Impingement Syndrome and Rotator Cuff Pathology

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Impingement

- Shoulder impingement is a pinching of the rotator cuff tendons between the acromion OR the glenoid rim and humerus.
- This can cause a spectrum of injuries from inflammation (bursitis and tendonitis) to a hole in the tendon (rotator cuff tear).
- There are two main types of shoulder impingement—external and internal.

Internal vs. External

- External or outlet impingement is typically associated with a compression of the cuff tendons against the underneath side of the acromion or roof.
- Internal impingement occurs in younger athletes who participate in overhead sports such as swimming, baseball, or tennis. Glenoid/Humeral with rotation

Possible Causes of Shoulder Impingement

- Outlet impingement
- Subacromial spurs
- Type 2 and type 3 acromions
- Osteoarthritic spurs of acromioclavicular joint (includes subacromial spurs)
- Thickened or calcified coracoacromial ligament
- Nonoutlet impingement
- Loss of rotator cuff causing superior migration of humerus (tear, loss of strength)
- Secondary impingement from unstable shoulder
- Acromial defects (os acromiale)
- Anterior or posterior capsular contractures (adhesive capsulitis)
- Thick subacromial bursa

Impingement Syndrome

- Most common source of pain and dysfunction in the athletes’ shoulder.
- Induced by repetitive activity, especially in the overhead position.
- Most common in baseball, tennis and swimming, but not limited to these sports.
- Sub-diagnoses: bursitis, tendonitis, and capsulitis.

Diagnosis/Prognosis

- Early diagnosis is critical for successful management.
- Progressive syndrome.
- Can result in rotator cuff tears, adhesive capsulitis and other secondary changes.
Pathophysiology

- The shoulder joint mechanism is widely accepted as the most mobile joint in the body.
- Gains in mobility often sacrifice stability
- Precise balance between bony and soft tissues in order to maintain the integrity of this joint.
- The rotator cuff is especially important in maintaining proper balance and function.

RTC functions as the “gyroscope” of the shoulder.

Actions Of The Rotator Cuff

-Externally rotate the humerus (excluding subscapularis).
- Decelerate the humerus in throwing/racquet sports (eccentrics).
- Create a force-couple to balance humeral head motion. 
  (a) Deltoid action elevates the humerus.
  (b) Stabilizes and depresses humeral head to allow greater clearance of the greater tuberosity beneath the acromial arch.
  (c) Imbalance or weakness leads to impingement and possibly tearing.

Impingement Syndromes

Internal Impingement - Definition

Injury and dysfunction due to repeated contact between the undersurface of the rotator cuff tendons and the posterosuperior glenoid. 
Walch JSES 1992

Internal Impingement

Some contact between these structures is physiologic but repetitive contact with altered shoulder mechanics may be pathologic.
Internal Impingement

For poorly defined reasons this contact in some athletes become pathologic and produces symptoms.

Normally in abduction and external rotation (ABER) there is obligate posterior & inferior translation of the humerus that allows for more motion and less contact between the greater tuberosity and the posterosuperior glenoid rim.

Mechanism of Internal Impingement

Andrews Theory:
- Repeated ABER
- Dynamic stabilizers fatigue
- Increase stress to anterior & IGHL
- Anterior capsule laxity to allow max ABER
- Increased contact of undersurface of RC and posterosuperior glenoid
- Reduction of posterior & inferior translation of HH

Burkhart & Morgan Theory:
- Repeated ABER
- Tight posterior capsule
- Superior translation of Humeral Head
- Increased contact of undersurface of RC and posterosuperior glenoid
- Torsional stress to biceps anchor
- SLAP II and Pseudolaxity
- Peel-off Mechanism

It is essentially an overuse injury associated with overhead athletes.
Internal Impingement

- Typically symptoms are present only while playing
- No symptoms with activities of daily living
- Represents about 80% of the problems seen in the overhead athletes

Internal vs. External

- External or outlet impingement is typically associated with a compression of the cuff tendons against the underneath side of the acromion or roof.

