Impingement Syndrome & Rotator Cuff Tears

Impingement Syndrome
Encroachment of acromion, coracoacromial ligament, or acromioclavicular joint on the rotator cuff tendons and the sub-deltoid bursa that lie beneath them

Causes of:
Abnormal structure of acromion
Humeral head depressor weakness/fatigue
Glenohumeral instability
Posterior capsule tightness
Sub-acromial crowding
Scapular stabilizer weakness/fatigue

Neuromuscular Insufficiency
Functional impingement due to muscular imbalance
Shift in fast-twitch to slow twitch amounts
Therapy in the early stages of impingement syndrome should focus on physiotherapy rather than decompression of the subacromial space.

RTC Functions
Stabilize the humerus in the glenoid fossa
Weakness in RTC causes loss of compression/depression mechanism
Results in superior shifting or migration of humeral head
Primarily a problem with flex and ABD

Glenohumeral Instability
Compromise of capsulo-ligament-labral complex
Results in abnormal translation following fatigue of dynamic stabilizers
Causes superior translation of humeral head during elevation

Posterior Capsule Tightness
Loss of internal rotation and horizontal adduction ROM
Causes pain at end of flexion due to impingement of humeral head on anterior-inferior acromion
Normal post capsule elasticity allows humeral head to stay centralized during shoulder flexion
Post capsule tightness results in superior migration causing impingement between soft tissues and acromion

Rotator Cuff Impingement Continuum
Impingement – Inflammation – Tendonitis - Fibrotic scar tissue formation - Bone spur
Partial RTC tear - Full-thickness RTC tear

Symptoms:
Pain
Acute or excruciating
Chronic low-grade aching
Pain in lateral arm (deltoid insertion)
Rarely referred below elbow
May have pain posterior deltoid and periscapular
Difficulty sleeping
Decreased range-of-motion
Active abduction and external rotation
“painful arc” 70-120° of elevation as inflamed tendons pass under CA arch
PROM generally full without pain
+ impingement tests
Muscle dysfunction
MMT of supraspinatus will be pain and or weakness
Weakness without pain suggest rupture or neurological injury
Pain without weakness suggests active tendonitis
Pain with weakness suggests partial tear
Crepitus with rotation of the humerus
Tendon and bursal thickening
Significant crepitus may be associated with spur formation or full-thickness RTC tears

Activities of Impingement
Throwing Sports; Swimming; Tennis; Vocation

Two Major Categories of Impingement: Classic vs. Secondary

Classical or Primary Impingement
Impingement of the supraspinatus against the coracoid process during activities that require shoulder abduction and some forward flexion
Can be due to several factors:
Decreased caudal glide of the glenohumeral joint
Tightness of the posterior capsule
Acromion morphology

Post Capsule Tightness
Normal post capsule elasticity allows humeral head to stay centralized during shoulder flexion
Post capsule tightness results in superior migration causing impingement between soft tissues and acromion

Secondary Impingement
The relative decrease in subacromial space due to another pathology or condition, e.g. instability

Neer’s classification Stage I

Characteristics:
Edema, inflammation and hemorrhage
Age <25 years old
Clinical Course: Reversible pathology
Therapy: Non-surgical, physical therapy

Neer’s Classification Stage II

Characteristics:
Thickening of bursa with fibrosis and tendonitis
Age 25-40 years old
Uncomplicated impingement
Clinical Course: Recurrent Pain with activity
Therapy: Patient may require surgical intervention. Partial acromioplasty with bursectomy and CA ligament resection with debridement

Neer’s Classification Stage III

Characteristics:
Bone spurs with tendon rupture
Age >40 years old
Complicated impingement
Clinical Course: Progressive disability
Therapy: Don’t do well with PT alone  Generally need anterior acromioplasty with RTC repair followed by PT

**RTC Tendinitis**
Inflammation of of any of the four RTC tendons
Most commonly supraspinatus
Avascularity of distal portion of tendon
Distal 1-cm “critical zone” due to poor perfusion
Constantly under tension to prevent downward subluxation force of gravity

**Mechanical Causes of Disruption of Vascularity**
Significant tension and compression during abduction
Significant tension during adduction

**Scapular Dyskinesis**

**Inferior Angle (Type I)**
At rest, the inferior medial scapular border may be prominent dorsally.
During arm motion, the inferior angle tilts dorsally and the acromion tilts ventrally over the top of the thorax.
The axis of rotation is in the horizontal plane.

