</tr>
<tr>
<td>196</td>
<td>64</td>
<td>260</td>
</tr>
<tr>
<td>128</td>
<td>68</td>
<td>196</td>
</tr>
<tr>
<td>137</td>
<td>54</td>
<td>190</td>
</tr>
</tbody>
</table>
**EMG Activity in Impingement**

Ludewig & Cook, 2000; Peat & Grahame, 1997; Myers, et al., 2009.

- Alterations in RTC muscle activation
- ↓ coactivation supraspinatus and infraspinatus
- Overall, ↓ RTC coactivation and ↑ deltoid activity at initiation of elevation

**Shoulder Kinematics in Impingement**

Ludewig & Cook, 2000; Lukasewicz, McClure, Michener, Pratt, & Sennett, 1999

- Shoulder impingement kinematic alterations:
  - ROM with scapular dyskinesis
  - clavicular movement
  - increased humeral head translations
- Alterations reduce SAS
  - ↓ clearance subacromial structures (Graichen, et al., 1999)
- Altered kinematics linked to:
  - altered shoulder and scapular muscle activation
  - altered muscle resting length

**EMG Activity alterations of muscles observed in impingement**

- **serratus anterior** ↓ 70-120˚ in scapular plane
- **upper trapezius** ↓ 40-100˚
- **Upper/lower trapezius** ↑ 61-120˚ scaption loaded
- **middle deltoid** ↓ ↑ 0-30˚, 30-60˚, 0-30˚
- **infraspinatus** ↓ ↑ 30-60˚, 60-90˚, 30-90˚, 90-120˚
- **supraspinatus** ↓ ↑ 30-60˚, 90-120˚
- **subscapularis** ↓ ↑ 30-90˚, 90-120˚

**Effectiveness of Rehabilitation**

Wilk, Andrews, et al., 2009; Fleming, et al., 2010; Osteras, et al., 2010; Physiother Res Int; McClure, et al., 2004; PTJ; Theisen, et al., 2010; Sauers, 2005; J Athl Train

- Conservative rehabilitation successful 42% (Bigliani type III) to 91% (Bigliani type I) and most shoulder injuries in the overhead athletes can be successfully treated non-operatively
- Evidence supports:
  - supervised shoulder and scapular muscle strengthening
  - thoracic mobilizations
  - glenohumeral mobilizations
  - supervised shoulder and scapular muscle strengthening with manual therapy
Effectiveness of Rehabilitation


- Systematic reviews of randomized controlled trials suggest:
  - therapeutic exercise is as effective as surgery in SIS
  - combination of manual therapy and exercise is better than exercise alone in SIS
  - high dosage exercise > low dosage exercise in SIS

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Impingement Treatment

Keys to Treatment – Early Phase

- Diminish pain &/or inflammation*
- Posture correction & patient education
- Normalize motion
- Capsular mobility and balance
- Establish dynamic stability (ER/IR)

Impingement Treatment

Keys to Treatment – Intermediate Phase

- Maintain correct Posture
- Full and pain free ROM
- Capsular mobility and balance
- Improve strength and endurance
**Impingement Treatment**

**Keys to Treatment – Exercises**

- Continue stretching and flexibility exercises
- Initiate complete shoulder program
  - Focus on endurance
  - Supraspinatus vs deltoid
  - ER exercises
  - Scapular muscle training
- Dynamic stabilization

**Impingement Treatment**

**Keys to treatment-Chronic Phase**

- Maintain flexibility of the joint capsule and musculature
- Continue Strengthening
- Improve endurance
- Gradual return to recreational activities

**Shoulder Exercise Fundamentals**

- Stretching, horizontal adduction (stable scapula)
- Avoid Inappropriate postures
- ROM (flexion, ER, IR)
- RTC strengthening (IR/ER)
  - Sidelying ER
- Scaption “thumb up”
- Prone horizontal abduction
- Prone rowing

**Secondary Shoulder Impingement**

- Overhead athletes
  - Primarily due to instability or Hypermobility
- Humeral Head displacement (Anterior and Superior) causing impingement
- Important to recognize and differentially diagnose
- Treatment
  - Enhance dynamic stabilization

ALWAYS adjust, add on, and tweak!!
Based on type of patient!
Secondary Shoulder Impingement
Due to Hypermobility

- Treatment
  - Dynamic stabilization
  - Re-establish proper muscle ratios and force couples
  - Joint proprioceptive drills
  - Joint neuromuscular control
  - Reestablish correct biomechanics
  - Apply impingement treatment concepts

Posterosuperior Impingement
Internal Impingement

- Overhead athletes
  - Occurs during abduction & excessive external rotation
  - Late cocking Phase of pitching
  - Loss of velocity, stiffness

Supraspinatus/Infraspinatus rubs on the posterosuperior glenoid rim and labrum

- Fraying of RTC and labrum
  - Andrews, 1988: Tech Orthop
  - Walch, 1991: JSES
  - Jobe et al., 1993: JSES

Rehab Internal Impingement

- Differential Diagnosis
  - Excessive ER, Loss of IR (GIRD)
  - Look for PST
  - (+) internal impingement sign (Meister, 2000: AJSM)
    - deep posterior shoulder pain with 90°-110° abduction, 10°-15° extension, and max ER
    - Sensitivity=75.5%; Specificity=85%
  - Posterior pain with palpation
Internal Impingement Sign

Rehab Internal Impingement

- Focus on:
  - Proprioception in functional planes
  - Normalize ROM, strength, endurance

GIRD=Post-inf Capsule Contracture
“Total Motion Concept”=ER+IR
Wilk et al, AJSM 2002
Ellenbecker et al, MSSE 2002
Wilk et al, JOSPT 2009

Treatment of Impingement
Bang, Deyle: JOSPT 2000

- Compared 2 treatment approaches shoulder impingement-prospective randomized clinical trial
- n=50, Dx=shoulder impingement syndrome (SIS) randomized groups:
  - Group I: exercise group
  - Group II: same exercise program with addition of manual therapy
- Intervention over 3 weeks for 6 visits
- Blinded Testers: assessed strength, ROM pain (VAS), functional assessment questionnaires
- RESULTS: BOTH groups improved
  - Manual therapy group demonstrated a statistically significant improvement in pain and strength vs Group I
Surgical Interventions
Internal Impingement

• Scope Debridement of Partial thickness tear of the Infraspinatus
  – Debrided if tear less that 25%-50% depth
  – Decreases pain and mechanical symptoms
    • Fukuda, 2003, JBJS
• Considerations:
  – Articular Surface is slow healing

Arthroscopy - 1999
10 college baseball players (20 shoulders)

• All completely Asymptomatic; No previous injury/problem; No steroid etc.
• Thorough physical exam
• Throwing/Non-throwing compared
• ABER view
  -100% throwing shoulders: internal impingement
  -40% partial cuff pathology
  -30% Labral Pathology
  -None of the Non-throwing shoulders had ANY signs of internal impingement
  -Significant pathology in throwing shoulder!
  -Difference!

Take Home Message

• The symptomatic, non-traumatic athlete’s shoulder should be regarded primarily as a functional problem irrespective of any structural changes on MRI!
• Use MRI as a primary indication for surgery?
• Operate just because “it’s possible”?
Shoulder Injuries in Youth Baseball

• Prospective cohort study of 298 youth pitchers conducted over two seasons (Lynman et al. 2001)
• Frequency of elbow pain=26%; shoulder pain=32%
• Risk factors for elbow pain=increased age, increased weight, decreased height, lifting weights during the season, playing baseball outside the league, decreased self-satisfaction, arm fatigue during the game pitched, and throwing fewer than 300 or more than 600 pitches during the season
• Risk factors for shoulder pain=decreased satisfaction, arm fatigue during the game pitched, throwing more than 75 pitches in a game, and throwing fewer than 300 pitches during the season
• CONCLUSION: Arm complaints are common (nearly half of subjects reported pain)

Shoulder Injuries in Youth Baseball

• 50% report pain after game( Parks & Ray, 2009)
• Solution????
  – PITCH LIMIT!!!
  – Rest between outings
  – Pitch type
• Prevents injuries and prolongs careers

Shoulder Injuries in Youth Baseball

• Youth pitch recommended pitches per week:
  – Ages 7-8: 50 pitches
  – Ages 9-10: 70-75 pitches
  – Ages 11-12: 80-85 pitches
  – Ages 13-16: 85-95 pitches
  – Ages 17-18: 105 pitches
• Practice and recreational pitching add to this strain
• http://www.stopsportsinjuries.org/

Rest Periods ARE Required!!!