External (Outlet) Impingement

- Outlet impingement occurs when the coracoacromial arch encroaches on the supraspinatus outlet

External Impingement Syndromes

Stage 1

- Edema and hemorrhage: reversible lesion usually seen in the second and third decade
- Exam
  - palpable tenderness over the greater tuberosity at supraspinatus insertion
  - palpable tenderness along the anterior edge of the acromion
  - painful arc of abduction between 60 and 120° increased with resistance at 90 deg

Impingement Syndromes
Stage 2

- Chronic inflammation or repeated episodes of impingement leads to fibrosis & thickening of supraspinatus, biceps, & subacromion bursa
- Inability to reverse process by activity modification
- Generally pts are between 25-40 years
- Age is less important than the duration of symptoms
- Symptoms consist of an aching discomfort, often interfering w/ sleep & work, and may progress to interfere w/ activities of daily living


Impingement Syndromes
Stage 2

- Mild limitation to both passive and active range of motion
- Arthroscopic acromioplasty & subacromial decompression do not require deltoid detachment & are assoc w/ cost savings & more rapid rehab
- Arthroscopic acromioplasty is perhaps most suited for type II lesions (w/ partial tears)
- Less useful for those with no tears or complete tears


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Impingement Syndromes
Stage 3

- rotator cuff tears, biceps ruptures, and bone changes
- Prolonged history of refractory tendinitis, significant tendon degeneration is the hallmark
- Usually in the 5th or 6th decade, and often prolonged periods of pain, particularly at night
- Weakness functional


Impingement Syndromes
Stage 3

- Limitation to shoulder motion; infraspinatus atrophy
- Weakness of shoulder abduction and external rotation
- Biceps tendon involvement with rupture or degenerative changes in a high percentage of pts with rotator cuff tears
- AC joint tenderness, esp if degenerative changes are present


Neer’s Progressive Staging

- Stage 1 - Reversible edema and hemorrhage in the rotator cuff and surrounding tissues.
- Stage 2 - Fibrosis and chronic tendinitis over time.

Neer’s Progressive Staging

- Stage 3: Irreversible degenerative changes of the rotator cuff, bursa, acromial arch and greater tuberosity. Small defects are found in the rotator cuff.
- Stage 4 - Progressive degeneration from Stage 3, cuff defects larger than one (1) centimeter.
- Stage 4: Implied loss of function.

Pre-disposition To Impingement

- Shape and slope of acromion (Bigliani).
- Bony intrusions (spurs/osteophytes).
- Repetitive falling trauma.
- Throwing/racquet sports.
- Repetitive overhead activity (painters)

Pre-disposition To Impingement

- Shape and slope of acromion (Bigliani).
- Type 1 - Flat
- Type 2 - Curved
- Type 3 - Hooked

Clinical Evaluation

- Allows anterior and superior migration of the humerus and increases the incidence of impingement.
Visual Inspection

- Observe the scapulo-humeral rhythm with scapular motion throughout the range, but more noticeable at about 60° of abduction.
- Scapula rotates 1° for every 2° movement of the humerus
- Allows increased range of motion at the glenohumeral joint.

Physical Exam – Observation / Inspection

- Front & Back
- Height of shoulder & scapulae
- Asymmetry
- Obvious deformity
- Ecchymosis
- Muscle atrophy
  - Supraspinatus
  - Infraspinatus
  - Deltoid

Palpation

- Surface Anatomy (Anterior)
  - Clavicle
  - SC Joint
  - Acromion process
  - AC Joint
  - Deltoid
  - Coracoid process
  - Pectoralis major
  - Trapezius
  - Biceps (long head)

Palpation

- At rest & with movement
- Bony structures
- Joints
- Soft tissues
**Palpation**
- Surface Anatomy (Posterior)
  - Scapular spine
  - Acromion process
  - Supraspinatus
  - Infraspinatus
  - Deltoid
  - Trapezius
  - Latissimus dorsi
  - Scapula
  - Inferior angle
  - Medial border

**Range of Motion**
- Forward flexion:
  - 160° - 180°
- Extension:
  - 40° - 60°
- Abduction:
  - 180°
- Adduction:
  - 45°
- Internal rotation:
  - 60° - 90°
- External rotation:
  - 80° - 90°

**Range of Motion**
- Scapular dyskinesis (Scapulothoracic dysfunction)
  - Compare scapular motion through ROM on both sides
  - Wall push-ups
  - Symmetrical
  - Smooth
  - No or minimal winging

**Impingement Signs**
- Passive Test - Stabilize the scapula inferiorly and lift the arm into flexion.
- Active Test - The patient grasps the uninvolved shoulder and then lifts the elbow toward the eyes.
  - Positive when painful or unable to complete motion or test.

