Rotator Cuff Lesions

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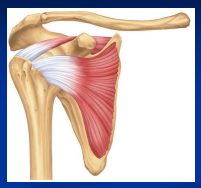
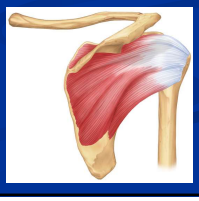
Anatomy

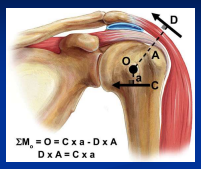
- Four musculotendinous units that comprise the rotator cuff
  - **Subscapularis** anteriorly
  - **Supraspinatus** superiorly
  - **Infraspinatus** posteriorly
  - **Teres minor** posteriorly

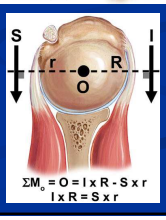




Mechanical Function of Rotator Cuff

- Compresses the glenohumeral (GH) joint to improve stability
- Aids in motion about GH joint
  - Most forces to create arm motion provided by larger muscles (deltoid)
  - Rotator cuff acts multiaxially during motion to maintain proper position of the humeral head within the glenoid
- Resists sliding or translation
  - Provides force couples = two muscles acting in same direction but at different locations on the joint
  - Provides stability and limits unwanted actions during shoulder motion
- When one portion of a force couple is weak or lost through injury or disease abnormal mechanics result → altered or lost shoulder function





Clinical Dysfunction

- Most frequently occurs in supraspinatus tendon
  - Relationship to coracoacromial arch
  - Vascularity
  - Mechanical loading
- Coracoacromial arch
  - Coracoacromial ligament anteriorly
  - Coracoid anteriorly
  - Acromion posterosuperiorly
- Dynamic outlet space (subacromial space)
  - Decreases maximally with abduction and internal rotation

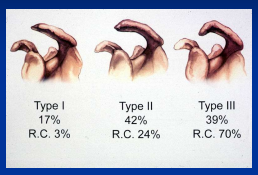
Incidence of Rotator Cuff Tears

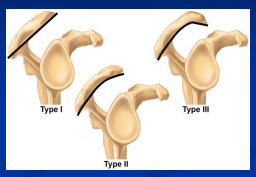
- Partial-thickness rotator cuff tears (PTRCTs)
  - Found in 13-37% of cadavers
  - Found incidentally in 15-33% of arthroscopies
  - Articular-sided tears 2-3 times more common than bursal-sided tears
  - Peak incidence 5th and 6th decade
  - More common than full thickness tears
- Full-thickness rotator cuff tears (FTRCTs)
  - 7-40% of cadavers
  - Tempelhof JSES 1999
    - Ultrasound study on **asymptomatic** shoulders
    - 13% RCT in patients between age 50-59 years
    - 51% RCT in patients > age 80 years
- 50% chance asymptomatic RCT become symptomatic
  - Unclear why this occurs in certain individuals

Etiology of Rotator Cuff Lesions

- Primary/Outlet Impingement
- Internal Impingement
  - Glenohumeral Instability
- Eccentric Tensile Overload
- Intrinsic Degenerative Tendinosis
- Acute Traumatic Injury
- MULTIFACTORIAL!

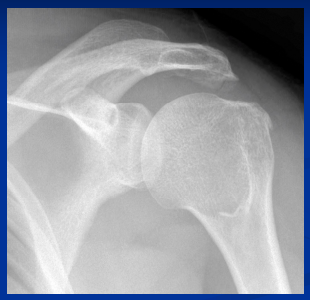
Primary/Outlet Impingement: Acromial Morphology





- Classification has potential for large interobserver and intraobserver variations
- Remains gold standard for evaluating acromial morphology
- Useful for correlating morphology with rotator cuff tears

