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Feature Articles

What We Can Do about Rotator Cuff Repair Failure

The authors review the risk factors for rotator cuff failure and provide advice on what orthopaedic surgeons can do to optimize surgical results.

By Benjamin Bruce - November 4, 2013 0 Feature Articlesrotator cuff tears

Authors

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Introduction

Surgical techniques to address rotator cuff tears have evolved over the past decades from open to arthroscopic repairs. No definitive clinical studies compare open versus arthroscopic treatment; however, arthroscopic treatment has the theoretical advantage of being able to evaluate and address the glenohumeral joint, as well as minimize soft tissue dissection.

Although tendon healing is not a prerequisite for successful long-term outcomes after rotator cuff surgery in terms of pain relief, activity, mobility, or patient satisfaction, [1-5] several reports have demonstrated improved outcomes in patients who have documented healing of their rotator cuffs, compared with patients who developed recurrent tears. [4,6,7] Healed tendons have been shown to lead to more strength and higher constant scores. [3]

The literature describes a host of factors that contribute to rotator cuff failure. Surgeons should understand the pre-, intra- and postoperative factors that contribute to rotator cuff healing, which will help in managing patient's expectations and improving outcomes.

The goal of this article is to review the risk factors for rotator cuff failure and provide advice on how to optimize surgical results.

Preoperative Factors

Errors in Diagnosis: Failure to Recognize All Pathology

Successful treatment of rotator cuff tears hinges on identifying the source of the patient's symptoms. The presence of a rotator cuff tear on preoperative imaging or arthroscopy does not ensure that treatment of the cuff tear will address the patient's complaints. Other causes of shoulder pain should be evaluated before surgical intervention is undertaken, including:

- Biceps pathology
- Labral pathology
- Acromioclavicular joint arthritis
- Glenohumeral arthritis

- Suprascapular neuropathy
- Undetected os acromiale (made worse by acromioplasty)
- Cervical radiculopathy
- Adhesive capsulitis
- Neuromuscular disorders
- Referred pain from cardiac, pulomonary, or gastrointestinal disease

Patients with significant preoperative stiffness (total passive range of motion less than 70°) may have poorer outcomes after isolated rotator cuff repair. [8]

Tear Factors

Preoperative MRI assessment of a rotator cuff tear can be used to predict the likelihood of healing.

- Tear size
    - Larger tears are more likely to fail after repair than small tears [6,9]
    - Risk of retear after surgery increases by twofold for each 1-cm increase in tear size [10]
- Fatty infiltration
    - Greater fatty infiltration of the infraspinatus is an independent prognostic factor for postoperative retear [11,12]
- Tendon retraction
    - Retraction in either the coronal or sagittal plane is a poor prognostic indicator for tendon healing [3,12]
    - Tendons less than 15 mm long on MRI with a Goutallier stage of 2 or 3 resulted in a 93% failure rate in healing [12]
- Delamination of the subscapularis and/or infraspinatus
    - Increases the likelihood of postoperative retear [3,6]

Patient Factors

- Age
    - Risk of the rotator cuff failing to heal significantly increases with age
    - Patients over the age of 65 have a 43% chance of healing their tendon [3]
    - Increased age at rotator cuff repair predicts need for revision rotator cuff repair [13]
- Osteoporotic bone [6]
    - Bone mineral density (BMD) found to be an independent risk factor for rotator cuff healing
        - 9% failure for BMD > -1
        - 30% for BMD between -1 and -2.5 (osteopenia)
        - 42% for BMD < -2.5 (osteoporosis)
- Comorbidities
    - Patients with more comorbidities have significantly increased risk for revision rotator cuff surgery [13]
    - Diabetes has been shown to be an independent risk factor for rotator cuff failure
- Smoking
    - Detrimental to healing rates [14]
    - Cigarette smoking is positively correlated with presence of tear, as well as tear size [15]
    - After rotator cuff repairs, non-smokers found to have significantly improved postoperative UCLA scores than smokers [15]

Intraoperative Factors

The goal of rotator cuff surgery is to anatomically restore the rotator cuff to its insertion in a tension-free fashion. While there are multiple strategies for accomplishing this goal, we have found the following strategies to be useful in our clinical practice.