**Medial Border (Type II)**
At rest, the entire medial border may be prominent dorsally.
During arm motion, the medial scapular border tilts dorsally off the thorax.
The axis of rotation is vertical in the frontal plane

**Superior Border (Type III)**
At rest, the superior border of the scapula may be elevated and the scapula can also be anteriorly displaced.
During arm motion, a shoulder shrug initiates movement without significant winging of the scapula occurring.
The axis of this motion occurs in the sagittal plane

**Symmetric ScapuloHumeral (Type IV)**
At rest, the position of both scapulae are relatively symmetrical, taking into account that the dominant arm may be slightly lower.
During arm motion, the scapulae rotate symmetrically upward such that the inferior angles translate laterally away from the midline and the scapular medial border remains flush against the thoracic wall.
The reverse occurs during lowering of the arm.

**Reliability of Scapular Classification Systems**

**Causes of Scapular Winging**
Long thoracic nerve palsy; Serratus anterior weakness

**Lateral Scapular Slide Test**
Used to determine the stability of scapula during GH movements
Designed to quantitatively measure scapular stabilizer strength by evaluating scapular symmetry as various loads are placed on surrounding musculature
Patient stands with arm resting at side
Examiner measure the distance from the base of the spine of scapula to spinous process of T2-3, from inferior angle of scapula to spinous process of T7-9, or from T2 to superior angle
of scapula
Kibler described 3 positions, resting arms at side, 45° abduction with hands on hips and thumbs posteriorly, and 90° abduction with medial humeral rotation
Davies and Dickoff-Hoffman suggest measuring also at 120° and 150° of abduction
Kibler, Davies and Dickoff-Hoffman suggest that each position should not vary greater than 1.0-1.5 cm for each side
Greater distanced may be seen above 90° of abduction as the scapula rotates more during normal scapulohumeral rhythm

Intratester ICC’s: 0.81-0.95
Intertester ICC’s: 0.18-0.69

Intratester ICC’s: 0.75-0.80 w/o impairment
Intratester ICC’s: 0.52-0.66 with impairment
Intertester ICC’s: 0.43-0.74 w/o impairment
Intertester ICC’s: 0.45-0.79 with impairment

**Acromion Morphology**
Shapes: Type I = Flat; Type II = Smooth Curve; Type III = Anterior Hook

**Acromion Types**
Acromial types II and III have an increased incidence of RTC tears and impingement lesions.

**Acromion humeral interval**
Glenohumeral joint at 0° Abd x = 11mm
Glenohumeral joint at 90° Abd x = 5.7mm

**Outcomes of Non-operative**

**Anterior Acromioplasty**
Most widely used surgical procedure for pain due to primary impingement
Can be performed open or arthroscopically
Arthroscopic technique advantages:
Function of deltoid less interrupted
Less scarring
Glenohumeral joint easily evaluated
Disadvantages
Technically demanding
Difficult to assess how much acromion has been removed

**Davies Empirical Observations Concerning Acromioplasty**
DOS: Post-operative soreness for several days
Wk 1-2: Symptoms decrease for first time
Wk 2-4/6: Symptoms return
Wk 6-8: Symptoms slowly decrease 2° to synovialization or psuedomembrane developing over anterior edge of acromion which is now bare denuded bone with exposed free nerve endings

**Rehabilitation Considerations**
Mobilizations: Caudal glides; Posterior glides; Accessory joints
S-T joint -usually hypermobile 2° to compensation
Strengthening of RTC musculature
PRICE: Protection; Relative rest; Ice; Compression; Elevation
Modify biomechanical problems
Kinesthesia and proprioception
Progressive return to activity

**HYPERMOBILITY:** 2º Impingement; Hypermobility Syndrome: (HMS)

**Beighton Scale**
Passive extension of 5th metacarpophalangeal joint past 90 degrees
1-point for each for total of 2 points
Passive opposition of thumb to forearm.
1-point for each for total of 2 points
Hyperextension of elbow past 10 degrees
1-point for each elbow
Hyperextension of the knee past 10 degrees
1-point for each
Trunk flexion so that hands/palms can be placed flat on the floor
1-point if can be done
Each limb separately for first 4 items, generating a possible score of 9
No universal agreement on threshold for HMS
Most use a 5/9 or 6/9 to indicate HMS

**Causes of Hypermobile/Secondary Impingement**
Decreased dynamic caudal glide
Posterior RTC weakness
Osseous deformity (Type II or III acromion)
Non-contractile posterior capsule/ligament tightness

**Generalized Ligamentous Laxity or Hypermobility Syndrome**
Hard to find!
Ill defined diagnostic criteria
Lack or radiological or laboratory findings
Diagnosis made through exclusion
Often do not have decreased mobility like so many other orthopedic conditions
May not have inflammation like others

**Classifications of Shoulder Instability**
Normal
Physiological laxity
Micro-subluxation
Subclinical macro-subluxation
Subluxation/subluxator/partial dislocator
Dislocator/luxator

