

All-Arthroscopic Patch Augmentation of a Massive Rotator Cuff Tear: Surgical Technique

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Abstract: Surgical management of massive rotator cuff tears remains challenging, with failure rates ranging from 20% to 90%. Multiple different arthroscopic and open techniques have been described, but there is no current gold standard. Failure after rotator cuff repair is typically multifactorial; however, failure of tendon-footprint healing is often implicated. Patch augmentation has been described as a possible technique to augment the biology of rotator cuff repair in situations of compromised tendon quality and has shown promising short-term results. The purpose of this article is to describe our preferred surgical technique for arthroscopic rotator cuff repair with patch augmentation.

Surgical management of massive rotator cuff tears remains challenging, and failure occurs in 20% to 90% of patients.^{1,2} Multiple surgical techniques have been described; there is no current gold standard. Treatment options include debridement with possible biceps tenotomy/tenodesis, partial repair, muscle transfer, tissue interposition, and repair with patch augmentation. Other potential solutions include hemiarthroplasty and reverse total shoulder arthroplasty; however, these solutions are not ideal for young patients with minimal glenohumeral articular disease. Patch augmentation has

been described as a technique to augment the biology of rotator cuff repair (RCR), with promising short-term results.³⁻⁵

Arthroscopic RCR with patch augmentation is best used in situations involving poor tissue quality with massive rotator cuff tears, tears of 2 or more tendons, and failed primary repair and/or revision rotator cuff surgery (Table 1). The purpose of this article is to provide our preferred surgical technique for arthroscopic RCR with patch augmentation. We postulate that this stepwise approach (Table 2)—which involves carefully selected portal placement—facilitates ease of suture passage, organization, and patch fixation while avoiding the morbidity of an open approach.

Surgical Technique

The patient is placed in the beach-chair position. General endotracheal anesthesia and supraclavicular regional blockade are typically used. After preparation and draping, a posterior portal is established 1 cm medial and 2 cm distal to the posterolateral corner of the acromion. The position of this portal is proximal and lateral to the standard posterior portal. This “higher” position facilitates subacromial work. A working portal is then established in the anterosuperior rotator interval by use of an outside-in technique. Diagnostic arthroscopy is commenced, and all associated glenohumeral pathology is addressed. The subscapularis is thoroughly inspected, and if necessary, subscapularis repair is completed.

The arthroscope is introduced into the subacromial space. A lateral portal is created at the midpoint

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Table 1. Indications and Contraindications to Arthroscopic RCR With Patch Augmentation

Relative Indications	Relative Contraindications
Poor tissue quality with massive rotator cuff tears (i.e., ≥ 2 tendons)	Active infection
Failure of primary repair or revision rotator cuff surgery (or both)	End-stage degenerative joint disease
Patient goals of pain relief and improved active elevation	Muscular atrophy of Goutallier stage II or greater
Adequate remaining tissue to allow repair	Patient goals of returning to preinjury shoulder
Young individuals for whom arthroplasty is a poor option	Irreparable tears in which the patch functions as a "bridge," which may be better treated with an open technique

between the anterior and posterior aspects of the acromion. A thorough subacromial bursectomy is performed. Bursectomy is critical to gain appropriate visualization. The rotator cuff musculature and tendon can then be mobilized by releasing any adhesions, especially within the rotator interval and supraglenoid recess. Adequate cuff mobility reduces shear stress on the traumatized tissues. Cuff mobility is assessed by pulling laterally and anteriorly on the supraspinatus and infraspinatus tendons separately and ensuring that the lateral margin of the tendon can be reduced to the greater tuberosity without significant tension with the arm in neutral abduction and rotation. Although previous authors have described successful results for bridging a gap between a medially retracted rotator cuff tear and the tuberosity with a patch, this use is considered off-label by the US Food and Drug Administration.^{4,5} The arthroscopic technique described in this article is used to augment repairable tears,³ not to bridge irreparable tears. The tuberosity is prepared with a shaver and burr while care is taken not to violate the cortex. To reduce tension on the repair, up to 3 to 5 mm of medialization of the footprint can be performed by removing the lateral-most cartilage. Accessory anterolateral and posterolateral portals 3 cm off of the anterolateral and posterolateral corners of the acromion can aid in the procedure.