Single-Row vs. Double-Row vs. Transosseous Equivalent

Double-row and transosseous fixation have demonstrated higher initial fixation compared with single-row techniques in cadaveric experiments. [15] However, clinical outcomes in randomized trials comparing double-row and single-row techniques have demonstrated equivalency.

- A randomized controlled trial did not demonstrate differences in quality of life or function between single-row and double row techniques. [9]
- Double-row fixation was found to have higher healing rates. [17]
- Higher healing rates have also been demonstrated with double-row fixation in massive rotator cuff tears. [18,19]
- A definitive study showing equivalence in revision repair rates has not yet been performed.

Recommendation

We make the following recommendations:

- Single-row fixation is adequate for small- to medium-sized rotator cuff tears.
- The transosseous equivalent technique should be used for larger tears.

Technique

Positioning

- Beachchair position optimal for visualization of cuff (Figure 1)
- Bump placed at medial border of scapula to bring shoulder forward and provide stability
    - Consider the use of arm positioner (Trimano, Arthrex, Naples, FL; Spider, Smith and Nephew, Memphis, TN) to alleviate need for multiple assistants
- Allow for forward elevation, abduction, and internal and external rotation to bring affected area into view
- Consider well-padded skin traction to increase subacromial space

Figure 1. Beach chair position (top). Move patient lateral on operating table to provide adequate exposure of the shoulder (bottom).

Visualization

- Hypotensive anesthesia to facilitate intraoperative visualization
    - Placement of a brachial plexus block may help with intraoperative blood pressure control for improved visualization
- Portal placement: We use posterior, anterior, lateral, and accessory lateral portals (Figure 2)
    - In suspected rotator cuff tears, the posterior portal may be established at a higher position than used for intra-articular pathology; facilitates access to the subacromial space
    - Lateral portal should be placed 1.5-2 cm lateral to the lateral edge of the acromion; commonly placed too superiorly, resulting in difficulty visualizing the rotator cuff
- Identified pathology will dictate accessory portal placement
- Use of an 18-gauge spinal needle will help optimize accessory portals
    - Spinal needle should be used to ensure satisfactory placement and trajectory of planned anchors
- Acromioplasty will help achieve space and visualization for subsequent repair
    - Avoid violating deltoid fascia to minimize swelling and fluid extravasation
- Subacromial space should be meticulously cleared of adhesions, fibrofatty, bursal tissue, and reactive synovitis
    - Goal is to provide an unobstructed view of the three major rotator cuff muscles (teres minor may be difficult to visualize)
    - Should include the lateral gutter and may be extended to the base of the coracoid anteromedially and the spine of the scapula posteromedially

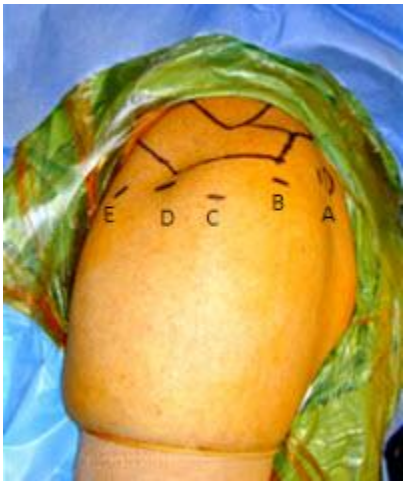

Figure 2. Portal placement: A, anterior portal; B, accessory anterolateral portal; C, lateral portal; D, accessory posterolateral portal; E, posterior portal.