<table>
<thead>
<tr>
<th>Ages 14 and under</th>
<th>Ages 15–18</th>
<th>Required # of Rest Pitchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>66+</td>
<td>76+</td>
<td>4 calendar days</td>
</tr>
<tr>
<td>51–65</td>
<td>61–75</td>
<td>3 calendar days</td>
</tr>
<tr>
<td>36–50</td>
<td>46–60</td>
<td>2 calendar days</td>
</tr>
<tr>
<td>21–35</td>
<td>31–45</td>
<td>1 calendar day</td>
</tr>
<tr>
<td>1–20</td>
<td>1–30</td>
<td>None</td>
</tr>
</tbody>
</table>
Shoulder Injuries in Youth Baseball

- Pitch type should also be limited to reduce injury
- Before age 10, only fast ball and change-up should be permitted
- Curveball, slider, knuckleball and screwball may be introduced with increasing age
- No curveball or slider between 9 and 14

Shoulder Injuries in Youth Baseball

- Andrews & Fleisig

| Age Recommended for Learning Various Pitches |  
|------------------------------ | -- |
| Pitch                        | Age      |
| Fastball                     | 8 ± 2    |
| Change-up                    | 10 ± 3   |
| Curveball                    | 14 ± 2*  |
| Knuckleball                  | 15 ± 3   |
| Slider                       | 16 ± 2   |
| Forkball                     | 16 ± 2   |
| Screwball                    | 17 ± 2   |

Shoulder Injuries in Youth Baseball

- Curveball and slider related to joint pain in young pitchers
- These pitches place high loads on shoulder and elbow
- Curveball requires new set of mechanics
- Adolescents more susceptible to injury because growth plates still open

Shoulder Injuries in Youth Baseball

- Info for kids:
  - More beneficial in pitching to have two or three above average pitches than it will be to have four or five mediocre or below average ones
  - At the highest level:
    - Most pitchers throw just three quality pitches
    - Relief pitchers and closers (Mariano Rivera) throw just two
Shoulder Injuries in Youth Baseball

• By adhering to the above recommendations, we can expect the occurrence of shoulder and elbow pain in young throwers to decrease.

• “Throwing is not dangerous to a pitcher’s arm. Throwing while tired is dangerous to a pitcher’s arm.” Rany Jazayerli (baseball writer).

Discussing Scapular Kinematics

<table>
<thead>
<tr>
<th>Scapular Kinematics in Impingement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 4: Scapular movement differences during shoulder elevation in healthy controls and the impingement population</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Sample</th>
<th>Unit</th>
<th>Abnormal elevation</th>
<th>Internal rotation</th>
<th>External rotation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lukasiewicz et al. (1999)</td>
<td>Electromechanical digitizer</td>
<td>20 controls, 17 SIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25-90 y.o. male and female</td>
</tr>
<tr>
<td>Ludewig &amp; Cook (2000)</td>
<td>sEMG</td>
<td>26 controls, 26 SIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20-71 y.o. males, overhead workers</td>
</tr>
<tr>
<td>McClure et al. (2006)</td>
<td>sEMG</td>
<td>45 controls, 45 SIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24-74 y.o. male and female</td>
</tr>
<tr>
<td>Endo et al. (2001)</td>
<td>Static radiographs</td>
<td>27 SIS bilateral comparison</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>41-73 y.o. male and female</td>
</tr>
<tr>
<td>Graichen et al. (2001)</td>
<td>Static MRI</td>
<td>14 controls, 20 SIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22-62 y.o. male and female</td>
</tr>
<tr>
<td>Hebert et al. (2002)</td>
<td>Calculated with optical surface sensors</td>
<td>10 controls, 41 SIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Male only, 30-60 y.o.</td>
</tr>
<tr>
<td>Laudner et al. (2006)</td>
<td>sEMG</td>
<td>11 controls, 11 internal impingement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Males only, 18-30 y.o.</td>
</tr>
</tbody>
</table>

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Scapular Kinematics in Impingement
Why Conflicting Results?

- Conflicting results due to:
  - smaller measurements scapular tilt and internal/external rotation (25°-30°) vs. scapular upward rotation (50°)
  - Type of impingement
  - specific muscular contributions unclear???
  - LACK of valid scapular motion measurement techniques
    - anterior/posterior tilting and internal/external rotation vs. upward rotation
- Agreement
  - overhead athletes ↑ upward rotation during elevation with exception of one study

Scapulothoracic Joint

- Scapula position effects:
  - AROM
  - Shoulder strength
  - PROM
  - Shoulder pathology
- Maintains consistent length tension relationships
- Acts as stabilizer-allow motion

Scapular Dyskinesis
Kibler & Sciascia, 2010:BJSM

- Altered scapula kinematics during elevation
  - observable scapular position/motion alterations in relation to rib cage
  - causes superior translation of the humeral head
    - decreasing the SAS
- Due to soft tissue lesion or bony abnormality along with weakness of tightness

Scapular Assessment
Kibler et al., 2002:JSES; 2009:Arthroscopy

- Inferior angle pattern (Type I)
- Medial Border Pattern (Type II)
- Superior Border Pattern (Type III)
- Normal (Type IV)
Scapular Assessment

Kibler et al., 2002:JSES; 2009:Arth

- 26 subjects videotaped
  - 4 evaluators (2 MD & 2 PT) all blinded
  - Determine which category
- 56 subjects
  - Two blinded evaluators categorized
  - 2 observational methods ("yes/no" and "4 type")
  - 3D scapular kinematics
- The inter-rater percent agreement
  - yes/no method produced a higher inter-rater percent agreement (79%) than the 4-type method (61%)
  - yes/no method had a higher sensitivity (76%) and positive predictive value (74%)

Scapular Observation Assessment

- Type I: Inferior border pattern
  - Inferior angle tilts posteriorly
    - Particularly in lowering arm
    - Dyskinesis in sagittal plane

- Type II: Medial Border Pattern
  - Winging of the medial border in ascending or descending phases of movement
  - Dyskinesis in the transverse plane

- Type III: Superior Border Pattern
  - Initiation of movement with shoulder shrug, without “winging”, and increased shrug with elevation
Scapular Observation Assessment

• Type IV: Normal Scapular Position

Scapular Inclinometer

• Dynamic test of scapular motion
• Reliability ICC= .89-.96
  – Johnson et al., 2001:JOSPT
  – Borsa et al., 2003:JAT

Scapular Retraction Test
Kibler, 2006:AJSM

• Perform provocative test
  – Assess strength of deltoid and RTC
• Patient retracts scapula and manually provide scapular stability the retest strength
  – Improved symptoms (strength) indicates scapular muscle control is compromised
• Supraspinatus strength improves with retraction
Special Testing

- Scapular Assistance Maneuver
  - Seitz, McClure, Finucane et al. JOSPT 2012
  - 42 subjects (21 with SAIS and 21 normal controls)
  - 3D motion analysis at 0, 45, & 90 degrees elevation
  - Increased posterior tilt at all angles
  - Acromiohumeral distance improved at 45 & 90
  - No change in isometric strength

AHI

- The narrowing of the Acromio-Humeral Interval (AHI) under 6-7 mm, has been considered to be a specific indicator for full-thickness cuff tears.

Scapular Assistance Test

Kibler: AJSM 2006

- Assist Scapula retraction and upwardly rotate as the arm is elevated
- (+) = decreased pain & increased ROM
- Indicates improvements in scapular motion may diminish pain
Scapular Tests

- Wall Push-Up
  - Observe for scapular dyskinesis

- Scapular Isometric Pinch or Squeeze test
  - Normal: Hold the contraction for 15-20 seconds without burning pain or obvious muscle weakness

- Lateral scapular slide test
  - Kibler, 1991: Clinical Orth

- 3-Dimensional Analysis
  - McClure et al., 2001: JSES
  - Ludewig & Cook, 2000: PTJ

- Moiré topography
  - Warner, 1992: Clinical Ortho Rel Res

Slouched Posture
Kebaetse et al., 1999: Arch Phy Med Rehab

- Shoulder abduction
  - ROM: Erect-slouched=23° difference
  - Strength: Erect-slouched=2kg difference

- Scapular kinematics
  - Upward rotation: Erect-slouched=6° difference
  - Posterior Tilt: Erect-slouched=4° difference

Normal Posture

- Shoulder Joint
- Hip Joint
- Knee Joint
- Ankle Joint
Yanda Upper Crossed Syndrome

This will help my posture!!!