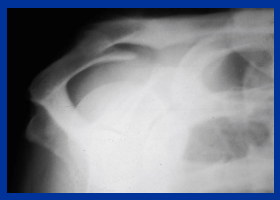
Primary/Outlet Impingement



Neer, 1972-- the cause of 95% of all cuff Tears

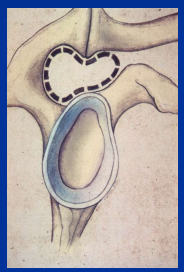
Primary/Outlet Impingement

- Acromial spur
  - Enchondral ossification
  - Nicholson: increase > 50 yrs



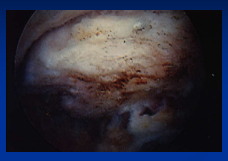
Primary/Outlet Impingement

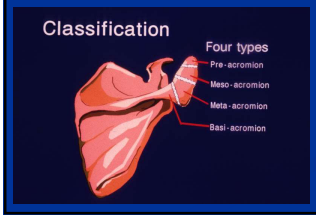
- AC joint spur, arthrosis

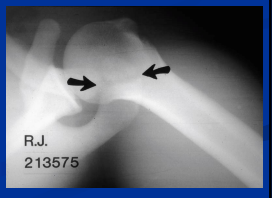


Primary/Outlet Impingement

- Os Acromiale
  - 1-15%
  - 62% bilateral
  - Pre, meso, meta
  - Hypermobility

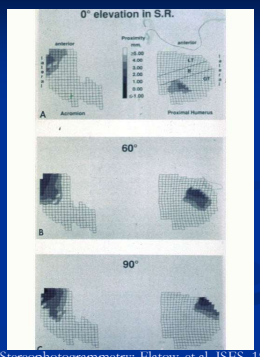






Primary/Outlet Impingement

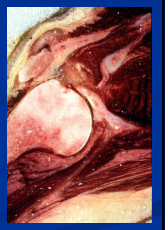
- Neutral: contact at anterolateral edge
- Elevation: contact shifts medially
- Maximal proximity 60-120° elevation
- Type III: increased contact
- Highest pressure anterolateral corner acromion
- Increased pressure with abduction angle
- Humeral rotation – little effect
- Increased pressure zone 14-18mm behind anterior acromion



Stereophotogrammetry: Flatow, et al JSES 1993

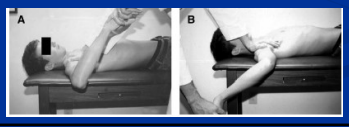
Internal Impingement

- Overhead athletes
- Posterior supraspinatus or infraspinatus lesions
- Associated with SLAP lesions
- Contact against posterosuperior glenoid rim in late cocking/early acceleration phase of throwing
- Anterior laxity



Internal Impingement

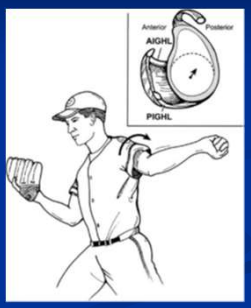
- Glenohumeral Internal Rotation Deficit (GIRD)
  - Loss in degrees of glenohumeral internal rotation of the throwing shoulder compared with the nonthrowing shoulder
- Symptomatic GIRD
  - >25 degrees
- Acceptable level of GIRD
  - <20 degrees
  - <10% of the total rotation in nonthrowing shoulder
- Cause
  - Tight posteroinferior capsule
    - Repetitive loading in the follow-through phase → hypertrophy of posteroinferior capsule



Burkhart & Morgan Arthroscopy 2003

Glenohumeral Internal Rotation Deficit (GIRD)

- **GIRD** → tightened posteroinferior capsule pushes humeral head posterosuperiorly in late cocking phase → shear forces at biceps anchor and posterosuperior labrum → peel-back phenomenon → **posterior type 2 SLAP lesion** → hyperexternal rotation causing both **anterior capsular laxity** and undersurface **posterosuperior rotator cuff tears**



Burkhart & Morgan Arthroscopy 2003

Treatment for GIRD

- Prevention of GIRD
  - 90% of throwers with symptomatic GIRD respond to posteroinferior capsular stretching program
  - Accomplished in 2 weeks
- 10% nonresponders to stretching
  - Those who developed type 2 posterior SLAP lesions
- Extremely unusual for high school and college pitchers