Recognize Pathology

- Evaluate articular surface, biceps tendon, labral pathology
- Evaluate type of rotator cuff tear; often best assessed from lateral portal (Figure 3)
    - Partial-thickness tears
        - Can be either articular or bursal sided
        - If more than 50% of tendon is torn, complete tear and treat as cresenteric tear
    - Cresenteric tear
        - Excellent medial to lateral mobility; will reduce to the greater tuberosity
        - Amenable to direct repair to bone
    - U-shaped tear
        - Poor medial to lateral mobility, but excellent anterior to posterior mobility
        - Amenable to margin convergence technique
    - L-shaped tear
        - Assess mobility of anterior and posterior leafs
        - Amenable to margin convergence technique
    - Subscapularis tear
        - Identify “comma sign” (arc formed by the coracohumeral ligament and superior glenohumeral ligament)
        - Will help in identifying the superolateral corner of the torn subscapularis tendon (Figure 4)

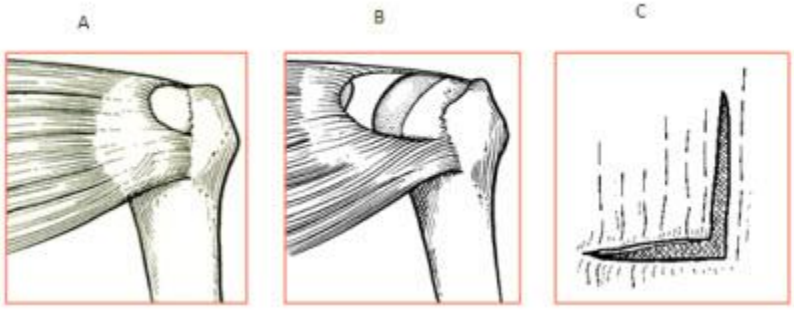

Figure 3. Tear configuration: A, crescent tear; B, U-shaped tear; C, L-shaped tear.

Figure 4. View from the posterior portal, subscapularis tear visualized (SubS = subscapularis; C = coracoid; G = glenoid).

Tendon Mobilization

- Goal of tendon mobilization is tension-free repair to greater tuberosity
    - Failure to mobilize tendon may result in tension overload of the medial row and failure of fixation [20]
- Tendon mobility assessed intraoperatively with an arthroscopic grasper through the lateral portal
- Tendon should be pulled in the direction of its fibers and easily reduce to the greater tuberosity to cover the anatomic footprint
    - Inability to achieve coverage of the anatomic footprint suggests arthroscopic releases will be required

Releases

- Release all adhesions between tendon and acromion
- Superior capsular release for poor supraspinatus mobility
    - Capsule is released from rotator interval anteriorly to scapular spine posteriorly
- Rotator interval can be resected to the base of the coracoid
- Traction stitch through tendon may assist in identifying and resecting adhesions
- Interval slide in continuity [21]
    - Used for massive contracted tears involving the subscapularis and the posterior superior rotator cuff
    - Steps
        - Skeletonize posterolateral coracoid with a shaver or cautery probe through lateral portal
        - Traction stitch through subscapularis may improve visualization
        - Place subscapularis under traction with suture, which will bring the rotator interval into view
        - Resect medial aspect of the rotator interval with a shaver, creating a “window” but preserving lateral aspect of the rotator interval, maintaining continuity between subscapularis and supraspinatus

Preparation of Greater Tuberosity

- Use electrocautery device and/or arthroscopic shaver (Figure 5)
    - Light decortication to create bleeding cancellous bone bed
        - Aggressive decortication may decrease pullout strength of anchors
        - Consider using burr on reverse to minimize bone resection.

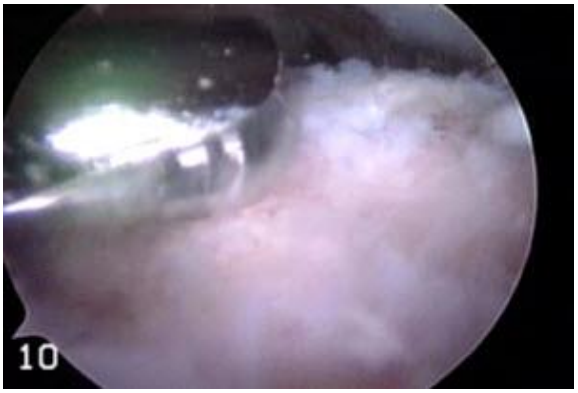

Figure 5. After ablation of the soft tissue on the greater tuberosity with a radiofrequency device, the footprint is gently decorticated with an arthroscopic burr. Consider using the burr on reverse to avoid aggressive bone resection.