**2º Impingement**
Hypermobility or 2º impingement mainly causes lesions to the inferior surface or the articular side of the rotator cuff musculature
75% of symptomatic impingement syndrome is due to type II and III acromion morphology
An outlet x-ray view can be used for diagnosis

**Microsubluxator**
No overt instability on clinical exam
Symptomatic shoulder
Testing selected parameters during controlled conditions (clinical exam) may not reveal the true degree of shoulder functional impairment since instability occurs during uncontrolled movements (tennis serve, baseball pitch)
The Relationship Between Shoulder Instability and RTC Impingement

1. Static stabilizers stretched = 1° problem
2. Increased translation of GH joint
3. RTC fatigue while attempting to limit translation
4. Overuse tendonitis results
5. Tensile changes occur (tendon fibers fail)
6. During elevation and rotation, the rotator cuff can’t control the humeral head
7. Anterior-superior head migration occurs.
8. Further dysfunction in mm control reduces scapular rotation (changes location of acromion)
9. Acromion limits forward flexion
10. Impingement syndrome occurs as a 2° process

Rehab Considerations for Hypermobility Impingement

Triad of Treatment
- Neuromuscular (kinesthetic) stability
- Noncontractile stability
- Contractile stability

Specific Goals
- Increased dynamic caudal glide
- Increased mobility and flexibility
- Create posterior dominant shoulder

Increase IR strength to decrease anterior translation

Internal (Inside) Impingement Syndrome

Mechanism of injury: When the shoulder is in a 90/90 position with horizontal extension a compressive force is created between the RTC (supraspinatus/infra spinatus) on the posterior superior glenoid labrum

Differential diagnosis: rule out posterior capsulitis, infraspinatus/teres minor strains, posterior labrum tear, posterior instability, quadrilateral space syndrome

Patient will complain of pain to palpation to the posterior undersurface of the acromion

Patient will have a positive Jobes subluxation/relocation test, BUT, the pain will be all posterior

Increased pain with the Jobe subluxation test, but pain posteriorly

When relocation test is performed posterior pain will decrease or be eliminated

Proposed mechanisms of posterior internal impingement

Anatomic causes
- Anterior laxity
- Posterior capsular hypomobility
- Hyperangulation during throwing
- Increased horizontal extension
- Over-rotation theory
- Repetitive microtraumatic theory

Clinical presentation: (Clusters of S & S)

Pain in posterior shoulder (deep to post/lateral acromion)

Pain with excessive ER at 90° abduction

Positive Jobe subluxation/relocation test (posterior pain)

Excessive ER, limited IR
This occurs on the articular side of the RTC tendon
The undersurface of the supraspinatus and infraspinatus “impinge” on the posterior superior labrum

**Posterior Internal Impingement Rehabilitation**

Identify the cause: hypo vs hyper (?)  
Change the causative factor  
Hypo – Treat like Primary Impingement  
Hyper – Treat like Secondary Impingement  
Dynamic stability  
Proprioceptive/kinesthetic training  
Neuromuscular reactive training  
Functional rehabilitation

**Systematic Review**

Only RCTs found  
Level 1 and 2 studies  
Effectiveness determined by statistical and clinical significance  
Exercise has significant effects on pain reduction and improved function  
No effects on ROM or strength!  
Manual therapy augments exercise  
Supervised PT no different than HEP!  
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Supervised PT no different than HEP!

**Criteria Based Rehabilitation Program**


**Phase I: Immediate Motion Phase**

Goals  
Re-establish non-painful ROM  
Retard muscular atrophy  
Decrease pain/inflammation  
**Exercises**  
AAROM in protected non-painful range  
Sagittal, scapular plane, IR/ER  
IR/ER began at 0°, then 45° and finally 90°  
Weight bearing activities such as kneeling or standing at a table with weight through hands as tolerated  
Scapular plane exercises  
Scapular upward rotation is better in scapular plane than in sagittal plane.  
Initially any overhead rehabilitation activities should be performed in scapular plane in patients with RTC tend.  
Pain free, sub-maximal isometric contractions at multiple angles  
Abduction at 30° and 60°  
Supraspinatus at 30° and 60°
ER at 0° of abduction
IR at 0° of abduction
Biceps isometrics
Criteria to advance to Phase II
Full non-painful ROM
Minimal tenderness and pain on clinical examination
Good strength - MMT (4/5) of shoulder internal and external rotators

**Phase II: Intermediate Exercise Phase**

Goals
Improve muscular strength
Improve muscular endurance
Improve neuromuscular control of the entire shoulder complex