The infraspinatus can commonly be repaired without patch augmentation by a single-row technique (Table 3, Video 1). An anchor is placed in the posterior tuberosity

Table 2. Surgical Steps in Arthroscopic RCR With Patch Augmentation

1. Perform diagnostic arthroscopy
2. Remove subacromial bursa
3. Mobilize rotator cuff
4. Prepare tuberosity
5. Repair infraspinatus
6. Place anchors and pass sutures through supraspinatus
7. Measure tear size and cut patch to size
8. Pass sutures through patch outside shoulder
9. Feed patch through lateral cannula
10. Position patch and tie medial row with lateral traction
11. Provisionally fixate patch with spinal needles
12. Place lateral row
13. Perform full passive range of motion to assess tension

by use of an accessory portal adjacent to the posterolateral border of the acromion. Sutures are then passed through the infraspinatus with a sharp-tipped penetrator. The supraspinatus tendon is repaired with double-row, transosseous-equivalent fixation with patch augmentation (Conexa; Tornier, Bloomington, IN). After percutaneous placement of the anterior and posterior medial anchors (Twifix; Smith & Nephew, Memphis, TN) at the articular margin, sutures are passed through the medial aspect of the supraspinatus in a horizontal mattress configuration spaced 3 to 5 mm apart. The anterior and posterior mattress sutures should be blue if the middle 2 mattress sutures are white, or vice versa, to facilitate placement in the corners of the patch. The infraspinatus repair can then be completed by conventional arthroscopic knot-tying techniques. The anterior-to-posterior and medial-to-lateral dimensions of the residual cuff and footprint are measured with a graduated probe. The patch is then cut to fit the dimensions of the rotator cuff medially and the footprint laterally (Fig 1).

The anterior limb of the anterior mattress suture is brought through the anterior cannula, and the posterior limb of the posterior mattress suture is brought through the posterior portal. The remainder of the sutures are then brought through the lateral cannula from anterior to posterior sequentially and passed through the medial border of the patch in the same order with the same spacing as they have been passed through the cuff. At this point, the posterior limb of the anterior mattress suture (differently colored than the inner sutures) should pass through the lateral cannula and then through the anteromedial corner of the patch. The anterior limb of the posterior mattress suture will pass in a similar configuration through the posteromedial corner of the patch. A shorter length of suture is left on the patch side, and a mulberry knot is tied behind the patch for the anterior and posterior corners. These knots will allow the corner sutures to drag the patch into the subacromial space. After all sutures have been passed (Fig 2), the patch is then rolled and fed into the lateral cannula by use of gentle tension on the free limbs of suture through the anterior and posterior cannulas. Once the patch passes into the subacromial space, these sutures should act as kite strings to facilitate unfurling of the patch into the correct orientation.

Table 3. Technical Pearls and Pitfalls for Arthroscopic RCR With Patch Augmentation

Pearls	Pitfalls
Perform an extensive subacromial bursectomy.	Inadequate bursectomy can impede visualization.
Mobilize the rotator cuff to reduce shear stresses on the tendons and improve excursion.	Inadequate mobilization can prevent primary repair or place excess tension on the repair.
If necessary (i.e., in cases with limited cuff mobility), the surgeon can medialize the footprint 3 to 5 mm to reduce tension on the repair.	An inappropriately sized patch will impede a complete repair.
Measure the defect with a probe so that the patch can be cut to the appropriate size.	Failure to use cannulas can easily lead to tissue bridges.
Careful suture organization is necessary. The use of differentially colored suture and applying clamps to paired sutures in sequential fashion can help.	Bunching of the patch may lead to subacromial impingement of the patch or maceration.
Place lateral traction on the patch while tying the medial row to avoid bunching.	Failure to bring the medial-row sutures through the lateral cannula and the patch sequentially can lead to crossed sutures.
Use percutaneous spinal needles at the corners of the patch during placement of the lateral row to ensure that the patch lies flat.	Failure to replicate the spacing of the sutures in the cuff during placement of the sutures through the patch can lead to bunching.