Anchor Placement

- Should be at 45° as described by Burkhart (Figure 6)
- Maximize pullout strength and minimize suture tension
    - May be less important with double-row technique

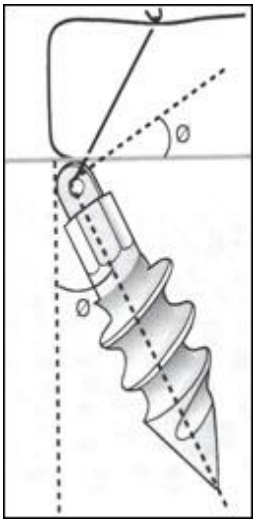

Figure 6. Anchor placement: Dead man's angle is at 45° to the tangent of the greater tuberosity.

Subscapularis Repair

- Should be performed before repair of posterior cuff
- Most subscapularis repairs performed with single-row technique
- A 70°, arthroscopic scope may be useful in visualization
- Diagnosis made by identification of "comma sign;" represents coracohumeral ligament
    - Comprised of superior glenohumeral ligament and coracohumeral ligament that forms the medial pulley of the biceps; represents superolateral edge of subscapularis
- Subscapularis repair should be considered for any tear involving more than superior third of the tendon
    - Should be addressed prior to fixation of any other rotator cuff tears
- Any involvement of the biceps or biceps instability should be addressed with biceps tenotomy or tenodesis (Figure 7)
- Rotator interval is resected through anterior portal

- Coracoidplasty may be considered to provide extra space for technical aspects of the repair and to minimize postoperative impingement of subscapularis
    - Expose posterolateral tip of coracoid with a radiofrequency device, followed by resection of the tip with an arthroscopic burr (Figure 8)
- Careful debridement of degenerated tendon margin
- Establish antero-lateral portal with 18-gauge needle localization to ensure satisfactory access to anterior shoulder structures
- Traction stitch outside cannula through accessory superolateral portal; useful during suture passage
- Tendon mobilization performed with:
    - Intra-articular release between inferior and middle glenohumeral ligament and subscapularis
        - May proceed to anterior scapular bone without neurologic risk
    - Superior margin release of subscapularis
    - Release adhesions between coracoid and subscapularis
        - Anterior to subscapularis, do not release tissue medial to margin of coracoid aponeurosis to avoid neurovascular compromise
- Light abrasion of lesser tuberosity and subscapularis footprint
- One or two anchors placed through anterior portal (Figure 9)
- Pass sutures via superolateral accessory portal with suture passage device of choice (Figures 10-11)
- Sutures tied in inferior to superior direction (Figure 12)

Figure 7. Biceps tendon demonstrates medial instability with probe (B = biceps tendon; H = humeral head).

Figure 8. Posterolateral tip of the coracoid is liberated of all soft tissue with radiofrequency ablation device (C = coracoid).

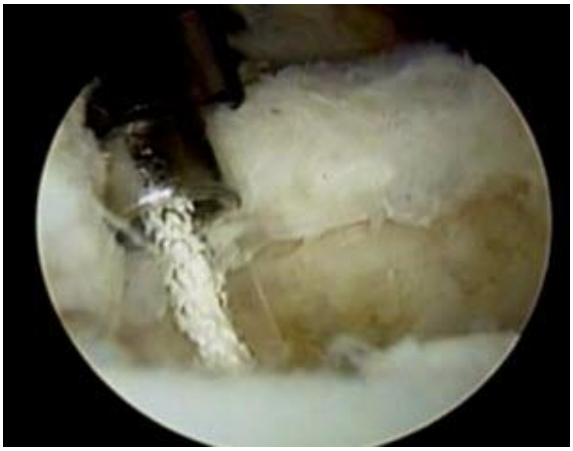

Figure 9. Anchor is placed at the superior margin of the subscapularis footprint.

