

American Academy of Orthopaedic Surgeons
Open and Arthroscopic Techniques in Shoulder Surgery
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Massive Rotator Cuff Tears
Principles & Open Mobilization Techniques
Including the Subscapularis
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Introduction

- Deltoid-detaching approach can be safe and reliable
 - Approach for posterior-superior cuff tears
 - Supraspinatus, infraspinatus, teres minor
- Indications for open repair
 - Ideal for large and massive tears
 - As originally described, mini-open approach is not ideal for large or massive tears
 - Limited exposure due to lateral acromion and incision size
- Mobilization techniques
 - Equipment
 - A number of devices facilitate successful repair
 - Releases
 - Subdeltoid/subacromial adhesions
 - Coracohumeral ligament release
 - Extra- and intra-articular steps
 - Interval releases -- anterior (rotator interval) and posterior
 - These steps facilitate secure repair
- Subscapularis
 - Diagnosis early and repair complete tears
 - Releases are essential circumferentially, especially in chronic cases
 - Strength slow to return, if ever completely

Notes

Surgical Principles of Rotator Cuff Repair

- Neer's four objectives for rotator cuff repairs
 - Closure of cuff defect -- tension-free, water-tight repair
 - Eliminate impingement lesions of coracoacromial arch
 - Preserve deltoid origin -- meticulous repair
 - Rehabilitation to prevent stiffness without disrupting repair
- Additional steps for traditional open repair
 - Excise inflamed bursa -- enough for exposure
 - Debride tendon edge -- minimally to freshen edge
 - Mobilize tendon -- glenoid rim releases, incise coracohumeral ligament, interval slides
 - Prepare bone of sulcus -- expose bone bed, but no trough necessary
- Gerber suggests that the "ideal repair should have high initial fixation strength, allow minimal gap formation and maintain mechanical stability until solid healing."
 - Mason-Allen locking suture technique grasps tendon securely
 - Especially useful during repairs under some tension

Classification

- Size measurement (Post, Cofield)
 - 3-5 cm large
 - > 5 cm massive
- Tendons involvement (Gerber)
 - 2 or more complete cuff tendons involved, i.e.,
 - Supraspinatus/infraspinatus
 - Subscapularis/supraspinatus
- Fatty degeneration and atrophy
 - Poor quality muscle has diminished function, even if repaired
- Acromiohumeral interval (AHI) -- on true AP radiograph
 - > 7 mm -- humeral head centered in glenoid
 - < 6-7 mm -- question reparability, especially in chronic or elderly
 - 5 cm or less -- consider another treatment

Limitations and Complications

- Superior approach for posterior superior cuff tears
 - Restore coracoacromial arch -- important if repair fails
- Anterior deltopectoral approach for complete subscapularis tears
- Limitations
 - Quality of repair is dependent upon good technique and
 - Careful management of soft-tissues
 - Decreasing tension
 - Strong fixation of tendon to bone during the healing process

- Overall outcome affected by, among other factors,
 - Extent of pre-operative motion
 - Quality of tendon and bone
 - Amount of muscle atrophy/degeneration
 - Diligent rehabilitation program
 - Motivated patient -- post-operative pain management
- Not advised to repair to a point medial to sulcus, i.e., into articular surface
- Complications
 - General, “including but not limited to”
 - Failure of tendon healing
 - Symptomatic re-tear (not all re-tears are symptomatic)
 - Infection
 - Persistent pain
 - Persistent weakness - pre-operative assessment of muscle
 - Axillary nerve lesion - keep split less than 4 cm
 - Post-operative stiffness

Clinical Evaluation for Posterosuperior Tears (refer to other sources for more complete information)

