The most common surgical pathology that we encounter in our shoulder practice at Southern California Orthopedic Institute (SCOI) is the symptomatic full-thickness rotator cuff tendon tear. Although we have a long history of repairing these tears using the arthroscopic-assisted approach that includes subacromial decompression and the mini-open lateral deltidoid split technique, in the last 18 years we have evolved our repair technique and have completely abandoned that approach. We now repair all rotator cuff pathology using exclusively arthroscopic visualization and instrumentation. After more than 4,000 arthroscopic rotator cuff repairs performed in our clinic using various scopes, anchors, stitchers, and knots, we have distilled our technique into a uniform system for essentially all repairable rotator cuff pathology we entitle the “SCOI Row.”

There are three key components of the SCOI Row cuff repair that must always be included:

1. A single row of strong suture anchors each loaded with three strands of high-strength suture.

2. The anchors are always inserted near the medial edge of the anatomical neck rather than lateral on the greater tuberosity, entering at a 45-degree or “tent peg” angle under the strong subchondral bone, a few millimeters lateral to the cartilage on the debrided (but not decorticated) cortex.

3. There are always microfracture punctures created in the tuberosity bone lateral to the anchors. These “vents” are deep enough to enter the bone marrow space in a direction aimed down the humeral shaft, thus avoiding the anchors and not compromising their fixation. The vents enable the vital bone marrow elements to flow out to cover and nourish the healing tendon by creating a red blanket or “Crimson Duvet.” The name Crimson Duvet refers to a “superclot” that originates from the bone marrow and overlies the surface of the tuberosity and the cuff following repair. When it clots, it creates a dense, fibrous meshwork replete with mesenchymal stem cells, platelets with their important growth factors, and cytokines, while also providing an “umbilicus” from each vent that will develop a new permanent blood supply to nourish the healed rotator cuff in the future (1–3).

The steps for performing the SCOI Row are consistent, reproducible, and reliable, and have given our patients the best possible chance for healing without unnecessary surgical morbidity and cost (see Chapter 17).
High-grade bursal-sided partial tears (BIII or BIV), particularly those with significant delamination and flap formation, are treated similarly to full-thickness cuff tears. The goal in these lesions is to repair all possible tendon back to bone without sacrificing the intact articular-sided remaining tendon. The same is true for interstitial or intratendon tears, some of which can be very large and symptomatic and require repair similar to that of a bursal flap tear (Fig. 20-1A–C).

Most bursal-sided cuff tears and many full-thickness lesions are associated with subacromial impingement related to acromial bony excrescences and spurs, and sometimes simply “encroachment” between the acromion and the tuberosity. In such cases, the repairs must be accompanied by an arthroscopic decompression, with recessing and smoothing of the undersurface of the acromion and the inferior surface of the acromioclavicular (AC) joint. The preoperative pain and disability associated with the condition can be quite severe, in part due to the torn edges of tendon and bursa catching under the subacromial spur when the arm is elevated. Postoperative pain relief is often rapid and dramatic. Rehabilitation after repair of the B4 tear or an intertendinous lesion is faster than for full-thickness defects because there is minimal tension on the repair, and, thus, earlier postoperative active mobilization is possible (Fig. 20-2).

In Chapter 17, we discussed the classification and preoperative workup for all patients with rotator cuff tears. In this chapter, we will reiterate only that each patient’s cuff tear is unique and requires personalized decision making, which always includes a comprehensive physical exam, careful review of x-rays, and often a magnetic resonance imaging (MRI). All scans must be reviewed by the Orthopedic Surgeon and not the radiologist alone. Older patients and any patient with possible medical comorbidities should be evaluated by a medical consultant and cleared for anesthesia before any surgery is entertained.

The spectrum of full-thickness rotator cuff tears is variable, ranging from small lesions with minimal retraction to massive tears with degenerative tissues, tendon laminations, and side-to-side (medial to lateral or oblique) tears. When a full-thickness tear can be repaired back to bone with minimal tension, secure fixation, and has reasonably good-quality tissues, the cuff will likely heal. If the tendon tissue is degenerative or of poor quality, especially if it cannot be repaired without tension or it requires heroic circumferential capsular releases, it will be more likely to fail. These situations will often benefit from a biologic augmentation (Chapter 22) or patch interposition grafting (Chapter 23).
Steps in Repairing a Full-Thickness and Significant Bursal-Sided Rotator Cuff Tear Using the "SCOI Row"

Set up the patient in the lateral decubitus position as described for diagnostic arthroscopy, and then perform the 15-point video-recorded arthroscopic exam viewing from both the posterior mid-glenoid portal (PMGP) and the anterior mid-glenoid portal (AMGP).