Shortened Pectoralis Minor
Borstad & Ludewig, 2004:JOSPT

- Shortened Pectoralis minor demonstrates decreased scapular motion
  - Shortened pectoralis minor group at 90° elevation
    - 7° less external rotation
    - 7° less posterior tilting
    - 6° less upward rotation

The Office “BIG EIGHT”

- MOVE!! Out of your chair every 30-60min.
- Pectoralis Minor Stretch
- Scapular Muscle training
  - Lower Trap
  - Scapula Retraction
  - Shoulder extension
  - Shoulder ER
- Chin Tucks
- Neck Stretches (UT, LS)
  Perform minimum every day!
Abnormal Scapulothoracic Observations
Burkhart, Morgan, & Kibler, 2003

• SIS linked to following alterations:
  – SICK scapula
    • Scapular malposition
    • Inferior medial border prominence
    • Coracoid pain and malposition
    • and dyskinesia of scapular movement

Muscle timing in Impingement

• Delayed activation or deactivation of middle and lower trapezius
  – ↓ scapular stability
    • increase likelihood of impingement (Johnson et al., 1994: Clin Biomech)
• Muscle timing found to be changeable (Wadsworth & Bullock-Saxton, 1997: Int J Sports Med)
  – concept of selecting exercises with low UT/MT or UT/LT ratio’s
    • restore scapular muscle balance
**UT:LT Ratio Exercises**

- Clinically beneficial to enhance ratio of lower trapezius to upper trapezius
  - Poor posture and muscle imbalance
- High UT:LT ratio
  - “the press up” 2.35
  - “bilateral shoulder external rotation” 2.07

**Questions?**

---

**Evidence-Based Evaluation and Treatment of Rotator Cuff Pathology**

Presented by:
Christian Coulon, PT, PhD(c), OCS, CSCS, Cert MDT
Failure of the Rotator Cuff

- 70% of tears occur in individuals with sedentary lifestyles (Neer: Clin Orthop 1983)
- Tears occur >40y.o.
  - Typically 50-60 y.o.
- Typically due to gradual weakening (Hawkins:JBJS 1987)

Partial Thickness Tear Classification

- Success rates are better with better vascularity=bursal tear
- Tension on tear with movement=more difficult to heal
- Partial tears are more difficult to reliably detect on MRI than full thickness tears
Partial Thickness Tear (Bursal)

Partial Thickness Tear (Interstitial)

Coronal oblique T2W image of an interstitial tear within the supraspinatus 30% of partial thickness tears (Schaefeler et al., 2011) can occur in isolation or in combination with articular- or bursal-sided partial thickness tears.

Pasta Lesions

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

Paint Lesions

Yamanaka & Fukuda, 1987: The Shoulder

P – partial thickness
A – articular sided
IN – interstitial
T - tear
Full Thickness Rotator Cuff Tear

Coronal MR T2-weighted image depicting full-thickness rotator cuff tear (arrows); fluid filling the gap is enhanced.

Causes of RTC Failure

- Tendon Weakening
  - Age
  - Major trauma
  - Repetitive microtrauma
  - Disuse
  - Steroid injections (repeated)
  - Impingement
  - Poor vascularity and O2 uptake

Supraspinatus Vascularity

- Correlated RTC vascularity with shoulder position
- Less blood flow in distal supraspinatus during shoulder adduction
  - “wrying out of cuff”
- Shoulder abduction to 90 and Adduction to side=less blood flow

Microvasculatcty

- “critical zone” or decreased vascularity
  - Codeman 1934
  - Lindbloom et al, 1939
  - Rothman 1965
  - Rathburn and MacNabb, 1966
- “Rich in anastomoses” and “significant blood flow”
  - Moseley et al, 1983
  - Swiontkowski 1987
    - Laser Doppler
  - Iannotti 1989
  - Brewer 1979
    - AGE
Asymptomatic Cuff Tears

Pettersson 1989

- 71 healthy asymptomatic shoulders
- 18-85 y.o.
- 13 (18%) +arthrogram
- Symptom Free and no previous history

Asymptomatic Cuff Tears

Yamaguchi et al. 2001

- 45 patients with unilateral symptoms & a contralateral asymptomatic full thickness tear
- Age range 52-85, mean=69
- 51% became symptomatic within 3 years
- 9 of 45 has tear progression
- 0 had a decrease in tear size

Asymptomatic Cuff Tears

- FULL THICKNESS TEARS HEAL???

Biomechanics after a Cuff Tear

- Loss of Dynamic stability
  - Compress and centers humeral head
- Increased sheer force on humeral head
- Increased humeral head migration
Evaluation of the Shoulder

• Evaluate ROM, palpation, joint mobility, etc.
• Special testing
  – Clustering tests
• Functional testing
• Identifying a RTC tear

12 Essential Evaluation Elements

• Subjective History
• Inspection/observation
• Palpation
• Clearing Tests (cervical, thoracic, scapula)
• ROM
• Accessory joint motion
• Laxity assessment
• Muscle strength testing
• Special Tests
• Neurovascular assessment
• Imaging
• Functional assessment
Functional Outcome Measures

Desai et al., 2010,

The DASH and SPADI are recommended for use in the out-patient clinic.

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Development</th>
<th>Validity</th>
<th>Reliability</th>
<th>Responsiveness</th>
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<tbody>
<tr>
<td>DASH</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>OSS</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>SPADI</td>
<td>Fair</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>SRQ</td>
<td>Poor</td>
<td>Fair</td>
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<td>Poor</td>
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<tr>
<td>SDQ</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
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</table>

Functional Outcome Measures

Desai et al., 2010,

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Target population</th>
<th>Domains</th>
<th>Number of items</th>
<th>Range of scores</th>
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<tbody>
<tr>
<td>DASH</td>
<td>Upper extremity</td>
<td>Pain symptoms, physical, emotional, social</td>
<td>30</td>
<td>0–100</td>
</tr>
<tr>
<td>OSS</td>
<td>Shoulder operation</td>
<td>Pain, physical</td>
<td>12</td>
<td>12–60</td>
</tr>
<tr>
<td>SPADI</td>
<td>Shoulder pain</td>
<td>Pain, physical</td>
<td>13</td>
<td>0–100</td>
</tr>
<tr>
<td>SRQ</td>
<td>Shoulder disorders</td>
<td>Pain, function, social</td>
<td>21</td>
<td>17–100</td>
</tr>
<tr>
<td>SDQ</td>
<td>Shoulder symptoms</td>
<td>Physical, emotional, social</td>
<td>22</td>
<td>0–22</td>
</tr>
</tbody>
</table>

Functional Outcome Measures

- Disabilities of the Arm, Shoulder and Hand (DASH)
  - Measures physical function and symptoms in individuals with musculoskeletal disorders of the upper limb.
  - Tested in subgroups: Rheumatoid Arthritis, Carpal Tunnel Syndrome, distal radioulnar joint fractures, shoulder pathology
  - Measures activity limitation and participation restriction
- Upper Extremity Functional Index (UEFI)
  - Measures disability in individuals with upper extremity orthopedic conditions
  - Measures activity limitation and participation restrictions
  - Validated in upper extremity dysfunction or shoulder impingement/post--surgical

Functional Outcome Measures

- Shoulder Pain and Disability Index (SPADI)
  - Shoulder specific measure
  - 2 dimensions:
    - Pain (5 questions)
    - Functional activities (8 questions)

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean detectable change</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASH</td>
<td>12.8</td>
</tr>
<tr>
<td>UEFI</td>
<td>9</td>
</tr>
<tr>
<td>SPADI</td>
<td>18</td>
</tr>
</tbody>
</table>
Research Statistical Terms

- Sensitivity: (the *true positive rate*) measures the proportion of actual positives which are correctly identified as positive
- Specificity: (the *true negative rate*) measures the proportion of negatives which are correctly identified as negative
- Intertester reliability: degree which different testers can reach same result with test
- Intratester reliability: degree which same tester can reach same result with test

Likelihood Ratio (LR)

- the likelihood that a given test result would be expected in a patient with the target disorder compared to the likelihood that that same result would be expected in a patient without the target disorder
- high LR (above 5) rule in disease
- low LR (below 0.1) virtually rules out the disease