**Exercises**
Progress from submaximal isometrics to submaximal isotonic exercises
Initiate scapulothoracic stabilization exercises
Lighter weights/resistance for RTC muscles
Somewhat heavier weights/resistance for prime movers
Short-arc isotonics
Abduction 30° to 90°
Supraspinatus 30° to 90°
Flexion 30° to 90°
ER at 30° with towel roll
IR at 30° with towel roll
Biceps isotonics at 35° to 40° of shoulder flexion
D2 flexion RS at 30°, 60°, 90° and 120°

**Phase II: Intermediate Exercise Phase**

Criteria to advance to Phase III
Full non-painful ROM
No pain or tenderness on clinical exam
Strength that is 70% of contralateral shoulder or internal/external rotators, abductors/adductors

**Phase III: Advanced Strengthening Phase**

Dynamic strengthening exercises and drills
Goals
Increase strength, power and endurance
Improve neuromuscular control
Prepare patient for return to functional activities
Emphasis placed upon:
high-speed, high-energy strengthening drills, eccentric muscular contractions, diagonal movements and functional patterns

**Exercises**
Isotonic dumbbell movements
Resistive tubing exercises
Concentric/eccentric contractions
Isokinetics
Plyometrics
Neuromuscular control drills
Arm elevation from 0° to 60° isometric hold 2s
Arm elevation from 60° to 120° isometric hold
Supraspinatus from 0° to 60° isometric hold
Supraspinatus from 60° to 90° isometric hold
D2 flex UE, RS and SRH at 0°, 60°, 120° and 160°
Tubing D2 flex with isometric hold

Philosophy of Exercise Progression

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Rotator Cuff Tears, Repairs, and Post Operative Rehabilitation

Rotator Cuff Tears
25% of individuals in 5th decade of life (40-49 years of age) have RTC tears.
Majority of those occur in individuals age > 45 due to attritional and mechanical factors
33% of shoulders of cadavers in the 50-60 years of age.
Cadavers > 70 years of age 100% had tears
Many of these tears go asymptomatic
May be associated with smoking, repeated steroid injections and systemic diseases such as RA, gout, and neurogenic disorders
The end result of a degenerative process

Repair Outcomes
Failure rates as high as 90%
Generally accepted rate of 25-40%

Conservative Treatment Outcomes
High correlation of tears and advanced age
Asymptomatic tears will become symptomatic over 2.8 years
39% of patients with repeat US will have progression
High correlation of tears and advanced age
Asymptomatic tears will become symptomatic over 2.8 years
39% of patients with repeat US will have progression

Preoperative Expectations
Pre-operative expectations quantified with use of 6 questions from musculoskeletal outcomes data evaluation and management system questionnaire
Greater preoperative expectation correlated with better postoperative performance on SST, DASH, VAS and SF-36
Patients preoperative expectations regarding rotator cuff repair are associated with their actual self assessed outcome

Post-Operative Rehabilitation
Gradual change
Emphasis on:
Immediate motion
Muscle activation
Restricted functional activities
Due to improved surgical technique

**Primary Goals of Surgery/Rehab**

- Restore functional abilities of the upper limb
- Maintain integrity of repair
- Reduce pain; muscle inhibition
- Re-establish passive mobility
- Re-establish muscular balance/motor control

With all the clinical protocols we have, protocols following rotator cuff repair are probably the most individualistic
This is due to several factors

**Types of Repair**

- Deltoid split: open vs. mini-open
- Deltoid taken down
- Arthroscopy

**Tissue Quality**

- Soft Tissue Integrity; Muscular; Osseous Tissue Integrity; Bony

**Size of Tear**

- Absolute Size
- Number of Tendons Involved

*Age and tear size* are significant factors in tendon healing capabilities.

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Biceps and AC joint pathology increased risk of poor tendon healing by 11 times that without associated injury

**Location of Tear**

Which muscles were involved
- Isolated supraspinatus
- Supraspinatus and infraspinatus
- Subscapularis
- Combinations
- Supraspinatus isolated ~ 50% of time
- Can progress to include more cuff tendons
- 58-80% continue posteriorly from supraspinatus into infraspinatus
- Anterior extension into subscapularis occurs with moderate frequency

**Mechanism of Failure**

- Traumatic (approximately 3-5%)
- Gradual progressive or degenerative

**Surrounding Tissue Quality**

- Integrity of infraspinatus, teres minor and subscapularis
- Important for force couples

**Patient’s Lifestyle and Vocation**

- Strenuous activities (work, sports)
- Sedentary

**Rehabilitation Potential**

- Supervised rehabilitation
- Unsupervised rehabilitation

**Philosophical Approach to Rx: ROTATOR CUFF TEARS**
Education

Patients must be educated:
- Sling use
- Immobilization

Maximum improvement in pain and function may not occur until 1 year after surgery

Rehabilitation Following Rotator Cuff Repair

Overhead Throwing Athlete

In most cases, if an open repair is performed with an overhead throwing athlete, it would be a mini-open (deltoid splitting) or arthroscopic procedure to minimize the soft tissue morbidity; rather than the traditional open procedure where the anterior deltoid is taken down.