- History of pain and weakness
 - If just weakness, carefully reconsider indications (“skillful neglect”)
 - Acute massive tears, usually associated with prior pathology, symptomatic or not
- Atrophy, biceps disruption, AC pain may be component
- Assess active and passive motion, utilizing impingement test, if required
- Patterns of weakness
 - ER lag sign
 - With adduction -- infraspinatus
 - With abduction -- teres minor
 - Elevation in scapular plane -- supraspinatus
 - Lift-off, modified lift-off, belly press -- subscapularis
- Radiographs
 - True AP -- AHI, GT ?es, osteopenia
 - Outlet -- acromial morphology, spur
 - Axillary -- orthogonal GH view to AP
 - Zanca -- AC joint, inferior spurs
- Imaging
 - MRI -- coronal, axial and sagittal
 - All views contribute to full impression of tear size and muscle quality
 - Ultrasound -- limited view in massive tears superomedially
- Pre-operative
 - Consent to include possible bicipital surgery, incomplete repair or irreparable

- Insure AC joint is, or is not, a part of the pathology
 - Modified AC arthroplasty if excrescences involved
- Restore motion -- “If you operate on a stiff shoulder, you’ll more likely end up with a stiff shoulder.”
- When indicated, the earlier the repair, the less atrophy

Equipment

- Capable assistance -- maintain exposure, adjust arm position and rotation facilitates exposure
- Patient position -- ~45-60° in modified beach-chair, semi-sitting position
- Upper body positioners -- multiple devices that allow arm lateral to table to facilitate exposure
 - Extension/internal rotation -- posterior cuff
 - Flexion/external rotation -- anterior cuff
- Arm positioner -- used to maintain arm position, and, at times, apply traction
 - i.e., McConnell ASIP, Tenet Spyder
- Retractors -- further improves exposure
 - Kolbel or similar self-retaining
 - Narrow and wide blades
 - Richardson -- baby-sized and up
 - Darrach -- multiple sizes
 - Gerber -- modified laminar spreader with ring for humeral head
- Rasp -- can be used to insure flat acromioplasty, and roughen tuberosity
- Chisel
 - Bevel angled down for acromioplasty
 - Remove tuberosity bony excrescences (or bur, ronguer)
- Ronguer, curettes, bur -- to expose bone of sulcus
 - Formal trough not indicated
- Traction sutures
 - Assist with controlling tendon during mobilization and repair
 - Do not use tenaculums, towel clamps or Kocher clamps, which damage tendon
- Repair with non-absorbable braided suture, such as #2 size
- Transosseous approach
 - Instruments to create tunnels
 - i.e., Link awls and crochet hooks
 - i.e., Linvatec repair system, includes tenaculums for bone
 - Different sizes allow alternating tunnel position
 - Lateral bone augmentation for osteopenic bone
 - i.e., Cuff Link (Mitek) or plastic button
 - Two sutures per tunnel -- simple repair over bone, or other
 - Careful suture management with multiple tunnels
- Anchor approach -- not preferred

- With higher re-tear rate in massive tears, ? risk of anchor dislodging into joint
- Larger size for fixation in bone
 - Screw-in possibly better than push-in anchor in this setting
- Two sutures per anchor -- ? one horizontal mattress, other simple
- ? Consider second row of anchor (s)
- Taper needles - pass through tendon without slicing
 - Cutting needles not necessary

Surgical Technique

A. Pre-incision

- Prophylactic antibiotics administered within one hour of incision
- Interscalene anesthesia with sedation vs. general anesthesia
 - Interscalene blocks also provide post-op analgesia
 - Supplement with LMA general ?
- Examination under anesthesia
 - No motion deficits pre-op are preferred
 - "Mild" motion limitations can be manipulated
 - Greater ER, compared with contralateral, suggest complete subscapularis tear
- Beach-chair -- with all down surfaces padded
- Mark landmarks and planned incision(s)
 - In Langer's lines, good cosmesis, good exposure
 - Located about the anterolateral acromion
 - Cheat medial if distal clavicle excision planned
 - Inject lidocaine w/epi into planned incision(s)

B. Surgical Approach

- Superior incision -- 7-8 cm
 - Develop wide flaps
- Deltoid release off anterior acromion
 - Option 1 -- Over acromion, in one thick flap, to expose bone
 - Requires transosseous deltoid repair
 - Option 2 -- ~5 mm anterior to acromion
 - Healthy cuff of tissue for soft-tissue deltoid repair (Bigliani)
 - Requires elevating posterior flap from anterosuperior acromion
 - Extending split anteriorly limits subacromial exposure posteriorly
 - Extend deltoid split ~3-4 cm from lateral edge of acromion
 - Limit risk to axillary nerve
 - Place a stay suture at the end of the split to prevent propagation
 - Split located near anterior edge, in lateral raphe
 - If distal clavicle excision is planned, extend deltoid incision medial over AC joint