**Subacromial Impingement Syndrome**
- Impingement of:
  - Subacromial bursa
  - Rotator cuff muscles and tendons
  - Biceps tendon
- Between
  - Acromion
  - Coracoacromial ligament
  - AC joint
  - Coracoid process
  - Humeral head
- Rotator cuff tendonosis

**Impingement Signs**
- Neer’s Sign
  - Arm fully pronated and placed in forced flexion
  - Trying to impinge subacromial structures with humeral head
  - Pain is positive test
**Neer Impingement Test**
- Patient sitting
- Internally rotate the arm with the thumb facing downward
- Abduct and forward flex the arm
- Positive: pain as the arm is abducted

**Impingement Signs**
- Hawkin’s Sign
  - Arm is forward elevated to 90 degrees, then forcibly internally rotated
  - Trying to impinge subacromial structures with humeral head
  - Pain is positive test

**Hawkin’s Test**
- Patient standing with the shoulder abducted 90 degrees
- Internally rotate the forearm
- Pain with movement is indicative of possible pathology.

**Internal Impingement – Clinical Examination**

**ROM:**
- usually full range of motion
- dominant arm tends to have
  - 10-15 deg more ext rotation and
  - 10-15 deg less internal rotation at 90 deg abduction
- The most common for an overhead athlete is:
  - 2+ anterior laxity,
  - up to 1+ posterior laxity,
  - some inferior laxity,
  - but a firm endpoint

**Provocative tests:**
- Neer’s test = negative

**Hawkins test = negative**
Provocative tests:

- **Cross arm adduction test** = negative

**Internal Impingement – Clinical Examination**

Provocative tests:

- **O'Brien's test** = negative (unless SLAP lesion)

**Internal Impingement – Clinical Examination**

Provocative tests:

- **Crank Test** = Internal Impingement test = **Positive**
  (patient supine, 90 deg abduction and max external rotation. If pain experienced at the posterior part of the joint = positive, 90% sensitive)

- **Relocation test** = positive,
  (different from relocation test for anterior translation)

**Internal Impingement – Clinical Examination**

Relocation test of **Jobe**:

Pain in the posterior joint line when the arm is brought in abduction external rotation with the patient supine that is relieved when a posterior directed force is applied to the shoulder

**Internal Impingement – Clinical Examination**

Muscles strength = normal

**Impingement Injection Test**

- Injection of 10 cc of 1% lidocaine beneath anterior acromion will relieve pain in the case of an impingement syndrome
- Excessive pain during the injection, then there may be excessive pain following surgery
- ? Indicative of pain tolerance
**Rotator Cuff Tears**

- Drop Arm Test (Hoppenfeld) - The patient attempts to lift and/or maintain a position of 90 degrees of abduction.

**Rotator Cuff Tears**

- Manual Muscle Testing - Resisted abduction or "empty can position" (supraspinatus) or external rotation (infraspinatus and teres minor).

**Rotator Cuff Tears**

- Incomplete or partial tears will often not yield weakness.
- Weakness often confused with pain/apprehension.

**Shoulder Muscle Testing**

**Strength Testing**

- Test & compare both sides
- Be specific to muscle or muscle group
- Grade strength on 0 → 5 scale
  - 0: no contraction
  - 1: muscle flicker; no movement
  - 2: motion, but not against gravity
  - 3: motion against gravity, but not resistance
  - 4: motion against resistance
  - 5: normal strength

**Strength Testing**

- External rotation
  - Tests RTC muscles that ER the shoulder
    - Infraspinatus
    - Teres minor
  - Arms at the sides
  - Elbows flexed to 90 degrees
  -Externally rotates arms against resistance
**Strength Testing**

- **Internal rotation**
  - Tests RTC muscle that IR the shoulder
  - Subscapularis
  - Arms at the sides
  - Elbows flexed to 90 degrees
  - Internally rotates arms against resistance
  - Subscapularis Lift-Off Test
  - Other techniques