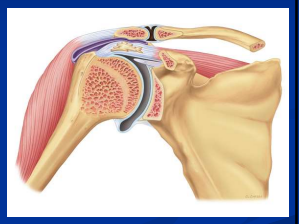
Burkhart & Morgan Arthroscopy 2003

Eccentric Tensile Overload

- Single Injury
- Repetitive stresses
  - Throwing
  - SS,IS eccentric contraction – deceleration phase
  - Prevent anterior subluxation
- Eccentric Tensile Overload → weakness, fatigue, tendinitis → impingement → tendon failure
- Rotator cuff tears in throwers
  - Occur in midsubstance of supraspinatus and infraspinatus tendons

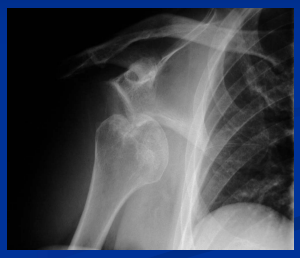
Intrinsic Degenerative Tendinosis

- Degenerative changes include
  - Disruption and thinning of tendon fascicles
  - Formation of granulation tissue
  - Dystrophic calcifications
  - Disorganization of collagen fibers
  - Abnormalities of the tidemark
  - Changes in cellularity
- Decreased vascularity with age
- Vascularity
  - Bursal > articular surface
- Bursal fibers tolerate tensile loads better than articular fibers



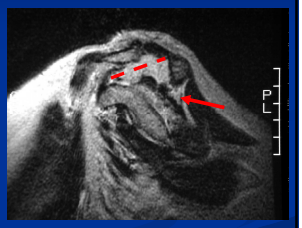
Acute Traumatic Injury

- Most commonly articular-sided rotator cuff tear
- Association with instability
  - Acute anterior shoulder dislocation
    - Patients > 40 years most common lesion is rotator cuff tear



Etiology
Current Thinking

- Primary/Outlet Impingement
  - Related but probably not simply cause and effect
- Etiology multifactorial
  - Intrinsic tendon degeneration (age)
  - Overuse
  - Trauma
- Fatty degeneration related to chronicity
  - Poor prognostic factor
  - Probably not reversible



Natural History of Rotator Cuff Tears

- No evidence of spontaneous healing
- Partial tears progress to full thickness tears
  - Yamanaka Clin Orthop 1994: tear progression to full thickness tear in 28% (serial arthrography)
- Critical depth in partial rotator cuff tear progression is 50% (Mazzocca AJSM 2007)
  - Beyond 50% tearing progresses spontaneously
- Full thickness tear extension
  - Tempelhof JSES 1999: tear extension in 39% (serial ultrasound)
- Rotator cuff tendon retraction and formation of adhesions
  - Complicates surgical repair
- Tendon deterioration (tissue-paper-quality tendon)
- Fatty degeneration and muscle atrophy
- Degenerative joint changes
  - Small percentage → rotator cuff arthropathy

Classification of Rotator Cuff Tears

- Partial Tears (Ellman)
  - A – Articular, B – Bursal, C – Combined
  - Grade I: 3mm
  - Grade II: 3-6mm
  - Grade III: >50% of cuff thickness
- Normal thickness of rotator cuff at insertion about 12-14mm
  - If >6mm space between articular surface and cuff insertion than tear >50%

Classification of Full-Thickness Tears

- Size of tear (Cofield)
  - Small < 1cm
  - Medium 1-3cm
  - Large 3-5cm
  - Massive >5cm
- Number of tendons involved (Gerber)
  - Massive: disinsertion of 2 or more tendons
- Muscle quality on MRI (Goutallier)
  - Stage 0: completely normal
  - Stage 1: some fatty steaks
  - Stage 2: marked fatty infiltration (more muscle than fat)
  - Stage 3: as much fat as muscle
  - Stage 4: more fat than muscle
- Tendon Retraction (Patte)
  - Stage 1: minimal retraction
  - Stage 2: retraction to apex of humeral head
  - Stage 3: retraction to glenoid

Clinical Presentation

- Symptoms
  - Pain
    - Nocturnal
    - Activity related
    - "Toothache" in the shoulder
  - Loss of function
  - Weakness, Fatigue
- Mechanism of Injury
  - Acute
    - Traction
    - Fall on outstetched hand
    - MVA
  - Acute on chronic
    - Repetitive overhead activity
  - Chronic
    - Insidious onset
    - Typical outlet impingement history
- Previous Treatment
  - Injections
  - Exercise programs
  - Surgery
- Patient expectations
  - Activity level
  - Motivation