Treatment of all full-thickness rotator cuff tears begins with debridement of the frayed edges of the cuff tendon on the articular side. Use a 5.5-mm motorized shaver, and work from both the posterior and the anterior portals. Take care to remove all remaining nonviable fragments of torn tendon from the "footprint" area of the humeral neck, and carefully debride the articular crescent area of the cuff. This is especially important because it is difficult to see the underside of the cuff when the scope is viewing from the bursal side during the repair. Observe and note all areas of delamination and partial articular-sided tearing to ensure that they will be included in the final rotator cuff repair (Fig. 20-3).

Move the arm to the bursoscopy position of 15 degrees of abduction by transferring the weights on the traction tower or changing the levers as needed. Twelve to 15 pounds of weight are usually sufficient for bursal visualization. Insert the scope into the bursa via the PMGP, and install a second cannula connected to an outflow drain in the AMGP. Perform a complete video-recorded bursal evaluation from both anterior and posterior portals.

While viewing from the AMGP, debride the posterior bursal curtain and any thickened lateral bursal shelf. This will improve visualization when the scope is returned to the PMGP and will facilitate instrumentation via the posterior cannula later in the repair.

With the scope in the PMGP again, create the mid-lateral subacromial portal (MLSA). Choose the entry point for the portal by testing with a spinal needle. Be certain to locate the portal on the "50-yard line," a position that is directly in line with the center of the cuff tear (not the center of the acromion) and at least 3 cm lateral from the acromial edge. Insert a smooth 6.25-mm clear cannula with a tapered obturator (Fig. 20-4).

Perform a selective subacromial smoothing (decompression) and mini- or complete distal clavicle resection as needed, on the basis of your evaluation of the preoperative x-ray, the patient’s symptoms, and the arthroscopic findings (see Chapters 15 and 16).

Shave and, if necessary, lightly abrade the bone on the proximal humerus surface adjacent to the cartilage edge, and...
continue lateral for 2.5 to 3 cm over the lateral greater tuberosity. This area will be covered with neotendon as the healing cuff edge expands laterally and the footprint regenerates. Do not remove the thin cortical bone layer adjacent to the articular cartilage where the suture anchors will be inserted. It is important to preserve the bone in this area to maximize fixation strength.

With the scope in the Mid Lateral Subacromial Portal MLSP, complete the preparation of the rotator cuff. Remove any thin, feathered edge of tendon using a basket punch and shaver, but never debride it more medial than the articular cartilage to prevent placing additional tension on the repair. For bursal-sided tears, protect and preserve the remaining articular-sided cuff fibers (Fig. 20-5).

Assess the pattern of the tear using an atraumatic grasping forceps via the anterior and posterior cannulas. Experiment with various options to reposition the tendon back to the prepared bone bed, as well as for possible side-to-side sutures. Insert two 85-mm Dry-Doc “Blue” 7-mm cannulas in the anterior and posterior portals. If the patient is muscular or obese, use the 95-mm “Black Cap” blue cannulas to ensure adequate working length (Conmed/Linvatec, Largo, FL).

SIDE-TO-SIDE ROTATOR CUFF SUTURES

Placing side-to-side sutures to close the vertical component of an “L-shaped” tear has been an important advancement in our ability to repair larger lesions. The side-to-side sutures are important for two reasons: First, they help to reestablish the proper alignment of the torn tendon ends with their insertion site on the humerus; and second, they relieve a great deal of stress from the anchored suture–bone junction. There are two techniques that we use to perform side-to-side stitches: either the single-pass or the two-step method. Both of these use the Spectrum Suture Needles and Suture Shuttle-Relay (Conmed/Linvatec, Largo, FL) technique.

The single-pass method for side-to-side cuff suturing is used when the two parts of a coronal tear are well aligned. Perform the stitch using the longest-size (30 mm) crescent-shaped suture hook on a Spectrum (Conmed/Linvatec, Largo, FL) handle loaded with a Super Shuttle-Relay or a strand of #1 PDS monofilament suture.

Insert the needle through the appropriate cannula (either anterior or posterior, whichever gives the most direct approach), and align it by laying it over the top of the tear in the direction of the desired stitch. If the tear is a “V-” or “L-” shaped one, the first stitch should be medial near the apex.

Back the needle out to a point 1 cm from the edge, and turn the curve of the needle toward the tendon and drive it through with gentle pressure. Once the needle has passed through the near side of the tear, turn it 180 degrees so that the curve is facing toward the acromion, and advance it to observe the tip in the cleft between the two sides of the lesion. Advance the tip under the far side of the tear, and direct it through to penetrate 1 cm away from the edge of the tear. Often, it is helpful to assist the needle penetration by applying counterpressure with a grasping tool inserted via the opposite cannula.

