Basics of Arthroscopic Rotator Cuff Repair

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ABSTRACT

Traditional methods of open and mini-open rotator cuff repairs have shown excellent results in short- and medium-term follow-up and remain viable methods of treating rotator cuff pathology. A trend toward the arthroscopic repair of rotator cuff tears continues, however, and will probably accelerate as the next generation of surgeons is trained in arthroscopic treatment methods. The purpose of this article is to provide an overview of the arthroscopic treatment of rotator cuff repair with an emphasis on technique. An understanding of the principles of rotator cuff repair and arthroscopy serves as a basis for a step-by-step approach to arthroscopic rotator cuff repair.

Keywords: rotator cuff, arthroscopy, arthroscopic repair, technique, arthroscopic rotator cuff, arthroscopic rotator cuff repair, arthroscopic repair, rotator cuff tear, repair technique, mini-open, transition, basic, rotator, cuff repair

BACKGROUND

The principles of rotator cuff repair include: (1) minimal deltidoid disruption; (2) meticulous and secure repair of the deltidoid origin if it is taken down; (3) adequate decompression of the subacromial space; (4) careful evaluation of the tear size and configuration, tendon involvement, tendon quality, and tendon retraction; (5) secure fixation of the tendon to its bony origin, with appropriate mobilization and side-to-side repair, as necessary; and (6) careful, supervised rehabilitation to maintain shoulder motion while protecting the repaired tendon. These principles apply universally to rotator cuff repair. The different repair methods available vary in the technique used to visualize the torn cuff and allow its repair. Arthroscopic techniques are attractive because they minimize disruption of the deltidoid and, theoretically, allow for faster recovery time with less surgical morbidity. However, arthroscopic repair is technically challenging. Surgeons new to the technique may find adequate visualization and secure fixation difficult to achieve. Here, we provide a basic approach to performing arthroscopic evaluation and repair of the torn rotator cuff. There are multiple variations in technique, of course, but for our purpose, we will describe a technique that we believe is relatively straightforward, can be approached in a stepwise fashion, and with which we have had good success. Once mastered, arthroscopic rotator cuff repairs provide results that seem to be equal to those obtained with open and mini-open procedures.1-9

TECHNIQUE

Positioning and Draping

The patient is brought to the operating room, and anesthesia is obtained. We use interscalene block combined with light sedation; general anesthesia can also be used in addition to or in place of regional anesthesia, per patient and surgeon preference. Once adequate anesthesia is obtained, an examination under anesthesia is performed to document full range of motion. Secondary stiffness may develop in patients with a rotator cuff tear, making it important to document adequate range of motion before the start of the procedure. If stiffness is noted, a manipulation may be performed at the very beginning of the procedure to release adhesions. Arthroscopic cuff repair is easily performed in either the beachchair or lateral decubitus position. Because we perform our repairs exclusively in the beachchair position, we will describe that technique. Beachchair positioning is obtained by flexing the table at the hips, bringing the back and thighs into a higher position than the buttocks. The table is flexed at the knees to a comfortable position. In the final position, the acromion shoulder be parallel to the floor and the buttocks should be below the thighs in the “V” of the bed (Fig. 1), preventing the patient from sliding down the bed. The head is held gently in place by one of various commercially available positioners that allow the table to be dropped away from behind the operative shoulder. It is imperative to have adequate space behind and medial to the operative shoulder to maneuver the arthroscope. Having the acromion parallel to the floor is important to allow a comfortable operating position and also aids in orientation: the cuff will be directly below the acromion when visualizing from the subacromial space (Fig. 2). Once positioning is adequate, the table is turned slightly with the feet pointed away...
from the operative side. The monitor is placed at the feet on the nonoperative side. Care should be taken with draping to prevent draping out the portal sites. Ideally, the patient should be draped to the medial border of the scapula posteriorly, to the middle of the clavicle anteriorly, and to the level of the nipple inferiorly (Fig. 3).