- Or resect from inferior
- Release CA ligament from under acromion (subperiosteally to maximize length) and tag
 - Expect, and cauterize, thoracoacromial branch of coracoacromial artery
 - Can be taken along with deltoid in subperiosteal release
 - Argument can be made for leaving this in place, but it limits exposure
- Place retractors subdeltoid
 - Specifically-designed self-retaining retractors facilitate exposure

C. Decompression

- Subdeltoid/subacromial releases
 - First step in release techniques
 - Cobb elevator useful to release any scarred cuff tissue from undersurface of deltoid and acromion that is occasionally present, particularly posterosuperiorly
- Acromioplasty in this setting is controversial
 - If concerned about compromising CA arch, remove at least any sharp inferior spur
 - Chisel with bevel faced up, therefore slice will angle and exit inferiorly
 - Darrach retractor used to depress humeral head inferiorly
 - Often creates improved view for mobilization steps
 - Smooth/flatten undersurface with rasp to level of distal clavicle
 - Irrigate at this time and multiple times throughout case
- If distal clavicle excision is planned, complete with sagittal saw
 - Can enhance exposure of massive tear
- Palpate undersurface of AC joint
 - Correlate expectations with pre-op Zanca radiograph
 - Distal clavicle may be more prominent post-acromioplasty
 - Perform modified AC arthroplasty if bone projecting inferiorly has potential to compromise repair/outcome
 - Remove excrescences with chisel, rongeur, rasp

D. Assessment

- Tear pattern
- Tissue quality
- Tissue mobility
- Bone quality
- Other, i.e. biceps, pathology

E. Mobilization and Repair

- Assess exposure and identify tear edge
 - Bursa should be minimal in massive tears, but resect for exposure
 - Rotate arm to better visualize tear

- Place traction sutures from anterior to posterior, or anterior and posterior
 - Assess tendon mobility
 - Traction on these sutures helpful for all release steps
 - Determine if side-to-side sutures are indicated
- Mobilization
 - Allows for mobilization of tendon laterally over greater tuberosity
 - In case of U-shaped tear, this would allow for repair of the entire length of the tendon edge (in anterior-to-posterior direction) laterally over tuberosity
 - Extra-articular
 - Place Cobb (round tip) elevator over tendon medially anterior to posterior
 - Limited 1-2 cm medial to rim to avoid suprascapular nerve
 - Coracohumeral release
 - Incise thick soft tissue anteriorly to base of coracoid
 - Assess any improved mobility
 - Intra-articular -- glenohumeral release between superior labrum and cuff
 - Incise capsule from 3 o'clock to 9 o'clock
 - Use elevator to complete release
 - Can elevate supraspinatus from fossa 1-2 cm
 - Assess any improved mobility
 - Reparability
 - May be possible at this point in "V-" or "L-" shaped tears
 - Here, side-to-side sutures are part of the repair
 - Interval slide
 - Anteriorly, between supraspinatus and subscapularis
 - More frequently utilized
 - Sharply incise to base of coracoid
 - Assess any improved mobility
 - Posteriorly, between supraspinatus and infraspinatus
 - Less frequently used
 - Use base of scapular spine to guide
 - Careful of suprascapular nerve
 - Assess improved mobility
- Repair
 - Side-to-side sutures
 - Closes anterior and posterior tendon edges
 - In "V-" and "L-" shaped tears
 - Closes defect starting from apex, medially, progressing in a lateral direction
 - Place sutures to allow the flap in "L-" shaped tear to come laterally
 - Place desired number of these sutures, as indicated
 - #2 braided, non-absorbable