Pass a Suture Shuttle-Relay or PDS suture through the needle and retrieve it out of the opposite cannula with a grasper clamp (Fig. 20-6A–C).

FIGURE 20-5. Trim the thin, frayed degenerative edge of the torn cuff with a suction punch.

FIGURE 20-6. A–C. Make the first pass of the crescent suture needle through the tendon at the apex of the tear, and carry the Shuttle out of the opposite cannula.
If the Shuttle is used, load the eyelet with a strand of #2 braided suture and carry it back down the cannula, across the tear and out of the initial cannula.

We prefer to use #2 braided polyester suture (Ethibond) because it is very tissue-friendly and much less expensive than the newer polyethylene-braided sutures. If PDS is used as a shuttle, tie a simple half-hitch in the end of the suture and load the braided suture in the loop (Fig. 20-7).

Collect both the suture limbs out of either the anterior or the posterior cannula, whichever gives the best

**FIGURE 20-7.** Load the Shuttle outside the opposite cannula, and carry the braided suture across the tear.
view of the tear, with a crochet hook and tie them together using a sliding-locking knot. We prefer the Tennessee slider knot for the PDS sutures and the SMC knot for braided sutures (Fig. 20-8).

Repeat the process for additional side-to-side stitches as often as needed to close intertendinous defects.

If the tendon quality is poor, create a figure-8 stitch. Retrieve the same suture limb that was carried through the tissue initially back out of the opposite portal using a crochet hook. Pass the side-to-side crescent-shaped suture needle a second time parallel to the first pass, and send the Shuttle. Retrieve the Shuttle and load it as before with the tail of the previously passed suture, and carry it back through the tissue to form a strong figure-8 stitch. Tie the sutures with a modified Revo knot.

FIGURE 20-8. Tie the sutures with a sliding-locking knot.
**Two-Step Side-to-Side Cuff Repair**

Use the two-step side-to-side repair when the torn edges of the tendon are not directly in line, and hence a direct side-to-side stitch will not work. This situation is found with a sagittal or posterior oblique “L-shaped” tear having a significant stump of good-quality tendon remaining on the greater tuberosity.

Plan the stitch by inserting a straight guide rod through the posterior cannula on the same side as the lesion. Using the rod as a visual guide, project the line of attack that will be needed to pass both ends of the suture. Usually, but not always, one of the directions will require a right- and the other a left-curved Spectrum 45- or 60-degree hook needle. Sometimes, a crescent-shaped needle will work best for one of the suture passes.

When repairing a posterior tear with a substantial fragment remaining on the tuberosity, the first stitch will be through that portion of tendon. Insert the 45-degree suture hook via the posterior cannula, and pass it through the cuff remnant on the tuberosity near the apex of the tear. Send the Shuttle through the needle and into view. Retrieve it out of the opposite cannula with a grasping clamp (Fig. 20-9).

**FIGURE 20-9.** The two-step side-to-side repair begins by passing a curved suture needle through the cuff remnant on the tuberosity and retrieving the Shuttle with a grasping clamp.
Load the suture, usually a #2 Ethibond (Somerville, NJ), into the Shuttle eyelet, and carry it through the tissue, leaving one limb out in each cannula (Fig. 20-10).

Insert the suture hook with the 45-degree curve in the opposite direction through the posterior cannula. It is helpful to temporarily reduce the tear using a grasping clamp in the anterior cannula to confirm the exact location for the second apical stitch. Pass the needle through the opposite portion of the tear from top to bottom and send the Shuttle through the needle. Retrieve the Shuttle with a grasper inserted in the cannula that contains the first suture limb.

Load the Shuttle with the suture outside the anterior cannula, and carry it back through the tendon from bottom to top, completing the side-to-side stitch. Collect both the suture limbs out of the most convenient cannula and tie them (Fig. 20-11).

Repeat the steps as often as needed to close the side-to-side component of the tear. Once the sutures are tied, the remaining stump of supraspinatus tendon is better approximated to the prepared bone of the tuberosity (Fig. 20-12).

FIGURE 20-10. Load the suture in the eyelet of the Shuttle, and carry it through the posterior cuff stump and out of the posterior cannula.