Clearing Exam

- Cervical Spurling Test
- Cervical AROM
- Palpation

Special Tests

Hegedus, 2012:BJSM

Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests
Special Tests

- Subacromial Impingement (Hegedus, 2012:BJSM)(pooled)
  - Neer test; Sensitivity:72%, Specificity:60%
  - Hawkins-Kennedy test; Sensitivity:79%, Specificity:59%
  - Painful Arc; Sensitivity:53%, Specificity:76%

Special Tests

- RTC tendinopathy (Hegedus, 2012:BJSM)(pooled)
  - Shrug sign; highly specific test >80%; LR+≥5.0

Clustering Tests

Park, et. al, 2005; JBJS

- Predicting Impingement
  - Hawkins-Kennedy, painful arc sign, infraspinatus muscle test all,
    - Positive, impingement syndrome of some degree was >95%
    - Negative, impingement syndrome of any degree was <24%
Clustering Tests
Park, et. al, 2005; JBJS

- Predicting Full-Thickness Rotator Cuff Tear
  - Painful arc sign, drop-arm sign, infraspinatus muscle test all:
    - Positive, 91% a full-thickness rotator cuff tear could be ruled in
    - Negative, 16% probability of a full-thickness rotator cuff tear

Age >65 y.o.?
- significant correlation between age and presence of full-thickness rotator cuff tear (p < 0.0001)
  - (+) (the painful arc sign, drop-arm sign, and infraspinatus muscle test)= 95%
- None of these tests are very specific or sensitive, but in conjunction a high likelihood prediction can be made

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>empty can</td>
<td>44.1%</td>
<td>89.5%</td>
</tr>
<tr>
<td>Infraspinatus test</td>
<td>41.6%</td>
<td>90.1%</td>
</tr>
<tr>
<td>Hawkins-Kennedy</td>
<td>71.5%</td>
<td>66.3%</td>
</tr>
<tr>
<td>Neer impingement test</td>
<td>68.0%</td>
<td>68.7%</td>
</tr>
</tbody>
</table>

Murrell and Walton, 2001:Lancet
Prospective study 23 clinical test in 400 patients

- No one test can make the diagnosis of RTC tear
- Three simple tests were predictive for rotator cuff tear:
  - supraspinatus weakness
  - weakness in external rotation (infraspinatus)
  - Neer/Hawkins Impingement
- ALL 3 (+), or if 2 tests (+) and ≥60y.o. patient, the individual had a 98% chance of having a rotator cuff tear
- Combined absence of these features excluded this diagnosis
Supraspinatus test

Drop Arm

Functional testing

Identifying a RTC Pathology

• Evaluate Strength and Integrity
  – Supraspinatus
    • Empty Can and Full can
  – Infraspinatus and Teres Minor
    • Infraspinatus Muscle Test at 0 and at 90/90 Teres Minor
  – Subscapularis
    • Lift off and Belly Press
Identifying a RTC Pathology

• Evaluate Strength and Integrity

Posture

• Must Address Posture in Shoulder Rehabilitation
• 6 week of pectoral stretching, scapular muscle and ER strengthening (Wang, 1999: Arch Phy

Shrug sign

• Occurs when strong deltoid over-powers a weak RTC
  – Causes superior humeral head migration
• DON’T ALLOW PATIENT TO PROGRESSIVELY EXERCISE THROUGH A SHRUG SIGN!

Conclusions

• Examination process is a combination of science and art
• Pull all information together and make differential diagnosis
• Examination process is more than just a location of pain
• Determine the causes of dysfunction
• Continually assess shoulder complex during treatment
Lab Techniques

- Joint Laxity assessment
  - Load and Shift Test
  - Sulcus Sign
- HVLA thoracic Manipulation (Video)
- Joint Mobilizations
  - Inferior/Superior/Posterior/Anterior
  - Scapular Mobilizations
- Scapular Retraining

Shoulder Lab

- Joint Laxity Assessment: Load and Shift
  - Assessment of anterior and posterior instability
  - Patient Position: Patient is Supine with arm in slight flexion (20°) and abduction (20°).
  - Examiner position: Examiner hand placement is over the humeral head with the thumb on the anterior shoulder and other four digits on the posterior shoulder. The non-examining arm is holding the patient arm steady just proximal to the elbow. The examining hand relocates the humeral head centrally in the glenoid and creates a loading force. In this 'loaded position' directional stresses are applied by translating the humeral head anteriorly and posteriorly. As the stress applied is increased the humeral head may be felt to ride up the glenoid rim. This test not only assesses the amount of translation but also provides an idea of the adequacy of the glenoid lip. It is critically important to compare the two shoulders to appreciate similarities or differences in translation.
  - Although translation is assessed initially in the neutral position with the arm by the side it is important to assess translations in other positions as well. For example by progressively externally rotating the arm in the normal shoulder in abduction one should appreciate less translation anteriorly as the inferior glenohumeral ligament (GHL) becomes taut and acts as a restraint. Similarly by internally rotating the arm posterior translation is diminished with an intact posterior capsular structure.

- Joint Laxity Assessment: Sulcus Sign Test
  - Assessment of superior capsule
  - Sup GH lig., coracohumeral lig.
  - Patient Position: Patient is sitting with arm at side
  - Examiner position: Standing next to patient with examining arm grasping the elbow proximal to the humeral epicondyles and applies inferior traction. The area adjacent to the acromion is observed and dimpling of the skin indicates a (+) sulcus sign
  - No independent validity established

<table>
<thead>
<tr>
<th>GRADE</th>
<th>DESCRIPTION</th>
<th>TRANSLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>mild</td>
<td>0-1cm</td>
</tr>
<tr>
<td>II</td>
<td>moderate</td>
<td>1-2cm or to glenoid rim</td>
</tr>
<tr>
<td>III</td>
<td>severe</td>
<td>&gt;2cm or over the rim of glenoid</td>
</tr>
</tbody>
</table>

Grading scale of Displacement in Load and Shift test (Hawkins & Schutte, 1988)
Shoulder Lab

• Glenohumeral Joint Mobilization 101
  – Resting position (open packed)=55° abduction, 30° horizontal abduction
    • Surrounding tissue lax
  – Closed packed position= full abduction and external rotation
    • Surrounding tissue under max tension
  – Capsular Pattern= external rotation, abduction, internal rotation

Shoulder Lab

• Glenohumeral Joint Mobilization 101
  – Traction: passive translatory bone movement at a right angle to the treatment plane (separate surfaces)

Shoulder Lab

• Glenohumeral Joint Mobilization 101
  – Glide: passive translatory movement where the joint surfaces are displaced parallel to treatment plane

Shoulder Lab

• Glenohumeral Joint Mobilization 101
  • Translatory glide mobilization grading
    – Grade I – small amplitude movement at the beginning of the available ROM
    – Grade II – large amplitude movement at within the available ROM
    – Grade III – large amplitude movement that reaches the end ROM
    – Grade IV – small amplitude movement at the very end range of motion
    – Grade V – high velocity thrust of small amplitude at the end of the available range and within its anatomical range (manipulation)
Shoulder Lab

• Translatory glide mobilization grading

![Diagram of shoulder joint mobilization grading]

- Grade I: unweighting or barely supporting joint surfaces 
  - Equalizes cohesive and atmospheric forces of the joint 
  - Alleviates pain by unloading and decompressing 
  - Nullifies normal compressive forces

- Grade II: slack of the capsule taken up (eliminates joint pain)
- Grade III: capsule and ligaments stretched

Shoulder Lab

• Distraction Mobilization Grading

- Grade I: unweighting or barely supporting joint surfaces
  - Equalizes cohesive and atmospheric forces of the joint
  - Alleviates pain by unloading and decompressing
  - Nullifies normal compressive forces

- Grade II: slack of the capsule taken up (eliminates joint pain)
- Grade III: capsule and ligaments stretched

Shoulder Lab

• Glenohumeral Joint Mobilization 101
  - Determination of Joint Mobility
    - Difficult to assess
    - Quantity graded in millimeters
    - Quality graded by "end feel"
    - Poor intra/intertester reliability
    - Best gauged by comparison to uninvolved side