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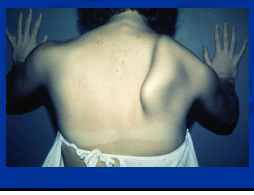
Physical Examination

- Inspection
  - Supra and infraspinatus atrophy
  - Swelling, sub-deltoid effusion
  - Long head biceps rupture
  - Anterior superior prominence of humeral head
  - Scapular winging
- Tenderness to palpation
  - AC joint, bicipital groove, posterior joint line, greater tuberosity
- Range of motion (active and passive)
  - PFE, AFE, AER (0^0), AER (90^0), IR (spine)



Physical Exam

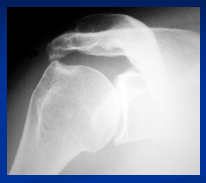
- Strength
  - FE, ER, IR, biceps
  - 0 = no contraction, 1 = flicker, 2 = move with gravity eliminated, 3 = move against gravity, 4 = move against some resistance, 5 = normal power
- Impingement/Rotator Cuff Tests
  - Neer impingement, Painful arc of motion, O'Brien, Speed, Overhead/cross-body adduction, Lift-off sign, Belly-press test, Drop-arm test, Lag sign ER (Hornblower's sign), Lag sign IR
- Cervical spine/Neurologic Exam
- Diagnostic injection/Impingement test
  - 10cc 1% plain lidocaine → % relief
- Park et al JBJS 2005
  - Combination of painful arc sign, drop-arm sign, ER/Infraspinatus weakness has high probability for full-thickness RCT

Differential Diagnosis

- Rotator Cuff Tear
- Deltoid tear
- Rotator cuff arthropathy
- Neurologic
  - Suprascapular neuropathy
  - Brachial plexopathy, Parsonage-Turner syndrome
  - Cervical spondylosis, stenosis, radiculopathy
    - Can cause shoulder pain and weakness that mimics rotator cuff pathology

Imaging

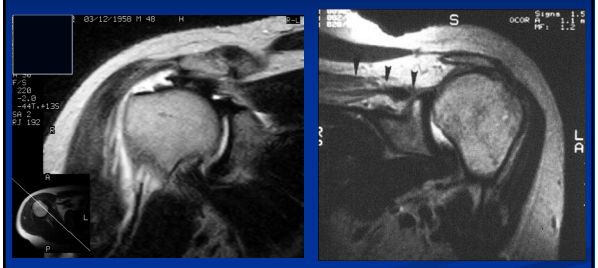
- Plain radiographs
  - True AP, ALVIS (20^0 caudal tilt), axillary lateral
  - Demonstrate skeletal and osseous changes suggestive of rotator cuff pathology
  - Impingement anatomy
  - Narrowing of acromio-humeral distance
    - <7mm consistent with RCT
    - <5mm = massive tear



Imaging

- Arthrography
  - Variable accuracy reported
  - Itio 80%, Gartsman 15%, Walch 47%
- Ultrasound
  - Operator dependent
  - More challenging with partial thickness than full thickness tears
  - Weiner and Seitz AJR 1993
    - Sensitivity 94%, Specificity 93%
- Magnetic Resonance Imaging (MRI)
  - Gold standard
  - Tendinosis vs Partial RCT vs full RCT
  - Muscle atrophy and retraction
  - Full RCT: 99% sensitive, 95% specific
  - Partial RCT: 56-72% sensitive, 85% specific (Traughber, Goodwin, 1995)
    - Negative MRI does not exclude possibility of partial thickness RCT!!
- Arthrogram MRI may improve sensitivity
- MRI: ABER views improve detection of undersurface delamination