Figure 10. Suture passing device used to pass shuttling PDS suture through subscapularis tendon (SubS = subscapularis; H = humeral head).

Figure 11. PDS suture is used to shuttle non-absorbable suture through subscapularis tendon (SubS = subscapuarlis).

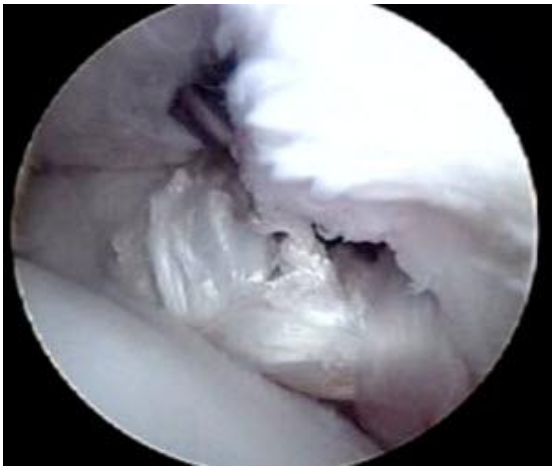

Figure 12. Repaired subscapularis tendon.

Transosseous Equivalent (TOE) Technique

- Useful for medium to large crescent-type tears (Figure 13)
- Ensure adequate preparation of greater tuberosity
- Medial anchors placed just lateral to articular surface (Figure 14)
    - Usually two medial anchors required, anterior and posterior
- Both limbs of each suture passed approximately 1-1.5 cm medial to the lateral edge of tendon (Figure 15)
    - Limbs should be passed lateral to musculotendinous junction
- One limb each from anterior and posterior anchors are subsequently passed through an interfence-type screw into lateral cortex of greater tuberosity, just lateral to lateral edge of tendon in line with posterior medial anchor (Figure 16)
    - Anterior limbs are similarly passed through an interference anchor placed just lateral to anterior medial anchor
- Completed repair compresses tendon against anatomic footprint in a criss-cross fashion (Figure 17)

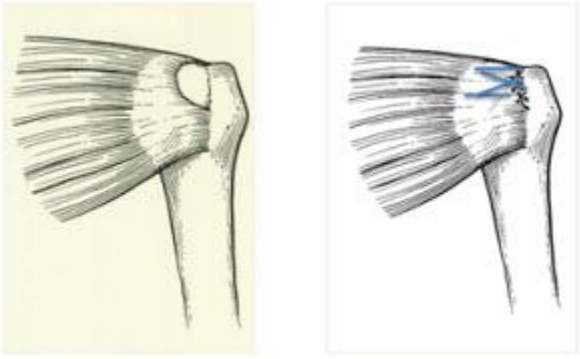

Figure 13. Crescent-type tear repair strategy.

Figure 14. Transosseous equivalent repair. Two medial row anchors are placed just lateral to articular margin (GT = greater tuberosity).

Figure 15. Transosseous equivalent repair. Sutures from medial row are passed through medial aspect of supraspinatus, lateral to musculotendinous junction.

Figure 16. Transosseous equivalent repair, placement of lateral row. One suture end from each of the medial anchors is placed through an interference screw and placed lateral to the posterior medial anchor.

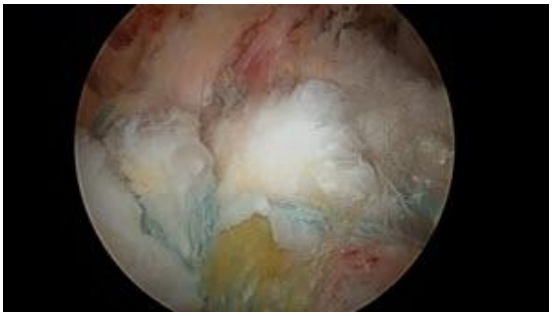

Figure 17. Completed transosseous equivalent repair.