Shoulder Lab

• Glenohumeral Joint Mobilization 101
  - Determination of Joint Mobility

<table>
<thead>
<tr>
<th>GRADE</th>
<th>DEFINITION</th>
<th>TREATMENT POSSIBILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>No Movement – joint ankylosed</td>
<td>No attempts should be made to mobilize</td>
</tr>
<tr>
<td>1</td>
<td>Extremely hypomobile</td>
<td>Mobilization</td>
</tr>
<tr>
<td>2</td>
<td>Slightly hypomobile</td>
<td>Mobilization-Manipulation</td>
</tr>
<tr>
<td>3</td>
<td>Normal, No dysfuncntion</td>
<td>No treatment needed</td>
</tr>
</tbody>
</table>

| HYPER  |                                |                                             |
| 4      | Slightly hypermobile           | Look for hypomobility in adjacent joints,   |
|        |                                | Exercise, taping, bracing, etc             |
| 5      | Extremely hypermobile          | Look for hypomobility in adjacent joints,   |
|        |                                | Exercise, taping, bracing, etc             |
| 6      | Unstable                       | Bracing, splinting, casting, surgical       |
|        |                                | stabilization                             |
Glenohumeral Joint Mobilization 101 Shoulder Lab

• Therapeutic Effects of Mobilization include:
  – stimulate synovial fluid
  – movement to nourish cartilage
  – maintain/promote periarticular extensibility
  – provide sensory input
  – neurophysiological effect used daily to treat pain
    • pain relief through neuromodulation on the sensory innervation of the joint mechanoreceptors and pain receptors
    • gates pain achieved by the inhibition of transmission of nociceptive stimuli at the spinal cord and brain stem level
  – neutralizes joint pressures

• Indications
  – pain relief
  – decrease muscle guarding or spasm
  – treat reversible joint hypomobility of capsular origin

**Thoracic HVLA and RTC**
Muth et al., 2012:JOSPT:level 4

• 30 subjects with RTC tendinopathy
• Assessed changes in scapular kinematics, muscle activity, pain, and function, pre-TSM and post-TSM
• Immediate improvements in shoulder pain and function
• TSM may be an effective component of their treatment plan to improve pain and function

**Thoracic HVLA and Impingement**
Haik, et. al., 2014:JOSPT:level 4

• 50 subjects with SIS
• Assessed changes in scapular kinematics and pain
  – before and after TSM
• Immediate improvements in shoulder pain and function
• TSM may be an effective component of their treatment plan to improve pain and function

61
Thoracic HVLA

- Some effects
  - **Mechanical**
    - ↑ ROM (Fernandez-de-las Penas. Et. Al., 2005; Clements et al., 2001; Martinez-Segura et al., 2006)
  - **Biochemical**
    - Changes in β-endorphin, serotonin, substance-P, anandamide observed in blood
  - **Neurophysiologic**
    - Muscle excitation or inhibition (conflicting research)
  - **Hypoalgesic**
    - Immediate decrease in pain (Martinez-Segura et al., 2006)

HVLA thoracic Manipulation

“What can do good can do harm”

- **Contraindications**
  - Neurological: cord compression, cauda equina compression, nerve root compression with increasing neurological deficit
  - Vascular: aortic aneurism, bleeding into joints, CAD, severe hemophilia
  - Bone: degenerative bone disease (Osteoporotic, osteopenia, Osteoarthiritic), tumor, TB infection, fracture, long term corticosteroid use
  - Lack of diagnosis
  - Patient positioning can not be achieved because of pain or resistance, excessive or extreme pain
  - History of spinal surgery (surgical fusion hardware)
  - Congenital abnormalities or space-occupying lesions
  - Lack of patient consent (verbal/written)

Mid Thoracic (T4-T9) AP Extension

HVLA Thrust

- **Precautions**
  - Previous shoulder surgical intervention
  - Complete rotator cuff tear
  - Acute spastic muscle region
  - Advanced DJD

**Complications**

- Pedicle fracture
- Thoracic compression fracture
- Rib fracture
- Thoracic disc herniation

- **Patient position:** Supine with hands across chest with far arm on top and arms not crossing, 2-3 rolled towels (patient morphology dependent) between chest and arms, elbows pointed directly vertical and anterior to the treatment segment
- **Examiner position:** Standing next to patient with underside hand making a “relaxed” fist (with or without battery) and the treatment transverse process on the middle phalanx of the 3rd digit and thenar eminence. Contact your xiphoid process or below onto the patients elbows. Keep an upright posture during thrust.
- **Technique:** An A-P force should be directed at the limit of available movement by dropping the knees at the moment of thrust deliver
- **NOTE:** Only perform if your expertise and skill level warrants. Remember this is a low amplitude but high velocity technique.
HVLA Thoracic Passive Manipulation

Shoulder Lab

• Joint Mobilizations: Posterior
  – Patient position: Supine with treatment arm off plinth in abduction (90°, altered based on needed treatment), elbow flexed to 90°
  – Clinician position: standing above shoulder with staggered foot position (outside foot in front of inside foot)
    • Distal hand: Grasp the patient’s distal humerus and elbow just above epicondyles; apply grade I-II traction
    • Proximal hand: Heel of hand placed against anterior humeral head with straight elbow
  – Mobilization technique: Grade III-IV AP mobilization is applied through your mobilizing arm against the humeral head. Incorporate trunk rotation through straight elbow to increase force of mobilization
  – May be performed in various degrees of abduction and with medial/lateral or inferior/superior biases based on patient symptoms and response

Shoulder Lab

• Joint Mobilizations: Anterior
  – Patient position: Prone with treatment arm off plinth in 90° of abduction, elbow flexed to ~90°
  – Clinician Position: Standing below shoulder with staggered foot position (outside foot in front of inside foot)
    • Distal hand: Grasp the patient’s distal humerus and elbow just above epicondyles allow forearm to hang toward ground; apply grade I-II traction
    • Proximal hand: Heel of hand placed against posterior humeral head with straight elbow
  – Mobilization technique: Grade III-IV PA mobilization is applied through your mobilizing arm against the humeral head. Incorporate trunk rotation through straight elbow to increase force of mobilization

Shoulder Lab

• Joint Mobilizations: Posterior/Anterior
Shoulder Lab

• Joint Mobilizations: Inferior
  – Patient position: Supine with treatment arm off plinth in 90° of abduction, elbow flexed to ~90°
  – Clinician Position: Standing above shoulder with staggered foot position (outside foot behind inside foot)
    • Distal hand: Grasp the patient’s distal humerus and elbow just above epicondyles; apply grade I-II traction
    • Proximal hand: 1st web space and heel of hand placed against superior humeral head with elbow at ~90°
  – Mobilization technique: Grade III-IV PA mobilization is applied through your mobilizing arm against the humeral head. Incorporate trunk rotation and weight shift through elbow to increase force of mobilization

Shoulder Lab

• Joint Mobilizations: Superior
  – Patient position: Supine with treatment arm off plinth in 90° of abduction, elbow flexed to ~90°
  – Clinician Position: Standing above shoulder with staggered foot position (outside foot behind inside foot)
    • Distal hand: Grasp the patient’s distal humerus and elbow just above epicondyles; apply grade I-II traction
    • Proximal hand: 1st web space and heel of hand placed against superior humeral head with elbow at ~90°
  – Mobilization technique: Grade III-IV PA mobilization is applied through your mobilizing arm against the humeral head. Incorporate trunk rotation and weight shift through elbow to increase force of mobilization

Shoulder Lab

• Joint Mobilizations: Inferior/Superior
  – Practice all with medial/lateral bias and/or all directions of the quadrant

Shoulder Lab

• Joint Mobilizations
  – Inferior/Superior
  – Practice all with medial/lateral bias and/or all directions of the quadrant
Shoulder Lab
• Self Joint Mobilizations

Speaking of COMPLIANT Patients!