**Portal Placement and Diagnostic Arthroscopy**

The anatomy of the shoulder is marked for later orientation. The acromion, spine of the scapula, clavicle, acromioclavicular joint, and coracoid should all be marked (Fig. 4). The posterior portal is created and used for initial visualization. This portal is identified by first identifying the posterolateral corner of the acromion, which should be easily palpable. Next, a notch can be palpated along the spine of the scapula, about 2 cm medial to the posterolateral corner. This marks the mediolateral position of the portal. Next, the soft spot is palpated about 2 cm inferior to the notch. This spot is marked. An 18-gauge spinal needle is used to penetrate the joint and 30 mL of isotonic sodium chloride solution may be injected to distend it. This is optional but makes for easier penetration of the joint with a trocar. Next, an incision is made, and a blunt trocar is used to penetrate the posterior cuff and capsule. Take note: the trocar should point toward the coracoid, which means it will be angling in a lateral-to-medial direction as it is inserted. A distinct “pop” should be felt as the posterior capsule is penetrated. If the joint was previously distended with isotonic sodium chloride solution, fluid egress from the joint will further confirm its position in the joint. The camera is

**FIGURE 1.** The beachchair position. Note that the buttocks are dependent on the “V” of the table, and the acromion is parallel to the floor.

**FIGURE 2.** The subacromial space. The acromion is at the 12-o’clock position, and the cuff is at the 6-o’clock position. Obtaining adequate visualization is a combination of appropriate arm positioning and adequate bursectomy.

**FIGURE 3.** Setup. The patient should be widely draped to the medial border of the scapula posteriorly, and the arthroscopy screen is opposite the operative side at the foot of the bed. A Mayo stand holds the arthroscopic instruments.

**FIGURE 4.** Marking the shoulder before beginning the procedure. The acromion, spine of the scapula, clavicle, acromioclavicular joint, and coracoid are all drawn before beginning the procedure.
inserted, and an inspection of the glenohumeral joint is begun. Elements of inspection should include the glenoid and humeral cartilages, the anterior and posterior labra, the biceps tendon and anchor, the subscapularis, the supraspinatus and posterior cuff, and the axillary pouch. As the supraspinatus tendon is most often involved in degenerative cuff tears in older patients, special attention should be paid to careful examination of its insertion. The anterior insertion of the supraspinatus tendon is most often involved. Visualization can be maximized by placing the arm in abduction and slight external rotation (Figs. 5A, B). Still photographs and/or video documentation are made of all structures, whether or not pathology is identified.

An anterior portal should be created to allow probing and debridement of the rotator cuff. This portal should be located exactly in the middle of the rotator interval, midway between the subscapularis tendon and biceps tendon, and likewise midway between the curve of the humeral head and the glenoid. Position of this portal is facilitated by placing a spinal needle into the rotator interval before skin incision. The incision for this portal

**FIGURE 5.** Positioning the arm in external rotation and slight abduction (A) allows excellent visualization of the rotator cuff as visualized from inside the glenohumeral joint (B).

**FIGURE 6.** A, A lesion is identified at the anterior articular insertion of the supraspinatus. B, The tear is marked with a spinal needle. C, A suture is then passed through the spinal needle and brought out the anterior portal. D, In the subacromial space, the suture is identified, and the cuff is probed to determine the extent of the lesion.
is created midway between the coracoid and the anterolateral border of the acromion. A blunt obturator/cannula is introduced under direct visualization (outside-in technique). The torn edge of the cuff is lightly debrided to create an inflammatory/healing response. In some cases, it may be difficult to determine whether a rotator cuff tear is full or partial thickness. Partial-thickness tears often begin on the articular side of the joint as the shorter, articular-sided cuff fibers “pull away” from their insertion. In cases of partial-thickness or questionable full-thickness tears, an 18-gauge spinal needle should be introduced percutaneously through the area of cuff pathology, and a monofilament suture passed through the needle and into the joint. This marking suture is then grasped from the anterior portal, and both ends of the suture are clamped outside the body. Later, when the subacromial space is entered, the suture will serve as a marker of the area of pathology seen in the glenohumeral joint (Figs. 6A–D). Often, this area is covered with bursa, and the marking suture allows precise identification of the area of maximal pathology. In general, we consider repair in tears that are more than 50% in thickness, especially in young, laboring individuals. Practically speaking, this involves an evaluation of how thin the cuff feels from the bursal side in addition to an assessment of the loss of cuff fibers on the articular side.