RTC surgery

"Assuming that a technically adequate repair has been performed, the postoperative treatment has a direct bearing on the prevalence of shoulder stiffness after a repair of the RTC." (Warner, J Bone Joint Surg, 1997)

Four Types of Tears

Bursal side partial-thickness; Mid-substance; Articular side; Full-thickness tear

Rotator Cuff Tears

Bursal side partial-thickness tear

More often occur at the musculo-tendinous junction

Partial Thickness Tear

1)-Superficial fibers from CH ligament
2)-Superficial fibers of SS and IS
3)-Deeper fibers of SS and IS
4)-Deep extension of CH ligament

Acute extension of a tear

Patient may relate their pain to a recent event
With continued questioning you may find a previous history of shoulder stiffness
This recent event may be the "straw that broke the camel’s back"

Tear Sizes

Small - less than 1-cm
Medium sized tear – 1-3 cm
Large sized tear - 3-5-cm
Massive tear - > 5-cm

History

Any event significant or not, followed by persistent shoulder pain
Pain worse with overhead or activities involving external rotation
Pain into lateral upper arm
Night time pain hallmark sign
Shoulder weakness and fatigue with ADL’s

Physical Presentation

May have atrophy, depending on chronicity of tear
Tenderness along tuberosities and AC joint
Full-thickness tear may be palpable
Crepitus with elevation of arm

Range of Motion
PROM generally greater than active
Loss of AROM

**Manual Muscle Testing**
Weakness of external rotation without pain sign of non-reactive full-thickness tear
Weakness with pain may indicate reactive full-thickness tear of partial-thickness tear

**Rotator Cuff Tear Rehabilitation**
Surgical techniques require special attention.
What tissue was split, released or taken down?
What type of fixation was used?
What was the size of the tear?
How long has patient been immobilized?

**RTC Tears**
Generally partial or split thickness tears occur in overuse type of injuries

**Small Tears (< 1.0 cm):**
Arthroscopically performed
1 cm or smaller occur in middle aged patients
Usually tear along the lines of the mms fibers
May require deltoid splitting
Can be sutured so that the pull of the RTC mms contraction will not separate fixation
Time for rehab accelerated since deltoid is split rather than taken down

**Medium (1-3 cm) to large tears (3-5 cm):**
More recently done arthroscopically
May require deltoid to be taken down
Tear can be more perpendicular to line of pull of contraction of the RTC
Will need more protection during healing phase
3 weeks for soft tissue to take
6 weeks for maturation of deltoids and RTC to withstand arm against gravity

**Massive Tears 5 cm or more and re-do’s**
Approximately six weeks should be allowed before moderate stress is applied to the repaired structures
12 weeks before lifting against gravity

**Crescent shaped**
Free margin of cuff tendon attached directly to bone with suture from suture anchor

**U-Shaped**
Side to side repair of lateral extent of tear leading to tear margin convergence
Repair free lateral margin of cuff tendon directly to bone with sutures from anchor

**L-shaped**
Anchor placement corresponds to elbow of L followed by repair of soft tissue component of elbow of the L to that point
Then side to side repair followed by repair of remaining lateral margin to bone with suture from suture anchor

**Arthroscopic Vs. Open**
Re-tear arthroscopic
Small single-tendon low as 29%
Massive – multiple tendons as high as 90%
Re-tear open
Small single-tendon low as 20-25%
Large > 1 tendon as high as 50%
Which is more useful, the “full can test” or the “empty can” test, in detecting the torn supraspinatus tendon?


**Empty Can Test**
Clinical usefulness of “full can” vs. “empty can” in detection of torn supraspinatus
143 shoulders of 136 consecutive patients
Positive if pain, muscle weakness or both
Full can 75% accurate
Empty can 70% accurate
Pain in 43% with full can; 50% with empty can
Both tests equivalent in terms of accuracy
Considering pain provocation, full can test may be more beneficial in clinical setting

**Diagnosis of RTC Tears**

**Factors that determine RTC tears.**
Age greater than 60 years
Weakness in shoulder abduction
Positive impingement sign (Neer’s or HK)
**98% chance of full-thickness RTC tear**

Positive painful arc sign
A drop arm sign
Weakness in external rotation
**> 90% chance of having full-thickness RTC tear**

**POST OP PROTOCOL**
Evidence for Post Op Care

Level I and II literature
4 studies
2- continuous passive motion
2- supervised vs unsupervised therapy
Huge need for well designed Level I and II trials

**CPM**

Level I study
32 patients – randomized into two groups
Control – standard PT
Experimental – standard PT + CPM for 3 weeks:8 hours per day
Mean age 56 years old
Subjective outcomes at 3 months

All improved with no significant differences between groups
Improved range of motion in males
Pain relief in females
Pain relief in those > 60 years of age

**Level I RCT**
14 men; 17 women: mean age 63 years
15 – passive ROM by clinician
17 – CPM; 4 hours/day for 4 weeks
After 4 weeks both continued identical protocol
Subjective outcomes, ROM, Strength
Outcomes at 22 months
No statistically significant difference between groups seen
Manual PT may be more cost effective.