- Can use #0 or #1, or alternate color to ease suture management
 - May place to bury knot, if desired
- Transosseous tunnels spaced along greater tuberosity
 - Vary position laterally (proximal to distal)
 - To avoid “postage stamp” appearance laterally
 - Cortical bone is better >2 cm distally
 - Exit tunnels medially, near to articular margin if planning to tie each suture over tuberosity (Place tunnels more lateral if mattress repair planned)
 - Place one or two (preferable) #2 sutures per tunnel
 - Use different colors (or vary size) to help distinguish between two
 - About two tunnels for each tendon, therefore ~4 sutures for each tendon
 - Carefully manage sutures with clamps, in some routine order
- Assess bone quality -- Use bone augmentation laterally, if needed
- Freshen tendon edge -- no need to resect significant amount
- Pass medial limb of all transosseous sutures through tendon with taper needle
 - Approximately 1 cm from edge
 - Start side of least tension to most
 - Usually posterior to anterior
 - Space (in AP direction) along tendon edge evenly
 - Carefully manage sutures
 - Place one of each pair in Mason Allen and other as simple
 - If tear is delaminated, capture entire thickness of tendon
- Use alternate suture configuration, if desired
 - i.e., mattress technique tied laterally
- Tie each suture securely
 - Start side of least tension to most
 - Usually posterior to anterior
 - Apply traction on tag suture near to specific repair suture
 - Tie knot laterally on greater tuberosity
 - Do not squeeze suture with clamp
 - Consider abducting the arm, as needed to increase security of each suture knot
- Assess quality and tension of repair
 - Place arm at side initially
 - Then, take arm through gentle range-of-motion
 - Use as guide for post-op rehab
- Partial repair, especially if head mostly covered, is better than no repair

F. Closure

- Repair deltoid
 - Plan to incorporate CA ligament into this portion of repair

- Transosseous -- can use two #2 braided, non-absorbable sutures in each of two drill holes
- Check to insure deltoid stay suture is intact ~4 cm laterally where it was placed
 - Close lateral deltoid figure-of-eight or a running suture
- Irrigate and achieve hemostasis
- Close subcutaneous tissue in layers, as needed
- Use subcuticular closure for more cosmetic healing
- Consider using anesthetic infusion for post-op analgesia
 - Insert prior to beginning closure
- +/- Cryocompression
- Consider sling with abduction pillow
 - A number of commercially available devices work well
 - Relieves tension from repair as healing ensues

Postoperative Rehabilitation (refer to other sources for more complete information)

- Use intra-operative assessment as guide
 - Inform patient pre-op that rehab course will be slow and deliberate
- Passive motion for 6 weeks
 - Limit, and progression, based on repair
 - Passively, 140° forward elevation
 - Gentle pendulum exercises
 - Supine stick exercises to 30°, but no pulley exercises
 - Continue with abduction pillow
 - Avoid arm extension
- Add active-assisted exercises at 6 weeks
 - Be cautious with pulley
 - Active exercises 10-12 weeks
 - Slowly add ADLs
 - Maximize motion
- Add strengthening by 3 months
 - Advise patient that strength gains continue to 12 months

Results

- ~85% satisfactory results reported from tertiary centers
 - Higher rates for pain relief
 - Lower rates for recovery of strength
 - This outcome requires muscle that can recover and repair remains intact
 - Rokito study -- >1 year to restore strength, and not equal to contralateral side
- Re-tear rate higher in massive tears
 - Higher success rate if repair remains intact
- Assessment of repair integrity -- Harryman ultrasonography study

- 5-years (range 2-11) post-repair
 - Supraspinatus repairs 80% intact
 - Supraspinatus/infraspinatus 57% intact
 - Supraspinatus/infraspinatus/subscapularis 32% intact
- Intact repair at follow-up
 - More active flexion
 - Better functions in ADLs
 - Large or small repairs function the same if intact
- Integrity of cuff at follow-up important factor in outcome, not pre-op size of tear
 - Functional loss related to size of recurrent defect
 - Older patients tended to have larger tears, higher re-tear rates
- Gazielly study (with ultrasound) correlated with Harryman study
- Clinical outcome, though, does not *necessarily* correlate with cuff integrity
 - Re-tears are not always symptomatic

