Rehabilitation for Arthroscopic RTC Repair

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NONOPERATIVE RTC REHABILITATION

• PT for 6 – 12 weeks is effective for treating atraumatic RTC tears in 75% of patients at 2 year follow up (Kuhn JSES 2013)

• 88% of RTC tears that were treated with medication, injection, and PT had no pain or only slight pain and 70% had no problem with ADLs at 13 year follow up (Kijima JSES 2012)

• Modifiable factors in patients with symptomatic, atraumatic RTC tears (Harris AJSM 2012)
  – ST dyskinesis
  – FF and abduction ROM
  – FF and abduction strength
EMORY SPORTS MEDICINE POSTOPERATIVE RTC REHABILITATION PROGRAM

• Goal is to progress functional recovery in a way that does not damage the repair site
• Clinical observation is that you should be concerned about activities outside of rehabilitation that could damage the healing RTC repair
• Patients need to be educated on activity restrictions throughout the rehabilitation program
REHABILITATION PRINCIPLES

• Protect healing tissue
  – Soft tissue to bone healing is a slow process
  – Avoid strain or micromotion to the repair site in early healing phase
  – Structural defects after arthroscopic RTC repair range from 13 – 94% (Dodson AJSM 2010)

• Prevent negative effects of immobilization
  – Post operative restrictions in ROM range from 3 – 23% (Parsons JSES 2010)
  – Patients who have LOM at 3 months after RTC repair have increased pain and lower outcome scores compared to patients without LOM (Namdari JSES 2010)
REHABILITATION PRINCIPLES

- Limit scapular compensation with active elevation
  - Presurgical compensation
  - Pain inhibition
  - RTC weakness (shrug sign)
  - Capsular restriction at the GH joint
  - GH joint mechanics are not fully restored at 2 years after RTC repair (Bey AJSM 2011)
REHABILITATION PRINCIPLES

• Restore posterior shoulder flexibility and ER ROM in overhead athlete
  – Dominant shoulder IR usually < nondominant
  – Good to know pre-op ER in throwers which can range from 115-140° (Wilk AJSM 2002)
REHABILITATION PRINCIPLES

- Improve scapular position and posture

  - Excessive scapular protraction diminishes acromial-humeral space (Solem-Bertoft Clin Ortho 1993)
  - Patients with impingement exhibit less posterior tilting than do subjects without impingement (Lukasiewicz JOSPT 1999)
  - Acromiohumeral distance increased with upright posture compared to normal posture with arm at 45° abduction (Kalra JOSPT 2010)
REHABILITATION PRINCIPLES

- Gradual progression with RTC/scapular strengthening exercise
  - Initial emphasis on slow/controlled movement
  - Light resistance
  - Normal scapulohumeral rhythm
- Establish muscular balance
  - ER/IR ratio 65% at 180°/second
  - Abd/Add ratio 82% at 180°/second (Wilk AJSM 1993/1995)
REHABILITATION PRINCIPLES

• Recovery of RTC strength could take 1 – 2 years (Rokito JSES 1996, Bigoni JSES 2009, Bey AJSM 2011)
• Muscle strength recovery depends on size of the tear (Shin AJSM 2016)
  – Small tears: 6 months
  – Medium tears: 12 months
  – Large to massive tears: 10% – 15% strength deficits at two years
REHABILITATION PRINCIPLES

• Restore Proprioception and Neuromuscular Control
• Gradual return to throwing and sports activities
FACTORS AFFECTING REHABILITATION AFTER ARTHROSCOPIC RTC REPAIR SURGERY

- Age
- Pre-surgical condition (ROM, strength, etc)
- Dominant or non-dominant arm
- Work/Sport activities/Overhead athletes
- Size of RTC tear
- Number of tendons involved and location of tear
- Tissue quality of tendon and bone
- General health/lifestyle habits
TREATMENT PRINCIPLES

• Patient Education
  – Postoperative precautions: ROM limitations, lifting, driving, work, etc.
  – Educate patient about healing process and protecting surgical repair
  – Use of sling: limits active use of the shoulder, protect patient from other people or falls and sling with abduction pillow decreases strain on the RTC repair
  – Proper positioning of arm for comfort and to promote healing, load reduced by 34N on RTC repair by passive elevation from 0 to 30° (Reilly JSES 2004)
TREATMENT PRINCIPLES