**Supervised vs. Unsupervised**

Level II RCT
Supervised PT vs unsupervised home program
Outcome: ROM, muscle force, subjective
Mean age 60 years
26 standard supervised PT; 32 unsupervised
24 week follow-up
No SSD in groups for:
ROM
Muscle force
Subjective functional outcomes

Level II study
Videotape based HEP vs personal instruction by PT.
54 videotape instruction; 54 personal instruction
Data collected at 12, 24 and 52 weeks
Outcomes: SPADI, U-Penn Shoulder Score
No SSD in outcomes
Assessors were not blinded to rehabilitation
Power analysis was not done

**Passive Range of Motion**
*Rehabilitation PROM*

Use of early joint mobilization and ROM
Prevent
Adhesions
Contractures
Periarticular structures
PROM exercises need to be started early in the rehabilitation program to prevent selective hypomobilities from developing
Selective hypomobilities
Create obligate GH translations

**Obligate GH Translations**
Occur when capsule has asymmetrical tightness
May be selective posterior or inferior
Surgery probably did not change this tightness which could have been there for years

**Asymmetrical tightening of the capsule causes obligate translations in a direction opposite to the tight tissue constraint**

Shrinkage in the inferior pouch of the gleno-humeral joint (selective hypomobility) is related to post operative pain after rotator cuff repair: radiographic and arthrographic comparison between patients with postoperative pain and those without it
Patients with shoulder pain after rotator cuff repair had reduced capacity and motion of the glenohumeral joint
Importance of joint mobilization to restore normal GH arthrokinematics

**Treating Soft Tissue Hypomobility**
The treatment of stiffness of the shoulder after repair of the rotator cuff.
“The postoperative treatment has a direct bearing on the prevalence of shoulder stiffness after a repair of the RTC.”

**Treating Hypomobility**
“The aim during the initial phase of treatment (the first 6 weeks after the operation) is to protect the RTC repair until it has healed while preserving passive motion.”
“Thus, failure to begin passive ROM in the first week after the operation can lead to loss of motion.”
Accessory movements including caudal glides, posterior glides, and anterior glides in 30° scaption
Physiological movements in flexion, scaption, ER (based on type of repair), IR

**Rehabilitation**
Determine effectiveness of posterior capsule joint mobilization on those with internal rotation motion loss
49 healthy college age subjects
20 Stretching only
19 Stretching + posterior capsule joint mobs

**Stretching/Mobilization Rehabilitation**
Randomized into 2 groups
Inclusion criteria
Asymptomatic
At least 10 degree loss of internal rotation motion
8 week treatment
Both groups increased internal rotation motion
Trends toward more motion improved with the addition of posterior capsule joint mobilization

**EMG Research and Rotator Cuff Rehabilitation**

**EMG Research**
EMG of the shoulder: an analysis of passive modes of exercise.
Supraspinatus: compared to MVC

**EMG Research**
Pulley Exercise – 17.6% MVC
Self-Assisted Bar Raise – 8.7% MVC
CPM Machine – 5.0% MVC
Codman’s Pendulum Exercises - ~5.0%
PT – Passive Range of Motion - ~5.0%

**Pendulum Exercises**
Conclusions: These results indicate that CPM and PT – PROM, by being more passive, may increase the safety margin for obtaining early PROM without disrupting the RTC repair

**Guidelines**
Many of the following factors will determine when AAROM, AROM, and RROM can be
initiated in the rehabilitation program
ARROM
Intramuscular fine-wire EMG
Passive, active and resistive exercises
“Supine Phase I exercises should be considered in the early postoperative period after shoulder surgery to achieve maximum motion while minimizing shoulder muscle activity.”

Aquatic Therapy

Supraspinatus:
Land – EMG – 16.68% MVC
Aquatics – EMG – 3.93% MVC
“These data suggest that shoulder elevation in the water at slower speeds resulted in a significantly lower activation of the rotator cuff and synergistic muscles. This decreased muscle activation during aquatic physical therapy allows for earlier active motion in the postoperative period without compromising patient safety."