MRI

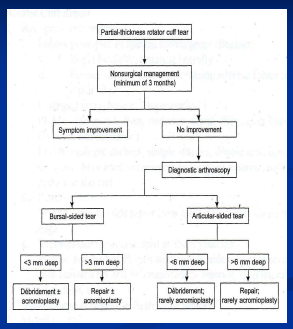


Treatment

- Partial-Thickness Rotator Cuff Tears
  - Nonoperative management
    - Steroid injections, nonsteroidal medication, modalities, activity modification, rehabilitation exercises
    - Direct treatment toward etiology of shoulder pain
      - Impingement: pain modalities, stretching, balanced strengthening
      - Instability: add proprioceptive training, plyometrics, throwing program
    - Success rate of 70%
    - A relatively long course of nonsurgical treatment (6-12 months) can be prescribed with minimal risk to the patient

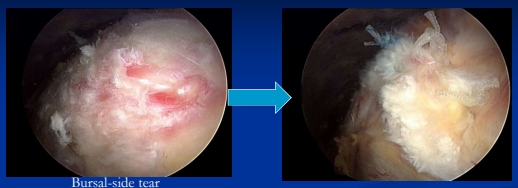
Operative Treatment of Partial RCTs

- Arthroscopic acromioplasty and **debridement** of rotator cuff
  - Gartsman, Ellman, Snyder: 75-83% satisfactory results
  - Cordasco (all tears < 50%): 92% satisfactory results, high failure rate in bursal-sided partial tears
  - Weber: 19% reoperation rate in 55 patients for ongoing pain
  - Kartus: 9/26 patients progressed to full thickness tears at average follow up of 9 years
- Arthroscopic acromioplasty and **rotator cuff repair**
  - Deutsch: 98% satisfactory results with takedown of intact portion of cuff and arthroscopic repair
  - Duralde: 92% good and excellent results with repair of torn cuff without takedown of intact portion

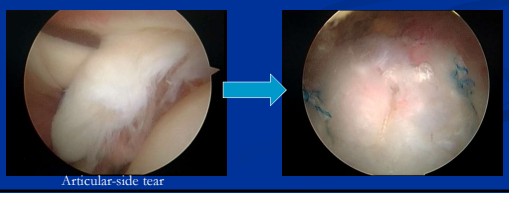


Duralde AAOS 2008

Treatment Partial RCTs



Bursal-side tear



Articular-side tear

Treatment of Full-Thickness Rotator Cuff Tears

- Nonoperative management
  - Benefits: avoiding surgery and its inherent complications
  - Risks: recurrent symptoms, tear extension, chronic changes (retraction, adhesions, "tissue-paper-tendon," fatty degeneration, muscle atrophy, rotator cuff arthropathy)
  - Similar protocol as nonsurgical treatment for PTRCTs
    - Limit failed therapy to 3-6 months
- Operative
  - Benefits: long-term pain relief, improved function, possible cessation of chronic changes
  - Risks: infection, nerve injury, deltoid injury
  - Indications: persistent pain with ADLs, night pain, pain unresponsive to nonsurgical care

Operative Treatment Full-Thickness RCTs

- Open acromioplasty/Open rotator cuff repair (RCR)
- Arthroscopic acromioplasty/Open or mini-open RCR
  - Indications for open RCR: large cystic changes in greater tuberosity, chronic renal failure patients (bone inability to hold suture anchors
- **Arthroscopic acromioplasty and arthroscopic RCR**

Results of Arthroscopic Rotator Cuff Repair

Author	Year	n=	F/U (mths)	Success
Tauro	1998	53	24	92%
Stollsteimer	1998	48	34	N/A
Gartsman	1998	73	30	90%
Cordasco	1999	65	54	91%
Weber	1999	126	36	92%
Hoffman	2000	45	34	N/A
Glyze	2000	87	25	95%
Wolf	2000	96	74	94%
Nottage	2001	35	38	91%
Burkhart	2001	62	42	95%
Wilson	2002	112	60	89%
Snyder	2002	48	39	96%

G Williams ppt

Arthroscopic RCR

- Ideal repair
  - High initial fixation strength
  - Minimal gap formation
  - Mechanical stability until healing complete
  - Restore footprint

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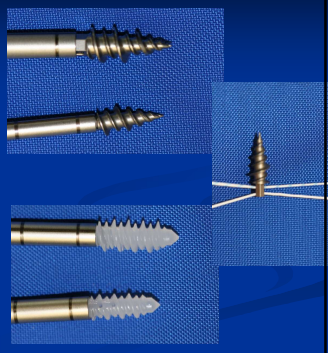
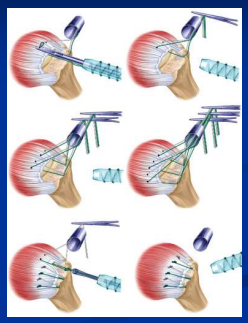
Arthroscopic RCR