The arthroscope is then removed from the glenohumeral joint, and the blunt trocar is used to enter the subacromial space. Visualization is often difficult at first because of bursitis and fibrosis. This must be accepted until a lateral portal can be created for bursectomy. The anterolateral portal is created about 3 cm posterior and

**FIGURE 7.** Bursectomy. A, Before bursectomy, the subacromial space is filled with bursal tissue, and visualization is difficult. B, After bursectomy and acromioplasty, the space is opened. C, Adhesions between the cuff and overlying deltoid are taken down in the lateral gutter. An adequate bursectomy is key to visualization.

**FIGURE 8.** Tear configurations. Tears may have almost any configuration, but larger tears commonly present as crescent shape (A), U shape (B), V shape (C), or L shape (D). Side-to-side repair is desirable as necessary to present a uniform free edge for repair to bone.
2 cm inferior to the anterolateral border of the acromion. The position of this portal should be posterior to the rotator cuff tear so that a second, more anterior, working portal can be placed directly over the cuff tear. A skin incision is made in Langer lines, and a 6-mm cannula is introduced and visualized in the subacromial space. A shaver or arthroscopic electrocautery device is used to create an initial working space for visualization. There has been some controversy about the necessity of performing a subacromial decompression in the context of a rotator cuff tear. We perform a thorough subacromial decompression, release the coracoacromial ligament, and perform an acromioplasty before cuff repair, except in irreparable tears or nonoutlet impingement tears. The tear is identified using the previously placed marking suture, and further debridement is undertaken in the lateral gutter of the subacromial space. A lateral bursectomy will facilitate visualization of the tear. Problems with visualization are generally the result of inadequate bursectomy (Figs. 7A–C). The tendon edges may again be lightly debrided with a shaver. The insertion site of the rotator cuff is identified and cleared of soft tissue.

Attention should be paid to careful evaluation of the character of the tear. Larger tears can take a number of configurations, including L shape, U shape, and V shape. The presence of delamination should be noted, and all layers should be included in the final repair. It is worth the time to carefully evaluate the tear shape and tissue quality to allow for planning of the repair (Figs. 8A–D). Smaller tears tend to be crescent-shaped and based at the anterior insertion of the supraspinatus. The cuff edge should be grasped from the lateral portal and reduced to its intended insertion to evaluate mobility and the quality of the tendon tissue. The ultimate goal of evaluation is to determine (1) cuff elasticity and potential for mobilization and (2) the best position of anchors and side-to-side sutures for a repair. Principles include securing the cuff to its anatomical insertion where possible,
minimizing tension across the entire repair and restoring coverage of the humeral head. Side-to-side sutures are used as needed depending on the tear configuration, but especially with large L-, U-, or V-shaped tears. The principle of margin convergence may be applied in circumstances where the tear cannot be anatomically reduced to its bony insertion in conjunction with bony fixation of the free cuff edge (Figs. 9A–E). An irreparable rotator cuff tear is present in the case of a large or massive tear with retraction, immobility, and poor tissue quality.

After a thorough evaluation of the tear, attention is turned to creation of a second lateral portal. We generally repair the cuff while visualizing through the lateral portal, which gives a direct view of the tear (Figs. 10A, B). A second anterolateral portal serves as the working portal through which instrumentation and knot tying will be performed. Creation of the second, more anterior working portal is facilitated by percutaneous placement of a spinal needle (Fig. 11). Attention should be given to placing the 2 lateral portals far enough apart so that they do not interfere with each other. The more anterior working portal is placed just off the anterolateral corner of the acromion to allow enough working space between this cannula and the lateral arthroscopic visualization portal. An incision is then made, and a large-diameter cannula is placed. We generally use a 6-mm screw-in cannula. Note that the position of the arm is critical to allow adequate visualization (Fig. 12), especially in large tears where the entire tear cannot be visualized at once.