- **Supraspinatus**
  - "Empty can" test
  - Jobe’s Test
  - Tests Supraspinatus
  - Attempt to isolate from deltoid
  - Positioned sitting
  - Arms straight out
  - Elbows locked straight
  - Thumbs down
  - Arm at 30 degrees (in scapular plane)
  - Attempts to elevate arms against resistance

**Supraspinatus Strength??**

- Partial thickness tear
- Full (Complete) thickness tear
- May be due to:
  - Impingement
  - Degeneration
  - Overuse
  - Trauma
- Partial tears
  - Conservative
- Complete tears
  - Surgery

**Rotator Cuff Tear**

- Abducted arm slowly lowered
  - May be able to lower arm slowly to 90° (deltoid function)
  - Arm will then drop to side if rotator cuff tear
- Positive test
  - Patient unable to lower arm further with control
  - If able to hold at 90°, pressure on wrist will cause arm to fall

**Rotator Cuff Tear: Drop-Arm Test**

- Bicipital tendonitis
- Acromioclavicular pathology
- Glenoid labrum (SLAP/Bankart) lesions

**Associated Lesions**
Conservative Treatment

- Control/diminish Inflammatory Response
- Rest
- NSAIDS/Injection (controversial)
- Modalities
- Benign Exercise - Painless, function preserving exercise such as pendulum, wall walking and wand exercise.

Exercise

- Stretch
- Strength
  - Endurance
  - Weight
  - Power

Exercise Variables

- ROM
- Muscle Group
- Resistance
- Speed
- Open/closed chain

Range Of Motion

- "Downstairs" first (<90 degrees elevation)

Range Of Motion

- "Downstairs" first
- Progressive elevation into painless arc
- Applies to rotation and elevation
Muscle Group
- Core

Muscle Group
- Scapula
  - Dips
  - Pro/retraction
  - ? Elevation
  - Serratus

Muscle Group
- Glenohumeral
  - Flexion/Abduction
  - Rotation
  - Horizontals
  - Lift off

Resistance
- Isometric
- Isotonic
- Isokinetic

Resistance
- Manual
- Machine Based
- Free weights
- Bands

Speed
Open/Closed Chain

Correct/Modify Behavior

- While not always a practical solution, efforts must be made to correct the insult.
- Overhead laborers can often benefit from something as simple as standing on a stool.
- Athletic performance can also be studied and modified to some degree.

Surgical Management

Acromioplasty: “SAD” Shoulder

- “SAD” - Sub Acromial Decompression
- Open Acromioplasty
- Arthroscopic Acromioplasty

Acromioplasty

- **Codman Acromioplasty:**
  - (Historical purposes) involves lateral acromioplasty or total acromionectomy

- **Neer Acromioplasty:**
  - Emphasis on resection of the inferior prominence of the acromion
  - May allow residual impingement of the anterior acromion

Rockwood Acromioplasty

- Two step acromioplasty
  - Anterior acromion which protrudes beyond the anterior edge of the acromion is resected
  - Undersurface of the acromion may be smoothed or beveled to convert it to a type I acromion;
  - Remaining anterior acromion should be thinned down to 8 mm in thickness
  - Consistent with the Synder classification system for acromial thickness.
Arthroscopic Acromioplasty / Cuff Debridement

- Objective good to excellent results achieved in over 70% of patients, subjective satisfactory results over 90%
- Indicated in cases of impingement syndrome and questionable rotator cuff tear repair, the shoulder scope will be able to determine the status of the cuff

Open Acromioplasty

- Indications:
  - Impingement syndrome
  - Patients w/ a stable impingement syndrome w/ good shoulder function (after a formal rehabilitation program)
  - Patients with worsening pain and function may undergo early acromioplasty if the usual non operative measures fail to relieve symptoms

Open Acromioplasty

- Deltoid "on" strategy
- Allows the acromioplasty to proceed without taking the deltoid off of the acromion

Acromioplasty Rehabilitation

Phase 1: Immediate Postoperative Phase

Goals:
- Restore passive and AROM as tolerated.
- Pain free sleep and activities of daily living to 90 degrees of forward elevation and abduction.

Weeks 0-4
- Cryotherapy (ice) to control pain and swelling.
- Passive, active-assisted and/or active ROM to tolerance (pendulum, pulley, PROM and/or wand exercises in all planes of motion.)
- Submaximal isometric strengthening exercises as tolerated.