- Anchor selection and placement (*Tingart AJSM 2004*)
  - Metal anchor: higher pull out strength in all regions (vs biodegradable)
  - Pull out strength higher in:
    - Proximal G.T. (both anchors)
    - Proximal anterior & middle thirds (metal)
  - Pull out strength biodegradable anchor in distal G.T. too low
- Depth of anchor placement (*Bynum AJSM 2005*)
  - Anchor insertion depth:
    - Deep placement – clinical failure via cutting of suture through bone
    - Deep placement – no catastrophic failure during cyclic loading
    - Std. & proud placement – suture degraded at eyelet & failed with cyclic physiologic loading
    - Anchor depth changes mode of failure



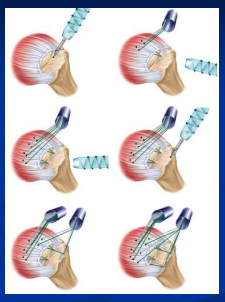
Arthroscopic RCR

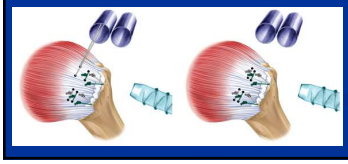
- Prepare Footprint
  - Bleeding bone surface
  - Avoid decortication
  - Begin lateral to articular surface
  - Remove bone spurs on G.T.
- Single row repair
  - Insert anchors anterior to posterior
  - 1 cm apart
  - 1-2 cm off articular surface



Double Row RCR

- Double row repair
  - Medial anchor placement
    - Medial aspect prepared footprint (lateral to articular margin)
    - Horizontal mattress 10-14 mm from tendon edge
  - Lateral anchor placement
    - In cortical bone lateral to footprint
    - Single, simple 5-8 mm from tendon edge



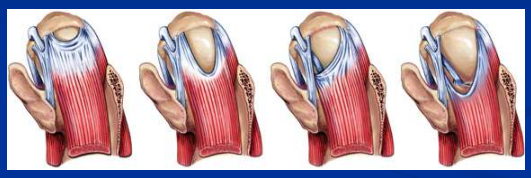


Single Row vs Double Row Repair

- Smith et al JBJS 2006 (cadaveric study)
  - Gap formation during static loading was significantly greater in the single-row group than in the double-row
  - Under cyclic loading double-row repairs failed at a mean of 320 N whereas the single-row repairs failed at a mean of 224 N
  - Conclusions: double-row technique demonstrates superior resistance to gap formation under static loading as compared with the single-row technique
- Franceschi AJSM 2007 (clinical study)
  - Mean operative time: 42min for single row, 65min for double row
  - UCLA score improved equally for single/double row groups at 2 year mark
  - Postoperative ROM improved equally for both groups
  - Postoperative MR arthrograms showed no statistically significant differences in rates of healing
  - Conclusions: mechanical advantages do not translate to superior clinical results, double row techniques more expensive (> suture anchors) and longer operative times

Treatment of Full-Thickness RCT

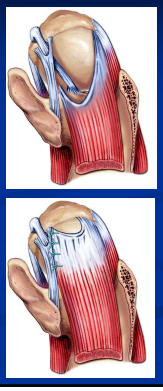
- Recognize tear patterns:



Crescent tear *U-shaped tear* *L-shaped tear* *Contracted, immobile tear*

Treatment of Massive RCTs

- Large U & L-shaped and contracted, immobile tears
- Avoid "heroic" measures to cover head
- Partial Rotator Cuff Repairs
  - Burkhart
    - 14 patients
    - 13 satisfied
    - UCLA 9.8 → 27.6
    - AFE 60° → 150°
  - Duralde
    - 24 patients
    - 12E, 6G, 5F, 1P
    - 87% satisfied
    - 83% pain relief
    - AFE improved 40°
    - Reach overhead- 87%
    - Lift 10# overhead- 58%