The medial-row repair can then be tied while a grasper holds traction on the lateral edge of the patch to avoid bunching. Because the medial-row sutures pass through the anchor, cuff, and patch, tying these sutures repairs the cuff to the tuberosity. The anterior and posterior sutures can be tied with the mulberry knot in place, or alternatively, the suture can be retracted and the mulberry knot cut before tying. Percutaneous spinal needle placement can also be used to hold 1 edge of the graft-cuff junction down as the opposite side is tied.

To complete the lateral-row repair, the lateral corners of the patch are fixed with percutaneous spinal needles

impacted into the humerus to avoid bunching. The lateral humeral cortex is then cleared of soft tissue, and 1 suture limb from each knot of the medial row is then crossed and incorporated into anterior and posterior knotless lateral-row anchors (Footprint PK; Smith & Nephew). The arm is brought through passive range of motion to ensure appropriate construct tension without gap formation (Fig 3).

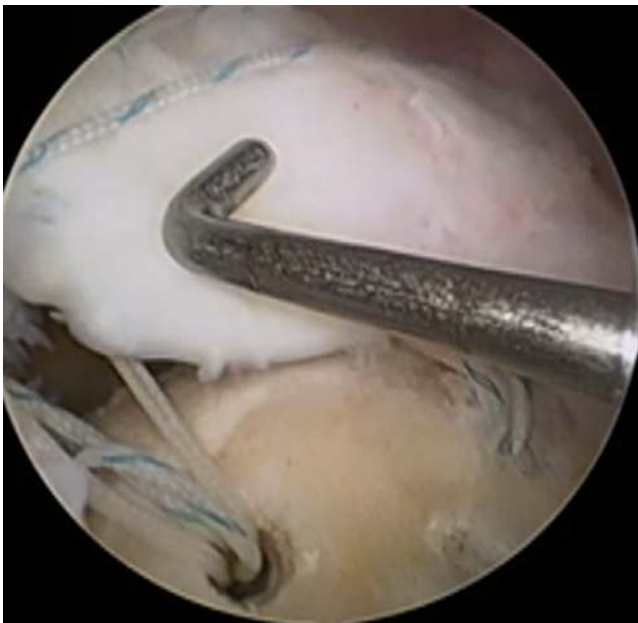


Fig 1. The subacromial space of a patient in the beach-chair position with the camera in the lateral portal after bursectomy, cuff mobilization, tuberosity preparation, medial-row anchor placement, suture passage, and infraspinatus repair, with an arthroscopic graduated probe measuring tuberosity dimensions to ensure proper patch sizing.

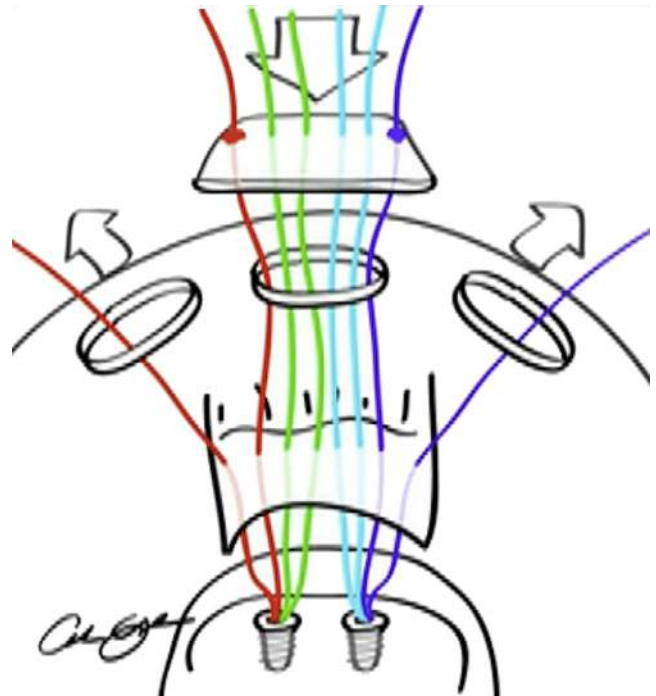


Fig 2. Placement of the sutures through the cuff and the patch in preparation for passage of the patch into the subacromial bursa. As shown, the anterior limb of the anterior mattress suture is passed through the anterior cannula, the posterior limb of the anterior mattress suture is passed through the anteromedial corner of the patch, and a mulberry knot is tied behind the patch to allow the suture to be used to drag the patch into the bursa. A similar procedure is performed for the posterior mattress suture.