• EMG activity of the supraspinatus with ADLs (Gumey JOSPT 2016, Long JOSPT 2010)
  – Typing 7% MVC
  – Brushing teeth 12% MVC
  – On/off sling 12% MVC
  – Walking 15% MVC
  – Drinking 21% MVC
  – On/off shirt 25% MVC
TREATMENT PRINCIPLES

• Patient Education
  – Home exercise program: keep it simple
  – Rehab progression

• Mobility
  – ROM: passive/active-assisted/active
  – Joint mobilization
  – Stretching: muscular/capsular
RANGE OF MOTION

Which exercises are passive and active-assisted?

Several EMG Studies:
McCann (Clin Ortho 1993) – Passive/Active-assisted/Active/Resistance
Dockery (Ortho 1998) – Passive/Active-assisted
Kelly (J OSPT 2000) – Active exercises in water
Wise (J SES 2004) – Limb support with Active ROM
Long (J OSPT 2010) – Small/large pendulum exercises
Gaunt (SH 2010) – AAROM of elevation exercises
Jung (KSSTA 2015) – Passive FF/ER

Clinical Application: All ROM exercises studied had some level of supraspinatus activity. Note that all studies done on normal patients.
RANGE OF MOTION

• ROM exercises with minimal supraspinatus activity (< 10% MVC)
  – CPM
  – Small pendulum (20 cm)
  – Therapist assisted FF, ER, IR in supine
  – Self assisted elevation in supine
  – ER/IR with stick
  – Active elevation in water at slow speed (45°/second or less)
RANGE OF MOTION

• ROM exercises below 20% MVC of supraspinatus
  – Pulleys
  – Supine cane elevation
  – Supported wall climbing with elbow bent
RANGE OF MOTION

- EMG activity of the supraspinatus in postoperative patients compared to baseline (Murphy JSES 2013)

TER <BL
TFF =BL
PER =BL
Pendulum =BL
PFF-supine >BL
PFF-table >BL
PFF-pulley >BL
RANGE OF MOTION

What arc of motion produced the least stress on the RTC repair?

Cadaver studies
- Safe zone of passive motion which does not cause too much tension on the RTC repair includes > 30° of elevation in scapular/coronal planes and 0 - 60° of E.R. in scapular plane (Hatakeyama AJSM 2001)
- Cyclic loading (50N) of the supraspinatus showed gap formation was greatest for IR (45°) followed by ER (45°) and least for neutral position (Ahmad AJSM 2008)
- 30° of ER produces tension in the anterior suture and 30° of IR produces tension in the posterior suture (Howe AJSM 2009)
JOINT MOBILIZATION

• Cadaver study by Muraki (Man Therapy 2007) evaluated mechanical effects of joint mobilization on repaired RTC tendons

• Grade III traction, anterior and posterior glides at 30° produces no significant strain on RTC repair as compared to relaxed position

• Avoid all joint mobilizations at 0° scaption and inferior glide at 30° scaption
STRETCHING: MUSCULAR/CAPSULAR

- Cadaver study by Muraki (Clin Bio 2006) showed significant strain on the supraspinatus with extension and horizontal abduction.
- Cadaver study by Izumi (AJSM 2008) showed that IR with elevation from 0 to 60° of scaption and IR at 30° extension (HBB) were the best positions to stretch the posterior capsule.
ACTIVE RANGE OF MOTION

• Active elevation produces moderate supraspinatus activity (20 – 50% MVC)
  – Elbow bent: 25% MVC
  – Elbow straight: 30% MVC
  – Elevation at 90°/sec in water: 27% MVC
  – Elevation at 100°/sec: 49% MVC
STRENGTHENING

Several EMG studies evaluating shoulder muscle recruitment during strengthening exercises

- Kronberg (Clin Ortho 1990) – Isotonic/Pulley Apparatus
- Townsend (AJSM 1991) – Isotonic/CKC of GH muscles
- Moseley (AJSM 1992) – Isotonic/CKC of Scapular muscles
- Kelly (AJSM 1996) – Isometric RTC muscles
- Alpert (JSES 2000) – Effect of load and speed on RTC and deltoid muscles
- Reinold (J. Ath. Train 2007) – Isotonic/Supraspinatus and deltoid muscles
STRENGTHENING