FIGURE 20-11. Two Step STS

Video Two Step STS
FIGURE 20-11. The second curved needle is passed through the opposite side of the cuff, and the Shuttle is retrieved, loaded with the suture, and carried through the cuff and out of the opposite portal.
SUTURE ANCHOR FIXATION OF ROTATOR CUFF TEARS TO BONE USING THE “SCOI ROW” TECHNIQUE

We have been favorably impressed with the enhanced strength of cuff tendon fixation to bone achieved when three sutures are utilized in each suture anchor as opposed to the single- or double-loaded suture anchor methods used in the past (4,5). Multiple simple sutures loaded in strong anchors placed at the “tent peg” angle in the sturdy bone near the medial edge of the footprint to minimize suture–cuff tension is an important part of the “SCOI Row” philosophy. Suture management may appear somewhat complicated with three sutures per anchor, but with a little preparation, practice, and careful attention to detail, it becomes a routine, gratifying, and cost-efficient method for all cuff repairs. Our recommendation is to use one triple-loaded anchor for every 1 to 1.2 cm of cuff tear. One may elect to use fewer sutures per anchor on occasion when only one or two stitches are needed to complete a repair, or on occasion when a mattress suture is desired. It is a rare occasion that we choose not to use all three sutures.

STEPS TO PERFORM THE STANDARD “SCOI” ROW

1. Continue viewing from the MLSP while inserting a spinal needle percutaneously next to the acromion to determine the proper position and angle for placement of the triple-loaded anchors.

2. Test the position of the needle by angling it both anteriorly and posteriorly to be certain the entry point for the anchor placement is acceptable. The needle entry site chosen should correspond to the center of the tear so that it can be used for two or three anchors if needed. For larger tears, two different entry sites may be required. The posterior anchor is inserted first.

The needle should be directed at the insertion site for the anchors 5 mm away from the edge of the cartilage. This insertion position will ensure that the sutures are in the optimal position to cause the least amount of tension at the suture–tendon interface (6–8). The angle of incidence to the bone for anchor placement is crucial, and should be like a “tent peg” of 45 degrees into the dense subchondral bone. This angle will guarantee the strongest fixation of the cuff edge and best resist anchor pullout. If the insertion angle is too vertical, it will enter the softer bone of the greater tuberosity, thereby increasing the risk of anchor failure (8). The anchor eyelet should be aligned to face the direction of the cuff to prevent sutures twisting or crossing during stitching. Seating the anchor 2 to 3 mm below the cortical surface allows for a “halo” of open space around the eyelet that permits bone marrow to escape from the anchor socket to improve healing. We prefer to use standard anchors with the proximal eyelet design rather than fully threaded anchors to allow this bone marrow halo. Of course, if the bone is weak, then an anchor with an additional cortical thread may be a better option (Fig. 20-13).

Helpful Hint to Improve Visualization. If the cuff tear is appreciably lateral or anterior, visualization may be difficult with the scope in the lateral acromial portal. A helpful hint in these instances is to reposition the arm into a little more abduction or what we call “midposition.” One way to do this is by readjusting the position of the overhead shoulder traction system until the ideal angle for optimum visualization is attained. Achieve this position by changing the weights on the cables or changing the height of the traction levers (Fig. 20-14).

We prefer to create 1-mm “pilot holes” before inserting the 5-mm suture anchors. Insert a small bone punch through a skin incision in the location chosen with the spinal needle. Direct the punch so that the pilot holes are created approximately 1 cm apart and the posterior hole angles 30 degrees posterior, the anterior hole 30 degrees anterior, and the central hole, if needed, is directly medial from the insertion site. This fanning out of the holes will ensure that each anchor has a solid wall of surrounding bone; if the holes are parallel, the wall of bone around the anchors may be thin, thus decreasing the anchor-holding strength. Even when self-tapping anchors are used, we still prefer to make starter holes to allow us to visually plan the layout for anchor placement, especially in hard bone. This pilot hole will also help avoid skiing or slipping of the anchor as it starts into the bone (Fig. 20-15).

3. At this time, it is convenient to create the bone marrow vents in the tuberosity. This will open the bone marrow space and set the stage for the Crimson Duvet. The Mini Revo punch (Conmed/Linvatec, Largo, FL) or a 1-mm microfracture bone awl is used to create the vent holes in the tuberosity, beginning a few millimeters away from the anchor pilot holes. The punch should be inserted about 1.5 cm deep and aimed down the humeral shaft into the tuberosity and away from the anchor pilot holes. The appearance of fat globules bubbling from the bone marrow vents ensures that the bone marrow cavity has been breached. We recommend four to seven vents depending on the size of the tear. Care must be taken when...
FIGURE 20-13. The suture anchors are inserted 5 mm lateral to the articular cartilage at a 45-degree or “tent peg” angle.

FIGURE 20-14. The arm is repositioned to optimize bursal visualization by changing the position of the traction unit.

FIGURE 20-15. Use the small bone punch to create the pilot holes for inserting the triple-loaded anchors.

FIGURE 20-16. The bone punch is redirected down into the lateral tuberosity away from the anchor holes and used to create four to seven bone marrow vents.