Dependent on adequate communication between the patient, therapist and surgeon.

“SAD” Outcomes

Arthroscopic Decompression with Acromioplasty and Structured Exercise Was No More Effective and Was More Expensive Than Exercise Alone


“SAD” Outcomes

Good results of arthroscopic acromioplasty were maintained at 12 to 14 years after surgery with excellent or good results shown in 77% of shoulders, and the long-term outcomes were superior to those after open acromioplasty.

Acromioplasty Rehabilitation
Phase II: Intermediate Phase

Goals:
- Full, pain-free AROM and light work activities.
- Modalities as needed.
- Joint mobilization and stretching exercises.
- Tubing exercises, particularly for internal and external rotation with the arm at the side.
- Weighted exercises may be initiated as tolerated.
- Flexion and abduction strengthening should be below 90 degrees.
- Internal and external rotation can also be performed while lying on the side.
- Periscapular stabilization exercises as tolerated.

Weeks 4-12
- Modalities as needed.
- Joint mobilization and stretching exercises.
- Tubing exercises, particularly for internal and external rotation with the arm at the side.
- Weighted exercises may be initiated as tolerated.
- Flexion and abduction strengthening should be below 90 degrees.
- Internal and external rotation can also be performed while lying on the side.
- Periscapular stabilization exercises as tolerated.

Acromioplasty Rehabilitation
Phase III: Advanced Strengthening and Return to Sports

Goals:
- Pain-free work and/or athletic activity.
- Begin heavier isotonic strengthening exercises.
- Strengthening above 90 degrees of forward elevation and abduction.
- Begin sports specific functional progression.
- Return to full work or athletic activities when pain-free throughout an entire functional progression.
- Maintain regular home exercise program: rotator cuff and periscapular muscle strengthening along with capsular stretching exercises.

Rotator Cuff Repair

Indications for Repair
- Intractable shoulder pain (especially night pain)
- Symptoms which cause loss of function or quality of life
- Failure of NSAIDS and formal physical therapy
- Failure of series of marcaine / steroid injections
- Full passive ROM pre-op is necessary for a successful operation (rule out frozen shoulder)

Relative contra-indications
- Superior migration of humeral head (which indicates massive rotator cuff tear)
  - Gartsman (JBJS 1997): Patients w/ radiographic superior migration of the humeral head had a poor result
- Deficient deltoid, subscapularis, and/or teres minor (either by clinical exam or by MRI) are more likely to lead to poor results

Rotator Cuff Repair
RTC Repair

Large tear from the "50 yard line." V or U shaped tears may require side to side stitches.

Arthroscopic knot tying instrument. Metallic anchors with sutures attached are inserted into the humerus.

RTC Repair

Sutures from tear to anchors. Tear draw down into trough.

Rotator Cuff Repair

- Open repair
- Mini-open repair
- All-arthroscopic repair

Rotator Cuff Repair: Open

- Incision over the shoulder and detaches the deltoid
- Improved visualization of the torn rotator cuff
- Acromioplasty
- The incision is typically several centimeters long.
- Open repair was the first technique used to repair a torn rotator cuff
- Restores function, reduces pain and is durable in terms of long-term relief of symptoms

Rotator Cuff Repair: Mini-open

- Smaller version of the open technique, incision 3-5 cm
- Incorporates arthroscopy to visualize the tear, assess and treat damage to other structures within the joint
- Avoids the need to detach the deltoid muscle.
- Once the arthroscopic portion of the procedure is completed, the surgeon proceeds to the mini-open incision to repair the rotator cuff.
- One of the most commonly used methods of treating a torn rotator cuff; results have been equal to the open repair.
Rotator Cuff Repair: All-arthroscopic repair

- Portals and arthroscopic technology to visualize and repair the rotator cuff.
- Challenging technique (steep learning curve).
- Results (appear) comparable to the mini-open and open repairs.
- Less long term data.