Subscapularis

- (Open Approach is addressed -- refer to other sources in this course for arthroscopic approach)
- Isolated tears and tears associated with supraspinatus/infraspinatus are less frequent
- Early diagnosis is beneficial to patient and surgical repair -- high index of suspicion
- Clinical findings
 - Slightly younger population for isolated complete subscap ruptures than degenerative supraspinatus tears
 - Often associated with trauma, forceful ER
 - Greater ER motion than contralateral side
 - Poor IR strength
 - Lift-off, modified lift-off and belly press used for diagnosis
- Imaging
 - Radiographs often not useful, unless chronic tears, where anterior subluxation is present
 - Axillary may reveal coracoid non-union
 - MRI is helpful to confirm tear, level of retraction, muscle quality
 - If biceps reported to be displaced anteromedially, look for subscap tear
 - Marked atrophy and fatty degeneration correlate with poor outcome

Surgical Approach

- Deltopectoral approach
 - Allows for full assessment of pathology, including biceps involvement
 - Don't be misled by scar across lesser tuberosity
 - Use this as guide medially to get to tendon edge

- Affords safe mobilization of tendon (360°)
 - Can identify and protect axillary nerve
- Equipment mentioned above useful, i.e. self-retaining retractor
- Address biceps tendon
 - Usually displaced medially
 - Often degenerative
 - Resect from superior glenoid and tag for later tenodesis, if planned
 - Absorbable screw fixation into socket in biceps groove preferred
 - Prepared for, but not completed, until after sutures passed for subscap repair
- Mobilization
 - Inferior muscular portion of subscap may be attached to humerus
 - Detach this and resect scar
 - Place traction sutures along tendon edge
 - Assess mobility of tendon
 - Expose and protect axillary nerve, with finger or narrow Darrach retractor, when releasing inferiorly
 - Superior release to base of coracoid, sharply
 - Anterior release with blunt elevator
 - Posterior (capsular) release
 - Combination of sharp and blunt dissection
 - From glenoid neck medial to coracoid base
 - Leave labrum intact
 - Continue inferiorly, with axillary nerve protected at all times
 - Utilize traction sutures to assist
 - Assess mobilization laterally over lesser tuberosity
- Repair
 - Abrade lesser tuberosity and sulcus, but no formal trough needed
 - Transosseous tunnels placed
 - Can be medial or lateral to bicipital groove
 - If transosseous supraspinatus repair planned, consider tunnels medial to (or within medial wall of) bicipital groove for superior fixation sutures (judicious use of an anchor in lateral lesser tuberosity may work)
 - Tunnels lateral to groove for inferior tunnels works well
 - Combination often used to complete the repair
 - Other side of tunnels
 - Should exit at medial LT/sulcus if plan is to tie sutures over biceps
 - Should exit laterally if mattress repair is planned
 - Two sutures per tunnel is one option if repair is planned over bicipital groove
 - If mattress suture repair planned, sutures can be spaced along tendon from superior to inferior prior to passing through tunnels

- Mason-Allen suture technique is ideal to grasp tendon
- Utilized bone augmentation as needed
- Perform tenodesis, if planned, prior to suture repair, if sutures pass over groove
- Securely tie repair with arm in IR
- Assess repair through motion to determine safe guidelines for post-op rehab
- Closure consists of confirming integrity of axillary nerve, achieving hemostasis, irrigating soft-tissues, and approximating layers
 - Consider anesthetic infusion for post-op analgesia
- Coracoidplasty not usually performed in open repairs, possibly because of less swelling

Postoperative Rehabilitation

- Sling utilized
 - Avoid arm extension
- Passive motion for 4 weeks, with ER allowed to limit based on OR assessment
- Active-assisted (stick and pulley) exercises added 4-6 weeks in strong, secure repairs in younger patients
- Active-assisted exercises progressed to active exercises for 8-10 weeks, then strengthening progresses
- Lift-off may always be weak and belly-press may remain positive or intermediate, especially in chronic tears and older patients

Results

- Limited studies in literature
- Gerber -- 81% good/excellent results for repair of isolated subscapularis tears
 - Warner concurs good success rate

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