4. Insert the first anchor through the same small accessory portal used for the punch. We prefer to insert the posterior anchor first. Screw it through the muscle and seat the tip in the pilot hole. Align the screw-in anchor so that it follows the direction of the pilot hole at the “tent peg” angle of approximately 45 degrees below the subchondral bone. Take care to avoid cutting out and damaging the articular cartilage. Ensure that the horizontal depth guideline on the screwdriver tip is seated 2 to 3 mm below the bone and the vertical guide mark is directed toward the rotator cuff, that
is, toward the desired direction that the sutures will pass (Fig. 20-18).

5. Retrieve the medial limb of the posteriormost suture that exits on the “cuff side” of the anchor eyelet out of the posterior cannula using a crochet hook. Choosing the strand that exits the eyelet closest to the cuff ensures that the sutures do not twist or tangle when tying. A helpful hint is to have an assistant color the end of the retrieved suture with a surgical marker pen. This will aid by identifying this as the “post” suture and simplify knot tying (Fig. 20-19).

6. Choose the appropriate suture hook for stitching that affords the best angle for passing the needle through the cuff via the posterior portal. The choice is made by laying a straight rod through the posterior cannula and over the posterior cuff, aiming it at the anchor. If the line is acceptable, use a crescent suture hook. If not, choose a 45- or 60-degree right- or left-curved hook, whichever gives the best angle for the stitch. Pass the hook through the cuff from top to bottom, 6 mm posterior to the anchor and 1 to 1.5 cm medial to the free edge. Visualize the needle tip exiting the bottom of the cuff, incorporating any delaminations, and feed 5 cm of the Shuttle through the needle (Fig. 20-20).

7. Grasp the Shuttle with a clamp and carry it out of the anterior cannula. Be certain that the grasper follows the path of the first suture exactly from the anchor to the cannula so that it does not cross lateral to the other sutures. If this occurs, the sutures will be tangled.

8. Load the Shuttle with the first suture outside the anterior cannula, and carry it back through the cuff from bottom to top and out of the PMGC (Posterior Mid-Glenoid Cannula) (Fig. 20-21).

9. Retrieve the partner limb of the first suture from the anchor into the posterior cannula with the crochet hook. Always watch carefully when retrieving the partner limb of a suture to be certain that it does not cross or tangle with another suture (Fig. 20-22).

Using “Suture Savers” to Organize and Protect the Sutures. If you prefer, as we do, to implant all the anchors and pass all the sutures before tying, it is very helpful to store each suture pair inside Suture Savers (Conmed/Linvatec, Largo, FL). Suture Savers are small, multicolored plastic straws that are available in a package of five that includes a nitinol wire loop suture loader.

Using the Suture Savers will prevent inadvertent tangling of the sutures and store the partner sutures together, making it easier to locate and retrieve them for tying. Also, leaving the sutures untied until all of them are passed permits us to better mobilize the edge of the tendon to visualize laminations and locate the tip of the Spectrum needle and Shuttle while suturing.

We always organize the Savers in a consistent color sequence, thus facilitating identification of the correct sutures when retrieving them for tying. Beginning from posterior, our color pattern is green, yellow, red, violet, and black. If the tear is large, we may use a second set of Savers, applying them in the same sequence.
10. Once the first suture is pulled through the cuff with the Shuttle, retrieve the partner into the posterior cannula and load the pair into a green-colored Suture Saver as follows:
   a. Insert a guide rod into the PMGC, remove the cannula, and relocate the sutures outside the cannula.
   b. Thread the ends of the suture into the eyelet of the Suture Saver loader that has been passed through the green Suture Saver.
   c. Pull the sutures into the Saver with the loader, and run the Saver down the sutures and into the portal (outside the cannula) to the top of the cuff. By holding tension on the post suture, the one passing through the cuff, the Saver will be directed to the top of the cuff. If this is not done, the Saver will seat near the anchor and obstruct visualization of the subsequent sutures.

FIGURE 20-19. The medial limb of the posterior suture is retrieved into the anterior cannula using the crochet hook, and the end of the retrieved suture is colored purple with a skin marker.
d. Fix a clamp on the Saver near the outer tip, thus locking the sutures in place.

e. Reinsert the blue Dry-Doc cannula over the guide rod using a cannulated obturator (Fig. 20-23A–C).

11. Retrieve the medial strand of the next (white) suture that exits the anchor closest to the cuff, and carry it into the anterior cannula with a crochet hook.

12. Insert a suture hook again via the posterior cannula, and pass it through the cuff from top to bottom, this time 6 mm anterior to the previous suture and 1 to 1.5 cm medial from the cuff edge. This stitch is located directly in line with the suture anchor. Advance the Shuttle through the needle, retrieve it, and carry it out of the anterior portal (Fig. 20-24).