Clinical Application

- **Mode:** isometric, isotonic, isokinetic, elastic resistance
- Strengthening exercises that limit activity of supraspinatus (IR and extension)
- Isometric exercises with elbow by side produce <40% MVC of supraspinatus and can provide pain relief
- Most effective exercises for GH and scapular muscles
- Arc of motion with highest EMG activity
- Speed increases RTC and deltoid activity between 0 and 60°
- Isometric/isotonic exercises that achieve maximal RTC activity with minimal activation of involved muscle synergists
STRENGTHENING

Supraspinatus EMG Activity with Isometrics

- Isometric with elbow by side (McCann)
  - IR - 8%
  - ER - 26%
  - FF - 25%
  - Ext - 14%
  - Abd - 36%
STRENGTHENING

Supraspinatus EMG Activity with Elastic Resistance

• Elastic resistance with elbow by side (McCann)
  
  IR – 7%
  ER – 37%
STRENGTHENING

- Supraspinatus EMG activation with scapulothoracic exercises using elastic resistance (Hintermeister)
  - Seated rowing – 32%
  - Forward punch – 48%
  - Shoulder shrug (retraction) – 44%
### Strengthening

**Supraspinatus EMG Activity with Isotonic (Townsend)**

<table>
<thead>
<tr>
<th></th>
<th>MVC</th>
<th>Arc of Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Military press</td>
<td>80%</td>
<td>0 – 30°</td>
</tr>
<tr>
<td>Scaption IR</td>
<td>74%</td>
<td>90 – 120°</td>
</tr>
<tr>
<td>Flexion</td>
<td>67%</td>
<td>90 – 120°</td>
</tr>
<tr>
<td>Scaption ER</td>
<td>64%</td>
<td>90 – 120°</td>
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</table>
Supraspinatus EMG Activity with Scaption (Alpert)

<table>
<thead>
<tr>
<th>NMW</th>
<th>MVC</th>
<th>Arc of Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>49%</td>
<td>30 – 60°</td>
</tr>
<tr>
<td>25%</td>
<td>79%</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td>75%</td>
<td>109%</td>
<td></td>
</tr>
<tr>
<td>90%</td>
<td>122%</td>
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</tr>
</tbody>
</table>
STRENGTHENING

Supraspinatus/Deltoid EMG Activity with three common rehab exercises (Reinold)

• Full-can, empty-can and prone full-can had similar supraspinatus EMG activity
• Full-can had the least amount of deltoid activity
• Full-can is the optimal exercise to recruit the supraspinatus while simultaneously minimizing superior shear force due to deltoid activity
TREATMENT PRINCIPLES

• Neuromuscular Control of Scapula and GH joints
  – Manual/PNF
  – CKC

• Functional Training
  – Plyometrics
  – Interval Throwing
  – Sport Specific Training Program
RTC REPAIR REHAB OUTCOMES

• Klintberg (Clin Rehab 2009): Pilot study showed no significant difference in pain, patient satisfaction, ROM, strength and Constant score between progressive (AROM 4 wk/ strength 8 wk) or traditional (AROM 10 wk/ strength 16wk) rehab protocols at 2 years

• Duzgun (Acta Orth Tran Turc 2011): Prospective study showed no significant difference in pain and DASH scores between accelerated (AROM 3 wk/strength 4 wk) or slow (AROM 6 wk/strength 8 wk) protocols at 6 months
RTC REPAIR REHAB OUTCOMES

• Lee (Arthroscopy 2012): RTC showed no significant difference in pain, ROM, strength, UCLA score and structural outcome (MRI) between aggressive PROM (FF to tolerance / ER to 30°) and limited PROM (only FF to 90° for 3 wk) groups at one year.

• Kim (AJSM 2012): RTC showed no significant difference in pain, ROM, functional and structural outcomes (US/MRI) between early PROM and no PROM (4 wk) groups at one year.
RTC REPAIR REHAB OUTCOMES

• Cuff (J SES 2012): No significant difference in patient satisfaction, RTC healing or ROM between early (2 days) and delayed (6 weeks) PROM groups one year after surgery.