Strain on repaired tendons
Small and Large tears
Strain small above 30° abduction irrespective of position of flex/ext/rotation

Shoulder Position

9 cadaveric shoulders
Strains on supraspinatus during joint mobilizations at 0 and 30° abduction
Intact and repaired tendons
Strain at 30° abduction in repaired tendon smaller than at 0°
At 30° abduction strain during joint mob not different except for inferior glide

Gap distances were 0 at 30° abduction
Gap distance 1.06 to 1.46 at 0° abduction
** Study on small induced tears
** Cannot assume same as large/massive tears

Shoulder Position

Cadaver study
Strain at 0 and 30° abduction
Tensile forces 30° in scapular plane = 0.5 kg
Tensile forces 0° in neutral = 3.0 kg
The strain in all of the planes decreased significantly with the arm elevated more than 30 degrees.

We concluded that more than 30 degrees of elevation in the coronal or scapular plane and rotation ranging from 0 degrees to 60 degrees of external rotation compose the safe range of motion after repair of the rotator cuff.

Tendon Strain

Failure load of repaired tendon
75-605 N
Failure load intact tendon
600-800 N

Massive Cuff Tendon Strain

Gap formation in arthroscopic massive open RTC repairs
Posterior repair site of gap formation
Bone quality?
Overall force vector of cuff may be directed posteriorly
May be non issue since most now do double row suture anchors
Double row suture anchors superior to single-row

*Resisted Range of Motion*

RROM exercises are begun at various time intervals depending on all the various characteristics of the RTC, type of surgery, etc.
Protective to the surgical repair
Shortened musculo-tendon unit length-tension
Neuro-motor control
Submaximal
Pain-free

**AROM Based on Tear Size**

Generally
- Small Tears (< 1.0 cm) 4 weeks
- Medium Tears (1-3 cm) 6 weeks
- Large Tears (3-5 cm) 8 weeks
- Massive Tears (> 5 cm) 12 weeks

**Conservative Sling Use**

- Small Tears (< 1.0 cm) 4 weeks
- Medium Tears (1-3 cm) 6 weeks
- Large Tears (3-5 cm) 8 weeks
- Massive Tears (> 5 cm) 12 weeks

**Sling Use per Wilk et al.**

- Small Tears (< 1.0 cm) 7-10 days
- Medium Tears (2-4 cm) 2-3 weeks
- Large Tears (2-4 cm) 2-3 weeks
- Massive Tears (> 5 cm) abduction pillow 1-2 weeks; Sling 2-3 weeks

**Arthroscopic SUD, Partial RTC/Debridement and Small (< 1 cm) RTC Repair Protocol**

**Phase I: Immediate Post Surgical Phase: Weeks 0-4**

**Goals**
- Reestablish non-painful ROM
- Maintain integrity of repair
- Retard muscular atrophy
- Prevent muscular inhibition
- Decrease pain/inflammation
- Independence in modified ADLs

**Precautions**
- No AROM
- No lifting objects, reaching behind back, excessive stretching or sudden movements
- Maintain arm in brace, sling
- Sling use for 4-5 weeks
- No support of body weight by hands
- Keep incisions dry and clean
No passive pulley exercise yet

**Criteria for Progression to Phase II**
- Passive forward elevation to $\geq 125$
- Passive ER in scapular plane to $\geq 75$
- Passive IR in scapular plane to $\geq 75$
- Passive abduction in scapular plane = 90

**Range of Motion**
- Pendulum exercises
- Abduction brace/sling (sleep also)
- No rope and pulley
- Finger, wrist and elbow AROM
- Griping exercises
- Passive PROM shoulder – supine
- Flexion to 110
- ER/IR in scapular plane $<30$
- Cervical spine AROM

**Passive ROM**
- Nourishment of articular cartilage
- Assists in collagen synthesis
- Assists in collagen organization

**Immobilation in 45° ABD**
- Measured passive tension in supraspinatus at time of repair
- Shoulder abduction increases tension in repair
- Shoulder abduction decreases tension in repair

**Mobilization in 30-45° ABD**
- Shoulder abduction decreases tension in repair
- Education
- Posture
- Joint protection
- Importance of brace/sling
- Pain medication use
- Pain and inflammation
- Cryotherapy
- E-stim

**Keys to Immediate Phase**
- Make sure PROM is gentle enough to minimize muscle guarding and splinting.
- Ensure proper sling positioning with adequate wrist support.
- Should be no excessive pain with ROM.

