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 coroacromial arch 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

2° Impingement

Hypermobility or 2° 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/infraspinatus) on the posterior superior glenoid labrum
Differential diagnosis: rule out posterior capsulitis, ifraspinatus/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/lat 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!
Exercise has significant effects on pain reduction and improved function
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!
Supervised PT no different than HEP!

Criteria Based Rehabilitation Program

Arrigo CA, Wilk KE. Shoulder exercises: A criteria-based approach to rehabilitation. In: *Orthopedic Therapy of the Shoulder*. Kelley MJ, Clark WA. Lippincott Williams and Wilkins, 1995.

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

Phase II: Intermediate Exercise Phase

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

Simple	Complex
Proximal	Distal
Single-plane	Multiple-plane
Isometric stability	Isometric mobility
Stability	Mobility
Controlled mobility	Skill mobility
Controlled environment	Uncontrolled environment
Horizontal movements	Vertical movements
Unidirectional movements	Multi-direct movements

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

Itoi E, Kido T, Sano A, Urayama M, Sato K. *Am J Sports Med* 1999;27(1):65-68

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
AAROM
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 >/= to 125
Passive ER in scapular plane to >/= 75
Passive IR in scapular plane to >/= 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

Immobilization in 45º ABD

Measured passive tension in supraspinatus at time of repair
Shoulder adduction increases tension in repair
Shoulder abduction decreases tension in repair

Mobilization in 30-45º 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” = 90-100º elevation while supine

Used so that the deltoid 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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