Shoulder Lab
• Noncompliant patient Joint Mobilizations

Shoulder Lab
• Scapular Mobilizations: Sidelying
  – Elevation/Depression
  – Retraction/Protraction
  – Oblique angles
    • Superiomedial/Inferiolateral
    • Inferiomedial/Superiolateral
• Patient must completely relax scapula musculature and be in comfortable position.
Shoulder Lab

- Scapular Mobilization: Sidelying Elevation/Depression
  - Patient position: Sidelying (facing clinician, pillow between clinician and patient), shoulder and elbow flexed and forearm resting on clinician’s forearm
  - Clinician Position: Lower arm under patients distal bicep (just above elbow) with hand placed around the inferior angle of the scapula with the thumb and forefinger along lateral and medial scapula borders. Upper hand grasps scapula spine, cupping heel of hand anteriorly over the clavicle
  - Mobilization technique: Grade I-IV mobilization is applied through scapula superior and inferior by using trunk to provide the key force through the arms

Shoulder Lab

- Scapular Mobilizations: Sidelying Protraction/Retraction
  - Patient position: Sidelying (facing clinician, pillow between clinician and patient), shoulder and elbow flexed and forearm resting on clinician’s forearm
  - Clinician Position: Lower arm under patients distal bicep (just above elbow) with hand placed around the inferior angle of the scapula with the thumb and forefinger along lateral and medial scapula borders. Upper hand grasps scapula spine, cupping heel of hand anteriorly over the clavicle
  - Mobilization technique: Grade I-IV mobilization is applied through scapula medially and laterally by using trunk to provide the key force through the arms

Shoulder Lab

- Scapular Mobilizations: Sidelying Oblique angles
  - (Superiomedial-Inferiolateral; Inferiomedial-Superiolateral)
  - Patient position: Sidelying (facing clinician, pillow between clinician and patient), shoulder and elbow flexed and forearm resting on clinician’s forearm
  - Clinician Position: Lower arm under patients distal bicep (just above elbow) with hand placed around the inferior angle of the scapula with the thumb and forefinger along lateral and medial scapula borders. Upper hand grasps scapula spine, cupping heel of hand anteriorly over the clavicle
  - Mobilization technique: Grade I-IV mobilization is applied through scapula at desired oblique angles by using trunk to provide the key force through the arms
Shoulder Lab

- Scapular Mobilizations Prone
  - Patient position: Prone with treatment arm off plinth in 90° of abduction, elbow flexed to ~90° and forearm resting on clinician’s lower lateral thigh, head rotated based on patient tolerance
  - Clinician position: Lower arm under patient’s bicep with hand placed around the anterior shoulder with thumb lateral to acromion and digits wrapped around humeral head (protects subacromial space). Upper hand grasps scapula spine, cupping heel of hand anteriorly over the clavicle. Arm direction changes with treatment plane (forearm should be in line with treatment plane). Digits of upper hand sit over medial border, inferior angle, or lateral border (depending on treatment plane).
  - Mobilization technique: Grade I-IV mobilization is applied through scapula at desired angles by using trunk to provide the key force through the arms

Shoulder Lab

- Neuromuscular exercise
  - Scapular Activation

Shoulder Lab

- Neuromuscular exercise
  - Scapular Activation Retraction/Protraction
Shoulder Lab
• Neuromuscular exercise
  — Scapular Activation Retraction/Protraction

Shoulder Lab
• Neuromuscular exercise
  — Scapular Activation Elevation/Depression

Shoulder Lab
• Neuromuscular exercise
  — Scapular Activation Elevation/Depression

Shoulder Lab
• Neuromuscular exercise
  — Scapular Activation Elevation/Depression
Shoulder Lab
• Neuromuscular exercise
  — SL ER with Perturbations
    • 5 reps of SL ER with scapula squeeze
    • Between sets of five
      — M-L, S-I perturbations at wrist
      — Overpressure Eccentric training with or without resisted concentric phase

Questions?

Evidence-Based Evaluation and Treatment of Rotator Cuff Pathology
Rehab and Specific Exercise

Presented by:
Christian Coulon, PT, PhD(c), OCS, CSCS, Cert. MDT
Rehabilitation of the shoulder

- Stages of Healing
- Surgical Considerations
- Importance of ROM
- Treatment Fundamentals
- EMG and Specific Therapeutic Exercise
- Exercise Progressions
- RTC repair Program

**Stage of Healing**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Days</th>
<th>Changes</th>
<th>Results</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Stage: Inflammatory</td>
<td>0-7  days</td>
<td>Vascular changes, exudation of cells and chemicals, clot formation, phagocytosis, and early fibroblastic activity</td>
<td>Inflammation and characterized by pain</td>
<td>Control effects of inflammation, modalities, immobilization, cautious gentle motion</td>
</tr>
<tr>
<td>Subacute Stage: Repair and healing</td>
<td>7-21 days</td>
<td>Removal of noxious stimuli, growth of capillary beds into area, collagen formation (easily injured)</td>
<td>Decreasing inflammation, pain synchronous with tissue resistance</td>
<td>Prevent contracture, gentle ROM, increase intensity gradually</td>
</tr>
<tr>
<td>Chronic Stage: Maturation/remodeling</td>
<td>21+ days</td>
<td>Maturation of CT, contracture of scar tissue, remodeling of scar, collagen aligns to stress</td>
<td>Absence of inflammation, pain after tissue resistance</td>
<td>Restore function, progressive lengthening, strengthening and movement re-education (motor control)</td>
</tr>
</tbody>
</table>

**LET IT HEAL!**
Don't Fight the Biology of Healing! You will lose every time!

- Conservative care of RTC tears
  - Kukkonen, et. al., 2014: Bone and Joint Journal
  - 173 patients >55 y.o. with small (<10mm) nontraumatic supraspinatus tendon tears and full ROM
  - 3 groups:
    - PT only
    - Acromioplasty and PT
    - RTC-R, acromioplasty, and PT
  - Suggest at one-year follow-up
    - Operative treatment no better than conservative treatment
    - Conservative treatment considered as the primary treatment
Conservative care of full-thickness RTC tears
- 31 studies >7 met inclusion criteria
- Improvements pain, ROM, function: 3 yr post-Tx
- Tx based on stage of healing
  - Included Tx:
    - Manual G1-2
    - Ther ex: CKC, light TB, establishing dynamic stability
    - Patient education
    - Continue HEP after discharge

Surgical Options for RTC tears
- Arthroscopic debridement
- Arthroscopic debridement and Acromioplasty
- Arthroscopic RTC intra or transtendinous repair for partial undersurface tears +/- mini-acromioplasty
- All arthroscopic repair for full thickness tears + acromioplasty
- Arthroscopic acromioplasty and mini-open RTC repair for full thickness tears

Factors that Influence surgical intervention
- The expectations and demands of the patient
- The activity level of the patient
- The age of the patient
- The severity and duration of the symptoms
- The response to non-operative treatment

Full Thickness Tear Size
- Small: 0-1cm²
- Medium: 1-3 cm²
- Large: 3-5 cm²
- Massive: >5cm²
- Concomitant Procedures
  - SLAP
  - Stabilization
  - Pectoral Repair

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Don’t ignore him!

Does RTC surgery work?

- Most frequent complication is FAILURE of the repair
  - After repair there is a significant retear rate:
    - Galatz, 2004:JBJS; found that large and massive tears integrity was lost in 90% of patients
    - Harryman, 1991:JBJS; recurrent RTC defects in 43%
    - Bishop et al., 2004:AAOS; recurrent tears found by MRI in 74% of patients with >3cm tears

Complications in Surgery

- Complications (10%) open and arthroscopic RTCR (Brislin, Field, & Savoie, 2007: Arthroscopy)
  - disruption of the deltoid origin
  - Infection (1.9%)
  - foreign body reaction
  - stiffness (most common 5% to 10%)
  - neurologic injury
    - Direct nerve injury, stretch neuropaxia, or complex regional pain disorder (RSD)

Postoperative Stiffness

- Contributing Factors (Huberty et al., 2009:Arthroscopy):
  - Diabetes
  - Hypothyroidism
  - adhesive capsulitis
  - calcific tendonitis
  - partial articular supraspinatus tendon avulsion repair
  - labral repair
  - workers’ compensation claim
  - Inadequate rehabilitation
    - underaggressive
    - patient noncompliance
- Preoperative shoulder stiffness is a risk factor for postoperative stiffness (Tauro, 2006: Arthroscopy)
  - preoperative total range of motion deficit of 70 or greater
Post-Operative Stiffness

- Lentell, 1992: JOSPT
  - Low load prolonged stretch (LLPS)
  - LLPS with heat
  - 40 min x 3 days
  - Long term improvement
- Sustained end range stretch
- JAS Brace
- Dynasplint

Why do they fail?