13. Load the white suture, and pull it back through the cuff into the posterior cannula using the Shuttle.
14. Place the white sutures in a yellow Suture Saver outside the posterior cannula and clamp them.
15. Pass the third suture 6 mm anterior to the middle suture, at a 30-degree angle from the suture anchor. This will create a fan-shaped pattern of sutures, ensuring a strong hold on the cuff without compromising the blood flow (Fig. 20-25).

16. If the cuff tear was measured to be greater than 1.2 cm, a second anchor will be needed and can now be inserted through the same skin incision as the first anchor. Once the second anchor is seated, the sutures are passed from posterior to anterior, similar to the first anchor, and unless more anchors are needed, all but the final suture are stored in Suture Savers.
17. If a third anchor is needed, it may either be inserted through the same skin incision or often through a second incision located 2 cm anterior to the first one using a spinal needle for direction. The third anchor should be at least 1.2 cm anterior to the second anchor, and it should be angled 30 degrees anterior and again 45 degrees medial in the “tent peg” angle to ensure the best stability.

18. It is often more appropriate to pass the most anterior suture through the AMGC and retrieve and load the Shuttle via the PMGC. Protect all suture pairs with Suture Savers using the same color scheme—green, yellow, red, violet, and black—as you progress from posterior to anterior (Fig. 20-26).

19. Tie the sutures in reverse order, that is, from anterior to posterior.

**FIGURE 20-22.** Retrieve the partner of the first posterior suture out of the posterior cannula with a crochet hook.
Continue viewing with the scope in the LSAP when tying the anteriormost sutures. Retrieve both anterior suture limbs into the AMGC with a crochet hook and tie them with an SMC sliding-locking knot. If the “post” suture has been marked with a purple surgical marker, it will be easy to identify as the correct one to load into the knot pusher. The “post” suture is always the limb that has been passed through and exits from the top of the cuff. This will ensure that the SMC knot seats on the top of the cuff and avoids crowding all three knots near the anchor eyelet.

20. Move the scope into the AMGP and insert a Crystal cannula or a 6-mm Dry-Doc cannula in the LSAP to tie the remaining sutures. Release the hemostat on the most anterior Suture Saver, and retrieve the sutures into the LSAP with a ring grasper or crochet hook. Tie the sutures

**FIGURE 20-23.** A-C. The Suture Savers are loaded outside the posterior cannula using the wire suture loader and passed down on top of the cuff.

**FIGURE 20-24.** Pass the needle for the second suture through the cuff 6 mm anterior to the previous suture, and carry the Shuttle into the anterior cannula.
FIGURE 20-24. (continued)

FIGURE 20-25. The third suture is stored in the red suture saver outside the posterior cannula.
with a sliding-locking knot followed by three alternating half-hitches. Cut the suture tails 3 mm from the knots.

21. Tie the remaining sutures by retrieving each subsequent suture pair, progressing from anterior to posterior into the LSAP and tie them (Fig. 20-27).

22. When all the knots are finished, return the scope to the LSAP and visualize the cuff repair while rotating the humerus to observe the stability of the fixation (Fig. 20-28).

Turn off the arthroscopic pump and observe the bone marrow vents. There will be a copious flow of bone marrow from each hole as the water pressure diminishes. The bone marrow will flow up to and over the rotator cuff to create a Crimson Duvet. Notice that there is very little blood flow (and of course no bone marrow) emanating from the cortical bone surface (Fig. 20-29).

**FIGURE 20-25.** (continued)

**FIGURE 20-26.** All suture pairs except the final anterior one are stored in Suture Savers outside the posterior cannula.
23. Close the skin portals using a single absorbable subcutaneous suture and Steri-strips. Dress the shoulder with a ProWick (Arthrex, Inc., Naples, FL) postoperative dressing, and apply an UltraSling4 or Ultrasling4 +15-degree ER (DJ Orthopedics Global, Carlsbad, CA) for postoperative protection (Fig. 20-30).

**Postoperative Care**

The postoperative treatment consists of protecting the cuff repair in an UltraSling4 neutral rotation brace or an UltraSling4 +15-degree external rotation brace for 5 to 6 weeks. The amount of time required in the sling depends on the severity of the tear, the quality of the cuff and bone tissue,
and the security of the repair. The patient begins exercises on the day of surgery, which include squeezing the rubber ball that is supplied with the UltraSling4 and performing active elbow, wrist, and hand movements. Shoulder shrugs and scapular adduction exercises are begun on the first postoperative day. The incisions are kept dry for 10 days, but showers are allowed if the wounds are covered with the waterproof bandages supplied with the ProWick postoperative dressing.

X-rays are taken at the first postoperative visit to document the position of the anchors and evaluate the decompression (Fig. 20-31).