Repair

Before repair, ensure the following: (1) excellent visualization with the scope placed in the more posterior of the 2 lateral portals; (2) a second, more anterior cannula in place directly over the tear; (3) and a mobile cuff and a general plan for the repair, including placement of suture anchors and the need for side-to-side repairs. The most common problem at this point is residual bursa
or adhesions between the deep deltoid fascia and cuff obscuring visualization from the lateral portal. If this is the case, use a shaver or electrocautery device from the posterior or anterior portal until visualization is not just adequate but excellent (Fig. 13). Now, grasp the cuff from the anterior portal and bring it to the position of the first anchor (Figs. 14A, B). Some authors place a traction stitch through the cuff before beginning repair. The traction stitch allows evaluation of the mobility of the cuff without the need for an instrument to be present in one of the cannulas, allowing traction to be placed on the cuff while instrumenting. We generally repair larger tears from posterior to anterior because the posterior cuff tends to be more mobile. For smaller tears, a single suture anchor is often used. Larger tears may require multiple suture anchors, and as a general rule, we use 1 to 2 anchors for each centimeter of tear size.

After the position of the anchor is confirmed, instruments are placed through the more anterior lateral working portal, and the anchor is placed. Again, we place the most posterior anchor first, as a rule, but this may vary depending on the tear size and configuration. The choice of anchor is a matter of surgeon preference. However, the use of metallic suture anchors makes subsequent magnetic resonance imaging difficult to interpret. In light of a well-established risk of re-tear, we believe that using a bioabsorbable anchor is more acceptable to patients and makes it possible to use magnetic resonance imaging to evaluate the repair postoperatively. We use a double-loaded anchor, although triple-loaded anchors are also available. Attention is now turned to suture passing.

There are 4 suture limbs projecting from the anchor, 2 from each suture. The more posterior suture is identified, and the post limb from this suture is the limb facing the cuff. The post limb is left in the anterior working cannula, through which the anchor is inserted. The other 3 suture limbs are taken out through a direct anterior or posterior portal (sometimes referred to as a holding portal) using a grasper. The posterior post limb is now the only suture remaining in the anterolateral working portal. It is critical to have only the post suture in the working cannula when it is passed. This will

![FIGURE 14. Determining the position of anchors. The cuff is grasped (A) and brought to its intended insertion site (B) to determine exactly where the anchor should be placed.](image)

![FIGURE 15. The suture passer is introduced (A), and the cuff is penetrated (B). The loop from the Suture Lasso is passed into the joint (C) and taken out the anterolateral portal, where the post is threaded through it. The Suture Lasso is then withdrawn from the posterior portal, drawing the post strand through the cuff (D). The result: the post has a large bite of tendon (E, F). An arthroscopic knot is then tied and cinched down (G) and backed up with multiple half hitches (H). In this example, tying was done through a posterior portal instead of the anterolateral portal.](images)
avoid tangling and frustration. The cuff is penetrated with a suture-passing device, and a suture relay method is used to pass the post limb through the tissue.