Margin Convergence

- Indicated in U-shaped and L-shaped tears: significant medial to lateral gap, lateral tendon edge not reducible to anatomic footprint after adequate release (Figure 18-19)
- Posterior and anterior leaves of rotator cuff are brought together with a side-to-side non-absorbable suture
- Best performed with arthroscope in lateral portal and a tissue penetrator used to transport suture across tissue
- Usually two to four side-to-side sutures required
    - Suture passed from posterior to anterior direction (Figure 20)
    - Tie in medial to lateral fashion (Figure 21-22)
- Lateral tissue margin then fixed to the greater tuberosity through anchors (Figure 23)

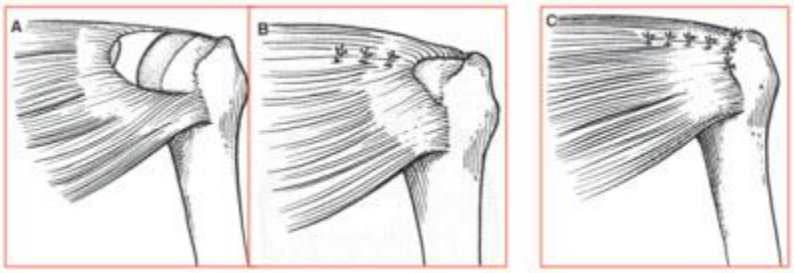

Figure 18. U-shaped tear repair strategy. Begin with anterior to posterior sutures. The lateral tendon edge is then repaired to the greater tuberosity.

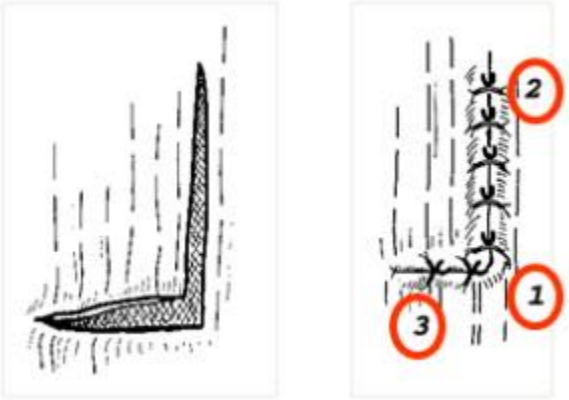

Figure 19. L-shaped tear repair strategy. Begin with an anchor placed at the elbow of the tear (if possible). Then perform side-to-side repair in medial to lateral fashion. Finally, repair lateral tendon edge to greater tuberosity.

Figure 20. Margin convergence, repair of U-shaped tear. Penetrating suture passing device used to pass non-absorbable suture from posterior to anterior.

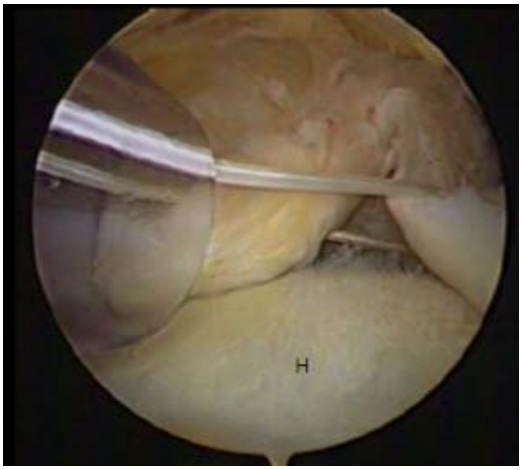

Figure 21. Both ends of suture brought out through lateral cannula and tied (H = humeral head).