Pendulum exercises are begun after the first week postoperatively. After 4 or 5 weeks, the patient is offered a pool therapy program for passive mobilization. Active-assisted elevation with a pulley and supervised physical therapy begin at 6 weeks. Resisted exercises for the scapula and subsequently the rotator cuff are added progressively as
symptoms allow. At 3 months, most usual daily activities are allowed, but no strenuous work or sports requiring heavy lifting or quick movements should be performed. Although we believe that the tendon is fairly well healed to bone by 3 months, it seems to take up to a year for the muscles to regain substantial strength.

Postoperative Results

In a study of our SCOI patients in 1998, Tom Murray and Georg Lajtai reported the minimum 2-year results of 45 patients with 48 medium to large (CII–CIII) cuff repairs. The average age was 57.6 years, and the mean follow-up was 39 months. Shoulder pain, as rated on the UCLA shoulder index, improved from 3.3 preoperatively to 9.3 at follow-up. Function improved from 5.4 to 9.5 out of 10. Perhaps the most important parameter is patient satisfaction with the surgery. This score improved from 0 preoperatively to 4.9/5 postoperatively, and no patient regretted having the operation (9).

In a more recent paper written by Sostak et al. (10), 52 consecutive shoulders having 2- to 4-cm full-thickness cuff tears were evaluated with MRI at a minimum of 1 year postoperatively. Forty-two repairs not requiring margin
convergence sutures, postoperative MRI showed that 40/42 repairs (95.2%) healed. When tears requiring the margin convergence technique were included, 47/52 (90.4%) repairs healed. All five re-tears occurred in patients over 60 years of age. All MRI scans documented restoration of the entire rotator cuff footprint on the tuberosity lateral to the anchors. The titanium suture anchors did not interfere with the postoperative scan in any patient, although they do show a bright artifact halo or “frequency shift” around each one in the bone. Ninety-eight percent of the patients were satisfied with their result. The mean WORC index score was 91%, with no significant difference in WORC score between healed and re-torn. No patient required revision rotator cuff surgery.

**FIGURE 20-31.** The x-ray documents that the suture anchors are located in the ideal position on the edge of the articular cartilage and are directed medially under the subchondral bone. The arch view documents that the undersurface of the acromion is smooth and the anchors angle away from each other.

**FIGURE 20-30.** The shoulder is covered with a ProWick postoperative dressing, and the arm is supported in an UltraSling4, +15-degree ER brace.

**TEN PEARLS FOR ARTHROSCOPIC ROTATOR CUFF REPAIR**

1. Begin the cuff debridement from the articular side using a 5.5-mm shaver from both the anterior and the posterior portals.
2. On the bursal side, visualize and debride the hypertrophic bursa, posterior bursal curtain, and lateral bursal shelf from both anterior and posterior portals.
3. Perform the subacromial decompression when needed, and remove spurs below the AC joint prior to cuff repair to improve visualization, decrease potential cuff impingement, and supply more bone marrow and growth factors for better healing.
4. Perform any side-to-side cuff repair before inserting suture anchors, and use the two-step suturing method with a Shuttle if the tear is oblique.
5. Debride the entire tuberosity footprint and create four to seven bone marrow vents. These vents will enable the formation of a Crimson Duvet that will supply new blood flow, platelets with their growth factors, and mesenchymal stem cells to ensure healing and footprint regeneration.
6. Use triple-loaded anchors placed 1 to 1.2 cm apart and just 5 mm lateral to the cartilage to minimize the tension in the repair, and afford a strong tendon-to-bone construct while avoiding excess cuff tension.
7. Pass the sutures 1 to 1.5 cm medial to the edge of the cuff with an angle of 25 to 30 degrees between each suture to create a fan-shaped pattern.
8. Store the suture pairs in Suture Savers once they are passed to avoid tangling and facilitate retrieval during tying.
9. Protect the arm in slight abduction and neutral rotation using an UltraSling4 to avoid internal rotation contracture, and lessen the tension on the suture–tendon construct.

10. Start the elbow, wrist, hand, and scapula rehabilitation exercises on the first postoperative day, but avoid any cuff-loading activities such as active abduction for 6 weeks.

FINAL THOUGHTS ON ARTHROSCOPIC REPAIR OF FULL-THICKNESS ROTATOR CUFF LESIONS

At the time of this publication, our shoulder team at SCOI has performed more than 4,000 completely arthroscopic cuff repairs, and we continue to find that patients are exceptionally pleased, with very few complications. This fact is gratifying, especially when compared with the previous open surgical approach and other reports of arthroscopic techniques for cuff repair in which complications and postoperative morbidity have been significant (12–15). We believe that in the future, as we recognize and diagnose rotator cuff disease at earlier stages, and apply these new techniques of surgical repair along with the biologic enhancement, we will undoubtedly continue to obtain consistently excellent results.