• Kneer (J BJ S 2014): no significant difference between early ROM and immobilization (6 weeks) groups in functional outcome scores, AROM and shoulder strength at 6, 12, and 24 months after surgery. 92% of tears were healed with no difference between rehab groups.
WHEN DO RTC REPAIRS FAIL?

- Majority of atraumatic reruptures occur in the early post-operative period (<3 months)
  - Miller (AJ SM 2011) 77% of reruptures occur within the first 3 months
  - Kluger (AJ SM 2011) 74% of all failures occur within the first 3 months
  - Nho (J SES 2009) 100% of reruptures occur within the first 3 months
  - Ahmad (J SES 2015) 25% retear rate in the first 12 weeks and 4% in the second 12 weeks
RTC REPAIR REHABILITATION

Emory Sports Medicine Approach to Rehabilitation of Arthroscopic RTC Repair based on:

• Basic science and biomechanical studies of RTC repair
• Biomechanical studies of rehabilitation exercises and activities
• Outcome studies
• Clinical observation
RTC REPAIR REHABILITATION

General Principles for small/medium RTC repair
• PROM/AAROM of the shoulder for 6 weeks
• AROM and submaximal isometrics at 6 weeks
• RTC strengthening at 9 weeks
  – Start with IR/ER with arm in scapular plane
RTC REPAIR REHABILITATION

Phase I - Protection Phase (0 – 6 weeks)

• Weeks 0 – 4
  – Sling for 6 weeks
  – Wrist and gripping exercises
  – Elbow AAROM/AROM
  – Pendulum exercises
  – Shoulder PROM – 120° of flexion and 30° of ER in scapular plane at 4 weeks
RTC REPAIR REHABILITATION

Phase I – Protection Phase (0 – 6 weeks)

• Weeks 4 – 6
  – Progress shoulder PROM as tolerated – 140° of flexion and 45° of ER in scapular plane at 6 weeks
  – Shoulder AAROM (pulleys, cane, etc.) as tolerated
  – Shoulder joint mobilization as needed except inferior translation
RTC REPAIR REHABILITATION

Phase II – Mobility/Strengthening Phase
(6 – 12 weeks)

- D/C sling
- Shoulder PROM/AAROM as tolerated with goal of full ROM by 12 weeks
- Shoulder AROM as tolerated with emphasis on scapulohumeral rhythm
- UBE for ROM with no resistance until 9 weeks
- Submaximal shoulder isometrics
- Scapular stabilization exercises
RTC REPAIR REHABILITATION

Phase II – Mobility/Strengthening Phase
(6 – 12 weeks)

- Bicep/Tricep strengthening with elbow by side
- RTC strengthening program at 9 weeks
RTC REPAIR REHABILITATION

Phase II – Mobility/Strengthening Phase (6 – 12 weeks)

- Neuromuscular control exercises (PNF, CKC, etc.) at 9 weeks
- Isokinetics for IR/ER in scapular plane at 9 weeks
RTC REPAIR REHABILITATION

Phase III – Dynamic Strengthening Phase (12 – 20 weeks)

- Maintain ROM/Capsular stretching
- Progress RTC strengthening and neuromuscular control exercises
- Upper body weight lifting program with RTC modifications – initiate pressing exercises in protected ROM at 16 weeks
- Plyometric training at 16 weeks for overhead athletes except throwing
RTC REPAIR REHABILITATION

Phase IV – Return to Activity Phase (20 – 26 weeks)

- Progress strengthening and plyometric program
- Initiate interval throwing/sport program
RTC REPAIR REHABILITATION

Sports Progression

• Golf: chip and putt at 3 months/full game at 5 months
• Tennis: ground strokes at 3 months/full game at 5 – 6 months
• Throwing sports: start after rehab and interval throwing program is completed
RTC REPAIR REHABILITATION

General Shoulder Rehabilitation Principles

- Trunk and lower extremity conditioning
- Cardiovascular conditioning
- Athlete’s involved in skilled sports (baseball, tennis, swimming, golf, etc.) should work with professional to monitor mechanics during return to activity phase
RTC REPAIR REHABILITATION

Return to Play Criteria

• Pain free full ROM
• Normal Strength: Isokinetic testing (Wilk 2002)
• Completion of interval throwing/sport program
• Compare sport specific skills to pre-injury level
THANKS!