- Surgical complications
  - Failure to restore the native footprint
  - Suture anchors are a weak link (tendon-suture interface)
- Diagnostic errors
  - Incorrect diagnosis or hidden pathology
- Technical errors
  - Surgical technique
- Failure to heal
  - Healing environment

Rehab following RTC repair

- How does failure of the RTC-R influence rehab?
  - Luedeka & Michener, 2013: Orthopaedic Physical Therapy Practice
    - Exercise which emphasized a CKC model
    - Allowed return to recreational sport
- Limited controlled motion is safe for appropriate patients
- Motion is good for healing tissue
- Immobilization can be detrimental for articular cartilage, tendons, ligaments, and collagen synthesis
- RTC rehab programs are multifactorial
Fermont et al., 2014: JOSPT

- Systematic Literature Review
- Examined Prognostic Factors for Successful recovery after RTC-R arthroscopic
- Examined 443 articles: 10 met review inclusion
- Better recovery = 12 prognostic factors

- Associated with better recovery
  - Younger age
    - <55 = 95%–87%
  - Male gender
    - Physical and quality of life (p=.001)
  - Higher bone mineral density (p=.001)
  - Absence of diabetes
  - Higher level of sports activity
  - Greater preoperative shoulder ROM (p<.001)
    - <120° = ER+IR
  - Absence of obesity
    - BMI > 30 kg/m² = ↑ operative time, hospital stay, smaller sagittal size of cuff lesion
    - Every cm = ↑ tendon defect 1.72 times
  - Less retraction
  - Less fatty infiltrate
  - No multiple tendon involvement
  - No concomitant biceps or AC joint procedures
  - Caution: Moderate level of evidence
    - Potential factors missing
Don’t let the patient be in charge!
Not the Right RTC program!

Klintberg et al., 2009: Clinical Rehab
• Prospective Randomized Study (n=14)
• Randomization into 2 groups
  – Dynamic stabilization and PROM day 1
  – PROM immediately no cuff loading 6 weeks
• Patient’s evaluated at 3, 6, 12, 24 months
• Pain, VAS, PROM, MMT, Functional index
• Early loading group was better at 3 & 6 months and slightly better for ROM, VAS & strength at 24 months

Lastayo et al: 1998, JBJS
• Prospective randomized study (N=32)
• Randomly assigned to 2 groups
  – CPM immediately
  – Manual PROM
• Shoulder pain & disability index
• Both groups were successful
• 84% excellent results, 6% good results, 7% fair results, & 3% poor results...no significant difference between groups
• “MOTION YEILDS FAVORABLE RESULTS”

PROM progression
• Based on Progress and End Feel
  – 30-45° abd ->90° abd ->0°
• Uhl et al, 2010: Phys Med & Rehab

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Supraspinatus</th>
<th>Infraspinatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine PROM opposite arm</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>Table Slide</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Wash Cloth Press up (AA)</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>Table Towel Slide (AA)</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>Standing Press up</td>
<td>29%</td>
<td>14%</td>
</tr>
</tbody>
</table>
PROM progression
Uhl et al, 2010: Phys Med & Rehab

• Table Slide
  — 5% EMG Supraspinatus
  — 2% EMG Infraspinatus

Dockery, Wright, LaStayo, 1998: Orthop

• Surface EMG applied to shoulder (n=10)
• 7 post-op exercises
  — Pendulum
  — Pulley
  — Self assisted bar with opposite arm
  — PROM
  — PROM ER/IR
  — Self assisted ER/IR
  — CPM device
• ONLY PASSIVE=CPM and PT PROM

Pendulums

How my patients do pendulums!
Jensen et al., 1995

- Studied effects of submaximal isometric contractions (5%-50%) while measuring blood flow in the supraspinatus tendon
  - Laser doppler flowmetry
- Results: Increased perfusion during all one minute contractions
  - Latent hyperemia post muscle contraction
- Provide for rationale to use submaximal isometrics IR/ER in scapular plane with slight elevation

Scapular Position & Kinematics

- Taping & Bracing
  - Significant change in Posture and Elevation
    - Lewis, 2005:JOSPT
    - Selkowitz, 2007:JOSPT
  - No change in pain but occurs at higher degree of motion

Pain Reduction Treatment

- Activity Modification
- Treat Trigger Points
  - Spray and stretch
  - Dry Needling
    - Kietrys, et al., 2013
  - Ischemic Compression
    - Travell & Simons, 1983:Myofascial Pain & Dysfunction

Flexibility

- Pectoralis Minor Stretching
  - Borstad & Ludewig, 2006:JSES
    - Compared 3 stretching techniques
      - Unilateral self Stretch (1st)
      - Supine Manual stretch (2nd)
      - Seated manual stretch (3rd)
  - Muraki et al, 2009:PTJ
    - Compared 3 stretching techniques
    - Scapula retraction at 30˚ flexion best
**Factors affecting Pectoralis Minor Stretch**
- Ability to relax
- Humeral abduction
- Humeral ER
- Position of scapula
  - Posterior tilted
  - ER

**Posterior Cuff Stretching**
- Self stretch and manual

**Evidence Based Treatment of impingement starts conservative:** (DeWitte, et al., 2011:BMC Mus Disord)
- Arm rest
- Rehabilitation
  - Interventions based on accurate clinical evaluation and stage of healing
  - Exercise progression based on pathology
- NSAIDs (acute)
- Subacromial injections

**Recent Shoulder Research**
- Scientifically based rehabilitation exercises
  - Facilitate recovery while placing minimal strain on healing tissues

**Specific Therapeutic exercise in Impingement**
- Target the Right Muscles! Avoid non-specific exercises.
Specific therapeutic exercise

- Recent research has demonstrated specific supervised exercises focusing on:
  - serratus anterior, trapezius, infraspinatus, supraspinatus, and teres minor
  - beneficial for impingement/shoulder
- Exercise prescription should be based on the EMG profile of exercise

EMG Activation

- 3 progressive levels of EMG activity in shoulder patients:
  - Minimal 0-39% MVIC
  - Moderate 40-74% MVIC
  - Maximal 75-100% MVIC
- Maximum voluntary isometric contraction (MVIC) used in normalization of EMG data and between subject comparisons
  - demonstrates lower variability
  - higher inter-individual reliability
- MVIC was standard for normalization in normal and orthopedically impaired population

Lower Trapezius

- maximally activate the lower trapezius
  - prone horizontal abduction at 135° with ER (97%MVIC)
  - Prone Full can: Wilk 1998:AJSM
  - standing ER at 90° abduction (88%MVIC)
  - prone ER at 90° abduction (79%MVIC)
  - prone horizontal abduction at 90° abduction with ER (74%MVIC, 63%MVIC)
  - abduction above 120° with ER (68%MVIC)
  - prone rowing (67%MVIC)
  - Table Press Down: activation
  - Wall Circles: if appropriate

Lower Trap Progression

- 67% MVIC
- 74-63% MVIC
- 27% MVIC
- 97% MVIC
Lower Trap Progression

- 88% MVIC
- 68% MVIC

Middle Trap Progression

- 77% MVIC
- 79% MVIC
- 87-96% MVIC

Middle Trapezius

- Maximally activate the middle trapézius
  - prone horizontal abduction at 90° abduction with IR (108%MVIC)
  - prone horizontal abduction at 135° abduction with ER (101%MVIC)
  - prone horizontal abduction at 90° abduction with ER (87%MVIC, 96%MVIC)
    - some agreement in amplitude of EMG
  - prone rowing (79%MVIC)
  - prone extension at 90° flexion (77%MVIC)

Supraspinatus

- Maximally activate the supraspinatus
  - push-up plus (99%MVIC)
  - prone horizontal abduction at 100° abduction with ER (82%MVIC)
    - Prone full can
    - prone ER at 90° abduction (68%MVIC)
    - military press (80%MVIC)
    - Standing Full Can
    - Empty can???
Reinold, Macrina, Wilk, 2007: J Athl Train

- EMG of supraspinatus and deltoid during 3 exercises (n=22 asymptomatic)
- Full can, Empty can, Prone full can
- No significant difference in supraspinatus EMG
- Posterior Deltoid: EMG greater in prone and standing full can

Avoid Empty Can

Supraspinatus Progression

- Maximally activate the infraspinatus
  - Scaption at 0° abduction (85%MVIC)
  - Prone horizontal abduction at 90° abduction with ER (88%MVIC)
  - Prone horizontal abduction at 90° abduction with IR (74%MVIC)
  - Abduction above 120° with ER (74%MVIC)
  - Flexion above 120° with ER (66%MVIC)
**Infraspinatus Progression**

- 85%MVIC
- 88%MVIC
- Flexion 66%MVIC
- Progress to Abduction 74%MVIC
- Standing with Tubing
- Sustained Holds Sitting on Ball Machines
- Prone on Ball