We have had the opportunity to evaluate hundreds of postoperative MRI scans of our patients following arthroscopic rotator cuff repairs using the SCOI Row. The rotator cuff typically appears to reattach to bone, and most of the postsurgical edema resolves by 6 to 8 weeks. The appearance of tendon continues to improve, becoming more robust and uniform with time. By 8 to 10 weeks, the regenerating footprint of the cuff has extended from the initial implant site on the edge of the cartilage laterally to cover an area 1.5 to 2 cm wide. This is the area of the bone marrow Crimson Duvet that spread from bone marrow vents in the tuberosity and covered the rotator cuff. It is this bone marrow clot that supplies the mesenchymal stem cells and the rich fibrin matrix that supports the platelets as they systematically degranulate and supply the growth factors necessary for optimal healing. It is very gratifying to observe a previously thin degenerative tendon mature into a more normal-looking structure over the course of a year (Fig. 20-32).

Although there is a trend in arthroscopic rotator cuff surgery to use newer radiolucent anchors that are made of various plastics and absorbable polymers, it is important for the surgeon to recognize that there are some potential problems when they are chosen. If an anchor fails and pulls out of the bone, it will be impossible to see it on a postoperative x-ray and difficult to locate even on an MRI. Unless there is a contraindication to using a titanium suture anchor, it is not likely that there is any advantage, especially when considering the cost, strength of fixation, and visibility on a postoperative x-ray (Fig. 20-33).

POSTOPERATIVE ARTHROSCOPIC EVALUATION AND BIOPSY OF THE HEALED FOOTPRINT

We have had occasion to take a second look at several shoulders during the recent and later postoperative periods. One patient appeared to have an infection at 1 week postoperatively, leading to an arthroscopic evaluation and lavage. There was no infection, and the arthroscopic evaluation revealed a large, organized area of

FIGURE 20-32. A patient who had an A2B2C3 rotator cuff tear fixed with three ThRevo triple-loaded suture anchors had sequential MRI scans pre- and postoperatively for 2 years. The footprint of the healing rotator cuff becomes visible on the MRI between the 4- and 8-week scans and matures in up to a year.
FIGURE 20-33. This patient had a degenerative rotator cuff tear requiring a simple repair. His surgeon chose to use a technique requiring five suture anchors and a capsular release. He continued to have pain, and although the x-ray was not helpful, the MRI demonstrated a catastrophic failure with a loose anchor in the deltoid muscle and required a rotator cuff allograft as a salvage procedure.

A rich crimson-colored granulation tissue bridging from the tuberosity to cover the rotator cuff, appearing like a red blanket or “Crimson Duvet.” A second patient also had some swelling and a small amount of drainage and tenderness around the anterior portal at 3 weeks postoperatively. His arthroscopic evaluation revealed no infection but a rich, maturing Crimson Duvet. Both patients had excellent results (Fig. 20-34).

FIGURE 20-34. At 1 week postoperatively, the Crimson Duvet appeared like a red blanket covering the tuberosity, the suture line, and the cuff. The second patient was evaluated at 3 weeks postoperatively, and the Crimson Duvet had matured to resemble a granulation tissue.
Another patient required additional surgery at 12 months following his A3B3C21/2 rotator cuff repair when he tore his biceps tendon and requested a tenodesis. His rotator cuff was completely healed, and the footprint on the bursal side appeared as a continuous, smooth, solid tendon that extended from the lateral aspect of the tuberosity to the muscle tendon junction. Only small tags of the colored sutures were visible, documenting the location of the previously placed sutures and anchors (Fig. 20-35).

Another patient suffered a traffic accident at 8 weeks postoperatively and re-tore her rotator cuff. Her MRI suggested that the rotator cuff footprint had begun to reform. At surgery, we documented that she had a dense layer of fibrous tissue covering the previously debrided tuberosity that grossly appeared like a rotator cuff footprint lateral to the suture anchors. A biopsy of her “Crimson Duvet footprint” showed organized fibrous tissue resembling immature tendon, with positive birefringence indicating tendon tissue lateral to the repair site, consistent with neotendon formation (Fig. 20-36).

One last patient also had a biceps tear that required surgical care at 2 years postoperatively. She allowed us to remove an area of the regenerated rotator cuff footprint to evaluate the status of the bone marrow vents. They appeared to have a core of vascular tissue resembling an umbilicus. It seems logical that the new blood supply emanating from the bone marrow vents is available to nourish the cuff and that it adds vitality to the healing process and ensures future blood flow to the tendon (Fig. 20-37).
Ch 20 Arthroscopic Evaluation and Treatment Using the SCOI Row Technique

References


Suggested Readings