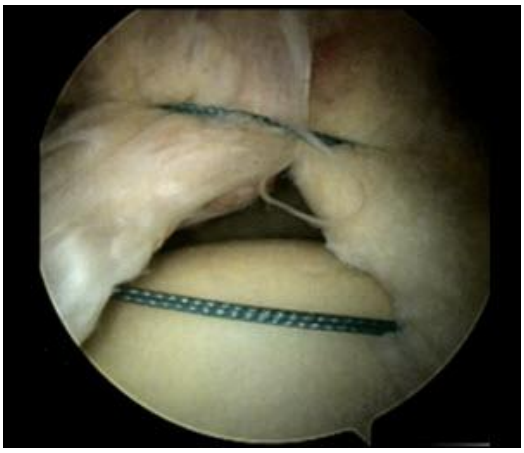

Figure 22. Subsequent suture passage is performed lateral to first suture, again from a posterior to anterior direction.

Figure 23. Final side-to-side repair demonstrates three side-to-side sutures. The lateral leaf of the cuff can be subsequently fixed to the greater tuberosity with single or double row anchor repair (GT = greater tuberosity).

Biologic Augmentation

- Platelet rich plasma (PRP)

    - Most high-level evidence suggests that PRP does not improve outcomes [22]
        - One study demonstrated a lower rate of retears by MRI [23]
        - One study found PRP may be beneficial in large to massive rotator cuff tears, but not in small to medium ones [24]
- Porcine xenograft [25]
    - Has not been shown to improve outcomes
    - Associated with postoperative inflammatory reactions
- Human dermal matrix allograft
    - Several studies have demonstrated improved outcome measures as well as healing by MRI compared with control groups [25-28]

Suture Management

- Consider use of traction stitch or use of grasper to pull tendon laterally and maintain tension while suture is passed
- All sutures should be separately clamped together before and after passage through tendon to avoid entanglement
- To assist in suture management, unpassed sutures may be placed through a portal, but outside the cannula
    - Unused sutures are placed through a cannula, a switching stick is placed through a cannula, the cannula is removed, and the sutures are removed from the cannula; cannula is replaced over the switching stick

Knot Tying

- Knot and loop security are prerequisite for rotator cuff healing
- Consider knotless anchor technique if uncomfortable with arthroscopic knot tying

Postoperative Factors

- Abduction pillow may minimize tension across repair and potentially improve vascularity to rotator cuff
    - Acceptable to remove immobilization for supervised therapy
- Cryotherapy minimizes postoperative pain medication requirements
- Postoperative protocol: Early vs late motion
    - In a prospective, randomized controlled trial between early and delayed range of motion (passive forward elevation to 120° allowed at 6 weeks), no difference in clinical outcomes without a significant difference in healing rates by ultrasound [29] (Table 1)
        - No patients required a postoperative capsular release
    - Other studies advocated for 6 weeks of sling immobilization, as it did not alter postsurgical stiffness [30]
- Traumatic failure
    - Fall
    - Non-compliance
        - Workers compensation cases noted to have increased non-complicance and worse outcomes [31]
    - Aggressive early motion
        - Initiation of early active glenohumeral management may compromise tendon healing

Table 1. Need Title

	Phase I	Phase II	Phase III	Phase IV
Approximate initiation	0-6 weeks	4-8 weeks	8-12 weeks	12-16 weeks
Primary goal	Protect repair	Establish neuromuscular control	Initial rotator cuff strengthening	Return to full activities
Secondary goal	Minimize adhesions	Eliminate abnormal substitution patterns		Advanced rotator cuff strengthening
Activities	• AROM hand, elbow, wrist • Gentle shoulder PROM • No AROM • Should be therapist guided; use of pulleys may activate muscles	• AAROM: Supine FF, ER, IR with cane • Prone scapulothoracic exercises • Failure to establish normal ST motion may allow impingement to re-emerge	• Isotonic and closed chain exercises • All initial strengthening below shoulder level	• Exercises performed in 90° abduction • Dynamic stabilization • Pliometics at end of phase

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References