Rotator Cuff Repair: Results

After rotator cuff repair

- 80 percent to 95 percent of patients achieve a satisfactory result:
  - Adequate pain relief
  - Restoration or improvement of function
  - Improvement in range of motion

Rotator Cuff Repair: Factors Decreasing Satisfaction

- Poor tissue quality
- Large or massive tears
- Poor compliance with post-operative rehabilitation and restrictions
- Patient age (older than 65 years)
- Worker’s Compensation claims

RTC Complications (10%)

- **Nerve injury** (1 percent to 2 percent): Nerve injury usually involves the axillary nerve.
- **Infection** (1 percent): Use of antibiotics during the procedure and sterile surgical technique limits the risk of infection. Antibiotic use after discharge from the hospital does not further decrease risk of infection.
- **Deltoid Detachment** (less than 1 percent): Careful repair of the deltoid and protection during rehab after an open repair are important to avoid deltoid detachment. Should not occur after a mini-open or arthroscopic repair.

RTC Complications (10%)

- **Stiffness** (less than 1 percent): Early rehabilitation protocols decrease the likelihood of permanent stiffness or loss of motion following a rotator cuff repair.
- **Tendon re-tear** (6 percent): Several studies documented tearing of the rotator cuff following all types of repairs.
  - It appears that tendon re-tear does not guarantee a poor result, return of pain, or poor function.
  - Higher rate of tendon re-tear with all-arthroscopic repair when the tear was more than 3 cm.

RTC: Rehabilitation
RTC: Rehabilitation 0-2 Weeks
- **Protection**: In a sling unless showering or exercises
- **Dressings**: Okay to shower after 2 days, sutures removed 8 - 10 days post-op
- **PROM**: Forward flexion and scaption (scapular plane) 2 - 3 times daily, 10 - 20 reps as tolerated, followed by icing--this can be done at therapy and independently
- **Pendulum and pulley exercises** frequently

RTC: Rehabilitation 0-2 Weeks
- **AROM**: Ball/putty squeezes, bicep curls, cervical stretches/exs., postural exs. as tolerated
- **Pain control**: Soft tissue massage, modalities as needed
- **Isometrics**: For uninvolved tendons as tolerated (submaximal)
- **Well body**: Walking, stationary cycling, stair machine without weight on arms

RTC: Rehabilitation 2 - 4 WEEKS
- **Protection**: Continue sling
- **PROM**: For repaired tendons in direction that shortens tendons
- **AROM**: Uninvolved tendons using caution to avoid stressing repair
- **Isometrics**: Uninvolved tendons as tolerated (submaximal to maximal)
- **Well body**: Lower body conditioning, pool therapy

RTC: Rehabilitation 2 - 4 WEEKS
- **Protection**: None
- **PROM**: GENTLE passive motion into previously protected ranges (as tolerated)
- **Resting pain** should be decreased
- **Motion** in most planes should be at least 75% of normal
- **Address arthrofibrosis**

RTC: Rehabilitation 4 - 8 WEEKS
- **Mobs**: Grade I - II without restrictions, Grade III cautiously until 6 weeks
- **AROM**: Gradually introducing against gravity active range of motion exercises into extension, pure abduction and external rotation
- **Other activities**: HEP bands, UBE

RTC: Rehabilitation 4 - 8 WEEKS
- **PROM**: Continue with passive stretching of involved tendons to pain tolerance
- **Mobs**: Grade I - IV as tolerated achieve FROM

RTC: Rehabilitation 8 - 12 WEEKS
RTC: Rehabilitation 8 - 12 WEEKS

- **AROM**: Progression should be high repetitions before adding resistance, (i.e. small increments, attaining 25-50 repetitions
- Monitor shoulder/postural mechanics and pain throughout all exercises.
- Other activities: Jogging, swimming in protected range of motion

RTC: Rehabilitation 3 - 6 MONTHS

- Range of motion: If motion is still limited, then emphasis remains on achieving full range. Motion should be nearly full.
- Emphasis shifts to strengthening.

RTC: Rehabilitation 3 - 6 MONTHS

- PNF patterns: Can be performed cautiously, increasing as tolerated
- Other activities: Rowing, UBE for strengthening, protected range weightlifting ("downstairs")
- Cautious and very gradual exercises that stress repair

RTC: Rehabilitation 6 MONTHS

- Range of motion: Aggressive stretching and strenuous resistive exercises
- Other activities: Swimming, weightlifting, begin throwing progression program (assumes adequate range of motion of 90 abduction and external rotation)
- Functional progression

Thank You!