There are many options to pass suture through the rotator cuff, and most companies have at least one and often multiple devices to accomplish this task. Generally, there are 3 methods of suture passing. First, antegrade single-pass devices (Smith and Nephew ElitePass, Arthrex Scorpion, Opus SmartStitch, etc) may be used to pass the post suture directly through the cuff in a single step using a combination grasper/needle shuttling mechanism. Second, various suture-passing devices (eg, Arthrex SutureLasso, Linvatec Spectrum, etc) allow the surgeon to pass a retrieving suture retrograde through the cuff, which is then looped or tied to the post strand and brought back through the cuff. Finally, various penetrating graspers (eg, Arthrex Birdbeak, Mitek Clever-Hook, etc) may be passed retrograde through the cuff to directly retrieve the post strand and pull it through. The choice of suture-passing instrument is dependent on surgeon preference and comfort, and we most often use the SutureLasso device (Figs. 15A–F). The principles involved are the same regardless of the device used. The suture passer should penetrate the cuff at a point determined to: (1) hold at least 1 cm of good cuff tissue and (2) bring the appropriate part of the cuff to the anchor with minimal tension. Because we start posteriorly and have already chosen the most posterior post, this first stitch is usually passed close to the posterior edge of the cuff tear. The post and its corresponding non-post strand may then be brought out through a holding portal and held until all limbs are passed, or they may be brought out through the anterolateral working portal and tied. For knot tying, practice outside the

FIGURE 16. A, Here, a small full-thickness tear has been marked in the subacromial space with a suture. B, It is repaired with a single suture anchor.

FIGURE 17. A large tear (A) repaired with multiple suture anchors (B).

FIGURE 18. There has been recent interest in suture-bridge (A) and double-row (B) techniques of repair, which increase the area of cuff opposed to the tuberosity and may increase healing potential.
operating room with an arthroscopy simulator is essential. We use a sliding, self-locking knot (the Fleega or giant knot) and back it up with 2 to 3 alternating half hitches on opposite posts. If a suture does not slide, we use a modified Revo knot consisting of multiple half hitches. This progression of steps is then repeated with the more anterior suture, which is passed through the cuff slightly anterior to the prior suture (Figs. 15A–H).

If the tear is small, the repair may be complete at this point. In larger tears, additional anchors are placed sequentially from posterior to anterior, and suture passing and tying are done immediately after the placement of each anchor. Especially for the beginning arthroscopist, this method minimizes the confusion and risk of tangling associated with multiple suture strands. We also use this method because the surgeon can evaluate the repair as it progresses, enabling him or her to modify the position of each subsequent anchor depending on how the repair is progressing as it is repaired from back to front. However, it should be noted that tying the sutures as they are passed may make it more difficult to pass subsequent sutures as the cuff edge is progressively tacked down.

Many tears are reparable with between 1 and 3 anchors. In a small tear, a single double-loaded anchor may be appropriate (Figs. 16A, B). As tears grow larger and more complex, more anchors are necessary (Figs. 17A, B). Larger, more complex tears may be repaired using double-row or suture-bridging techniques (Figs. 18A, B). It should be recognized that large and massive tears, especially in older patients, are at high risk for re-tear. However, the clinical outcome, even in the presence of a re-tear, remains acceptable.

**POSTOPERATIVE CARE AND REHABILITATION**

The patient is discharged from the hospital on the day of surgery. The patient is placed in a sling and is allowed out of the sling only for dressing and bathing. Active elbow and hand exercises are begun immediately and performed several times a day. In most tears, at 6 weeks postoperatively, passive range-of-motion exercises are begun including forward elevation, external rotation, and pendulum exercises. The patient performs these exercises 3 times daily at home, often in addition to formal physical therapy. The goal of rehabilitation is to minimize stiffness without putting tension on the cuff repair. Between 8 and 12 weeks postoperatively, active range-of-motion exercises are added. Strengthening exercises are held until at least 16 weeks postoperatively, depending on the size of the tear. A strengthening and stretching program is continued for 1 year postoperatively to maximize strength and results.

**SUMMARY**

Arthroscopic rotator cuff repair follows the same principles as open repair. These principles include minimal deltoid disruption, adequate decompression, careful evaluation of the tear, and secure fixation of the tendon to its bony insertion. Careful, supervised rehabilitation is also key to a good outcome. Attention to the details of patient positioning, accurate portal placement, and adequate visualization will result in less frustration and faster, more secure repair. In this review, we hope to have provided the basis for a thoughtful, step-by-step approach to rotator cuff repair that will minimize complications, optimize rotator cuff healing, and maximize postoperative results and patient satisfaction.

**REFERENCES**