Ideal Repair

- High initial fixation strength
- Minimal gap formation
- Mechanical stability until healing complete
- Restore footprint

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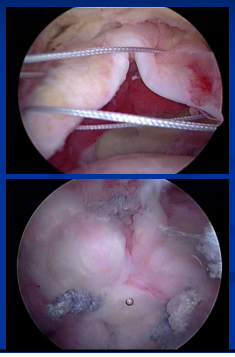
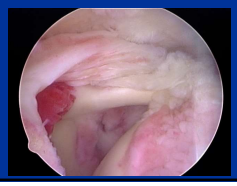
Successful RCR

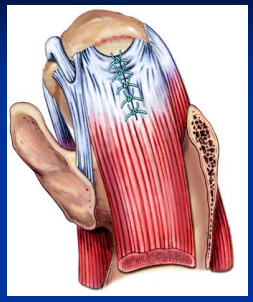
- Tendon quality
- Tendon grasping technique
- Bone quality tuberosities

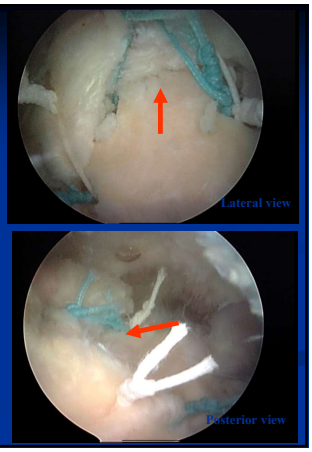


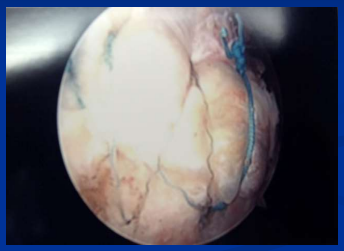


Arthroscopic RCR

- Crescent Tear
  - Single or double row repair

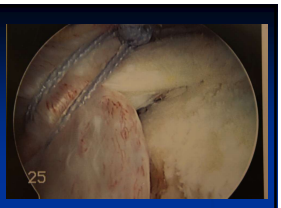


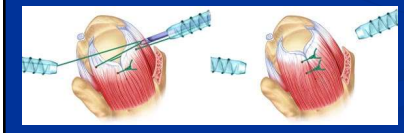


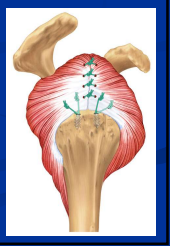


Arthroscopic RCR

- U-shaped tear
  - Margin convergence (medial)
    - start at apex of tear
    - medial to lateral
    - side to side repair
  - Tendon to bone (lateral)
    - converged tendon edge
      - posterior leaf
      - anterior leaf

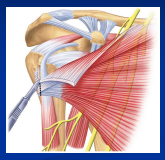


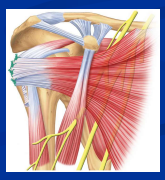




Tendon Transfers for Treatment of Massive/Recurrent RCTs

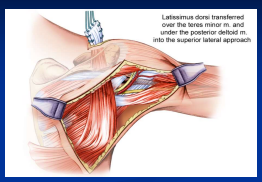
- Pectoralis Major Transfer
  - Chronic, retracted subscapularis tear or failed repair that is irreparable
  - Anterosuperior cuff defect with reparable supraspinatus
  - No static anterior subluxation on axillary lateral X-ray
  - Stage 3/4 fatty degeneration of subscapularis on MRI
  - Subcoracoid transfer

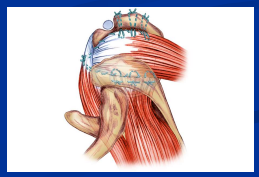




Latissimus Transfer

- Intact subscapularis, deltoid
- Pain, weakness, irreparable posterosuperior cuff defect
- Acromio-humeral distance < 5mm (true AP)
- No static posterior or anterior subluxation
- No advanced arthritis or stiffness
- No pseudoparalysis
  - Patient should have 90-100^0 of FE, but decreased ER
- Helps patient get hand to top of head, does not help patient raise arm!





Questions

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