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**Serratus Anterior Progression**

- Supine 90° punch 62%MVIC
- Dynamic Hug 73-80%MVIC
- 96%MVIC
- 100% MVIC

---

**Serratus Anterior**

- maximally activate
  - D1 diagonal pattern flexion, horizontal adduction, and ER (100%MVIC)
  - scaption above 120° with ER (96%MVIC MS, 84%MVIC LS)
  - supine upward punch (62%MVIC)
    - Kendall 1979
  - flexion above 120° with ER (96%MVIC MS, 72%MVIC LS)
  - abduction above 120° with ER (96%MVIC MS, 74%MVIC LS)
  - push-up plus (80%MVIC MS, 73%MVIC LS)
    - Moseley AJSM 1992
  - Dynamic Hug
    - Decker AJSM 1999
  - Wall slide
    - Hardwick JOSPT 2006 (>90%MVIC)

---

**Dynamic Hug**

- Start
- Finish
- >90%MVIC
- 100% MVIC

---
Specific therapeutic exercise

• Application of a towel roll while performing SL ER at 0°
  – ↑ EMG activity by 18-20% when compared to no towel roll (Reinhold et al., 2004:JOSPT)
  – Standing ER (Fleisig et al., 1998:NAOCB)
• Conscious Correction (De Mey et al., 2013:JOSPT)
  – ↑ EMG activity LT 13.3%

Specific therapeutic exercise

• Just looking at lower trapezius
  – Conscious Correction (13.3% LT) + add .5kg load (4% LT)+firmer grip (2% LT)= ↑ 19.3% EMG activity

Be Specific with your Therapeutic Exercises!!
Research has demonstrated exercises which may be more beneficial than others.
Stage of rehabilitation may contraindicate the specific exercise.
- Strengthening Progression RTC IR/ER
- Remember Progression of reps, sets, and exercises!

0 degrees → 45 degrees → 90 degrees

General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)
- Immediate Postsurgical Phase (Days 1-15)
  - Restrictions: No lifting of objects, No excessive arm motions, No excessive external/internal rotation or extension motions, No excessive stretching or sudden movements, No supporting of body weight by hands, Keep incision clean and dry
  - Isolated supraspinatus repair: Caution with excessive P/AROM IR (6-8 wks)
  - Combined supraspinatus and infraspinatus repair: Caution with excessive P/AROM IR (8 wks)
  - Isolated subscapularis repair: No ER (4 wks), Progress ER slowly from 4 weeks until 8-10 weeks
- Goals: Maintain repair integrity, Promote tissue healing, Gradually increase passive ROM, Diminish pain and inflammation, Prevent muscular inhibition

General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)
- Days 1 to 7
  - 30° abduction pillow brace (physician dependent)
  - Pendulum exercises and/or table slides (pain-free)
  - Active assisted ROM exercise (L-Bar)
    - ER/IR in scapular plane at 45° of abduction (pain-free ROM)
  - Passive ROM
    - Flexion to tolerance (no to mild pain)
    - ER/IR in scapular plane at 45° of abduction (pain-free ROM)
    - Limit ER and IR ROM to 25°-30° (pain-free ROM)
  - Elbow/hand gripping and ROM exercises
  - Submaximal pain-free isometrics (initiate day 5)
    - Flexion with elbow bent to 90°, ER, IR, Elbow flexors
  - Cryotherapy for pain and inflammation (Ice 15-20 min (4-6 times daily))
  - Sleeping: Sleep in pillow brace until instructed to discontinue
General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)

- Days 7 to 15
  - Continue use of pillow brace and sleeping in brace until physician instructs to discontinue, continue pendulum & table slide exercises, AAROM L-bar, manual PROM, elbow/hand therapy, submax isometrics, and ice (min of 5x day)
  - Progress passive ROM to tolerance
    - Flexion =115°, ER scapular plane at 45° abduction = 30°-35°, IR in scapular plane at 45° abduction = 30°-35°
- Active assisted ROM exercises (L-Bar)
  - Flexion to tolerance (initiate day 15 postop)
  - Begin posterior cuff NMES during isometrics at day 14
  - Initiate rhythmic stabilization ER/IR at 45° abduction

General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)

- Subacute Protection Phase (Day 16-Week 8)
  - Restrictions: No heavy lifting of objects or carrying heavy objects, No excessive behind the back movements, No supporting of body weight by hands and arms, No sudden jerking motions
  - Goals: Allow healing of soft tissue, Do not overstress healing tissue, Gradually restore full passive ROM (week 4-5), Re-establish dynamic shoulder stability, Decrease pain and inflammation
  - Days 15-28
    - Continue use of pillow brace and sleeping in brace until physician or therapist instructs to discontinue, continue pendulum & table slide exercises, AAROM L-bar, manual PROM, elbow/hand therapy, submax isometrics with NMES, rhythmic stabilization, and ice (min of 5x day)
    - Passive ROM to tolerance
      - Flexion =140°-155°, ER at 90° abduction = 30°-45° at week 4, IR at 90° abduction = 30°-45° at week 4
    - Active assisted ROM to tolerance
      - Flexion (continue use of arm support)
        - ER/IR at 90° abduction
    - Rhythmic stabilization drills
      - Flexion/extension at 100°-120° flexion
    - May use heat first if no joint effusion

General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)

- Weeks 4-5: GOAL: Patient should exhibit full passive ROM by weeks 4-6
  - Continue use of sling or brace (physician or therapist will determine when to discontinue), cryotherapy (PRN), all isometric contractions, manual PROM, AAROM, rhythmic stabilization, moist heat before ROM
  - Isotonics
    - ER/IR strengthening using exercise tubing at 0° of abduction (with towel roll)
    - Prone rowing with arm at 30° abduction to neutral arm position
    - ER strengthening exercises (SL ER)
    - Elbow flexion
  - Pool for light active ROM exercises
  - Rhythmic stabilization exercises: flexion anywhere from 45°-120°
General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)

- **Weeks 6-8:** Sling or brace (D/C during this period, physician dependent)
- **GOAL:** FULL ROM, no shrug sign by week 8
  - Continue P/AAROM and stretching exercises: For restricted ROM
  - Continue rhythmic stabilization, moist heat before ROM, Isotonics
  - Isotonics:
    - Shoulder flexion stopping at 90° in side-lying (gravity eliminated position)
    - ER at 90° abduction
    - Prone horizontal abduction (bent elbow)
  - Progress isotonic tubing exercise program
  - Scapula neuromuscular drills

**General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)**

- **Intermediate Phase (Weeks 8-16)**
- **Goals:** Full active ROM (wk 10), Dynamic shoulder stability, Gradual restoration of shoulder strength and return to functional activities
- **Week 8**
  - Continue stretching and passive ROM (as needed to maintain full ROM)
  - Continue dynamic stabilization drills
  - Progress active ROM "light" strengthening program
    - Full can in scapular plane to 90° of flexion (no shrug sign)
    - Prone horizontal abduction
    - Prone extension
  - Continue all prior exercises if warranted
- **Week 10:** Continue all exercises, Progress to all shoulder exercises
- **Weeks 12-16:** Progress all exercises, Continue ROM and flexibility exercises (PRN), Progress strengthening program
- **No residual pain present following exercises!**
General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)

- Advanced Strengthening Phase (Weeks 16-26):
  - Goals: Maintain full non-painful ROM, maintain integrity of repair, enhance functional use of upper extremity, improve muscular strength and power, and gradual return to functional activities
  - Weeks 16-20: Continue ROM and stretching to maintain full ROM (PRN), Capsular stretches, Progress shoulder strengthening exercises
    - Golfers: begin interval golf program (if appropriate, week 16)
  - Weeks 20-26: Continue all exercises, Gradually increase resistance
    - no pain during or after exercise and no substitution pattern

General Progression Post-op RTC repair (medium to large tear) (GHODADRA et al., 2009)

- Return to Activities (Weeks 26-36): Goals: Gradual return to strenuous work activities, Gradual return to recreational sport activities
  - Week 26: Continue shoulder exercise program (at least 4 times weekly until 1 year post-operation), Continue stretching, if motion is tight
    - Progress golf program to playing golf
    - Initiate interval tennis program
    - May initiate light swimming (weeks 26-29)
    - Continue progression to sport or work activity

Questions??
Thank YOU!!
— ccoulon@sports-medicine-institute.com