**Phase I: Immediate Post Surgical Phase: Days 7-35**
- Continue Sling use
- Pendulum exercises
- PROM: Supine
- Flex: to tolerance
- ER in scap plane: $>30$
- IR in scap plane: to body/chest

Elbow, hand, forearm, wrist and finger AROM
- Resisted isometrics/isotonics for elbow, hand, forearm, wrist and fingers
- Begin gentle glenohumeral **submaximal** isometrics in “Balance position”
  - “Balance position” = 90-100° elevation while supine
Used so that the deltid muscle generates a more horizontal (compressive force)
In supine this position will activate the cuff without superior migration of humeral head from
deltoid activity that would occur in seated.
Continue cryotherapy
Conditioning program
Walking
Stationary bike
Aquatherapy 3 weeks if wounds healed

**Phase II: Protection and Protected AROM Phase: Week 5-12**

**Goals:**
Allow healing of soft tissue
Do not overstress healing tissue
Normalize arthrokinematics

**Goals:**
Gradually restore full PROM ~ week 5-6
Improve neuromuscular control of shoulder complex

**Precautions:**
No lifting
No support of full body weight on hands
No sudden jerking motions
No excessive behind back motions
No bike or ergometer until week 6

**Criteria to progress to Phase III**

Full ROM
Minimal pain and tenderness
Good MMT of IR, ER, Flexion
Continue with brace until week 4-5
Gradually wean out of brace
DC sling by end of 6th week

**Keys to Protection and Protected Motion Phase**
Do not initiate scapula or shoulder muscle activation exercises until overall pain in shoulder is low.
Exercises can not/should not create pain or increased symptoms

**Phase II: Protection and Protected AROM Phase: Weeks 5-6**

**Range of Motion**
Initiate AROM shoulder flexion from supine position
Progressive PROM until full ~ week 6
May use heat prior to ROM/exercise/mobilization
Can use passive pulley now

**Range of Motion**
Normalize arthrokinematics of shoulder complex
Joint mobilizations
Controlled L-bar ROM
Self-stretches (capsular)

**Phase II: Protection and Protected AROM Phase: Weeks 7-9**

**Active Assisted ROM to tolerance**
Flex
ER/IR scapular plane
ER/IR supine at 90/90

**Passive Range of Motion**
Flexion: Full
ER at 90: To tolerance
IR at 90: To tolerance
Begin more aggressive IR stretching
Mobilization of posterior capsule/cuff critical
Begin shoulder extension, cross body and sleeper stretch

**Strengthening**
Initiate gentle RTC submaximal isometric exercises
Initiate AROM in other planes (flexion, scapular plane, abduction, ER, IR)
Pain-free – weight of arm
RTC/Scapular muscle small – so low load higher repetition
Initiate light isotonic program with dumbbells
Side lying
Shoulder musculature
Scapulothoracic musculature
Initiate neuromuscular control exercises
Initiate trunk exercises
Initiate UE endurance exercises

**Phase III: Early Strengthening Phase: Weeks 10 to 16**

**Goals**
Full AROM
Maintain full PROM
Dynamic shoulder activities

**Goals**
Gradual restoration of GH and ST strength, power and endurance
Gradual return to functional activities
Optimize neuromuscular control

**Precautions**
No lifting > 5 lbs
Exercises should be non-painful

**Criteria for Progression to Phase IV**
Ability to tolerate progression to low-level functional activities
Demonstrate return of strength/dynamic shoulder stability
Re-establishment of dynamic shoulder stability

**Phase III: Early Strengthening Phase: Week 10**

**Initiate strengthening program**
Continue exercises from weeks 7-9
Scapular plane elevation
Full can
Rowing
Prone rowing
Prone horizontal abduction

**Phase III: Early Strengthening Phase: Week 12**

**Strengthening program**
Continue exercises from weeks 10
BodyBlade
Flexbar
Boing
Light isometrics in 90/90
PNF D2 flexion/extension against light manual resistance
Initiate light functional activities as tolerated

**Phase III: Early Strengthening Phase: Week 14**

**Strengthening program**
Continue all previous exercises
Progress to fundamental exercises
Bench press
Shoulder press
Initiate low level plyometric exercises
2-handed drills progressing to 1-handed

**Phase IV: Advanced Strengthening Phase: Weeks 16-22**

**Goals**
Maintain full non-painful AROM
Advanced conditioning exercises for enhanced functional and sports specific use
Improve muscular strength, power and endurance
Gradual return to all functional activities

**Range of Motion**
Continue ROM and self capsular stretching prn

**Strengthening**
Continue progressive strengthening
Advanced proprioceptive neuromuscular activities
Continue dynamic stabilization
Dumbbell strengthening
Initiate tubing exercises side lying
ER/IR (slow and fast sets) tubing or side lying
Light isotonic exercise in 90/90

**Phase IV: Advanced Strengthening Phase: Weeks 20**

**Strengthening**
Continue dynamic stabilization
Joint mobilization if tight
Initiate interval sports programs if appropriate
Golf
Tennis
Swimming
Throwing

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