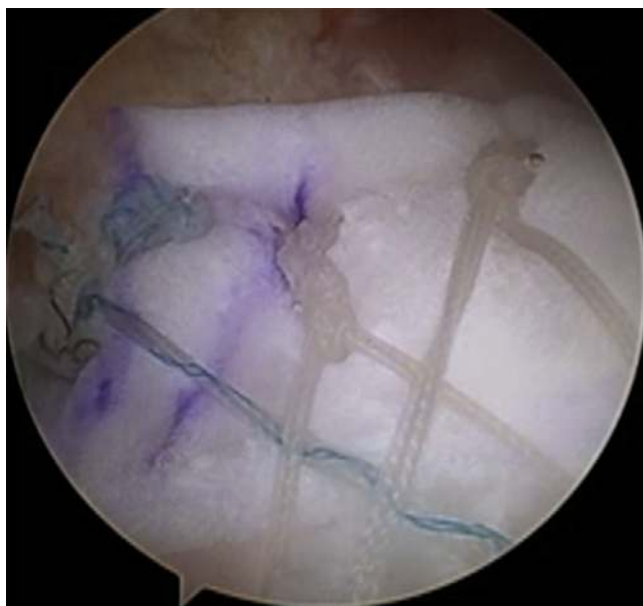


Fig 3. Arthroscopic image of the completed arthroscopic transosseous-equivalent RCR with patch augmentation as viewed with the camera in the lateral portal and the patient in the beach-chair position.

Postoperatively, patients are immobilized in a sling with an abduction pillow. Immediately postoperatively, patients begin pendulum and passive range-of-motion exercises. At 6 weeks postoperatively, sling use is discontinued and patients begin active-assisted range of motion. At 8 weeks, patients begin active range of motion and isometric rotator cuff strengthening, with progression toward return to full activity at 6 months postoperatively.

Discussion

Outcomes after RCR vary widely in the literature, with several factors—including patient age, comorbidities, tear size, tissue quality, degree of muscle atrophy, and chronicity of the tear—influencing both the clinical and radiographic outcomes. Despite recent advances in both diagnostic modalities and surgical techniques, the failure rate after RCR for tears of significant chronicity and poor tissue quality still remains high.² Often, clinical results do not correlate with radiographic results, further confounding outcome interpretation. Anatomic repair with footprint healing is correlated with better outcomes, and thus surgical techniques must focus on maximizing the cuff healing ability. The integrity of the repair construct can be compromised by poor tissue quality and substantial stresses placed on the repaired tendon-bone interface.⁶ In massive cuff tears, biologic augmentation of the repair may be helpful by strengthening the repair, adding collagen to the construct, and providing for a more anatomic repair.^{3-5,7}

Advantages of this all-arthroscopic technique include less potential for arthrofibrosis, lower rates of infection,

and decreased damage to the deltoid. In addition, no special equipment is required to perform this technique. Risks and limitations include potential maceration or twisting of the patch during passage, extended operative time, and high technical demand on the surgeon.

A variety of biologic and bioengineered RCR augmentation techniques have been described. When used for RCR augmentation, early clinical results have been promising; however, these materials run the risk of causing inflammatory reactions and potentially resorbing over time.⁸ Newer tissue processing and sterilization techniques, however, have mitigated these drawbacks and have shown minimal complications in animal and human studies.^{1,9,10}

Overall, surgical management of massive rotator cuff tears remains challenging, with failure rates ranging from 20% to 90%. Patch augmentation using the technique described in this article is an option in the treatment of massive cuff tears. Our technique, involving appropriate rotator cuff releases, careful and systematic portal placement, and sequential suture management, enables successful augmentation of difficult-to-treat rotator cuff tears that would otherwise require open management. Further clinical studies are needed to determine the long-term clinical outcomes and survivorship of such a technique.

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