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ESSENTIAL SURGICAL TECHNIQUES

SUBSPECIALTY PROCEDURES

Arthroscopic Superior Capsular Reconstruction for Treatment of Massive Irreparable Rotator Cuff Tears

An Update of the Technique for 2020

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Abstract

The treatment of massive, irreparable rotator cuff tears presents a substantial challenge to health-care professionals. Treatment options range from nonoperative to operative, including debridement, partial repair, biceps tenotomy, bridging patch grafts, muscle transfers, and reverse total shoulder arthroplasty. However, the results of such treatments are often mixed, and many carry a substantial risk of complications. Superior capsular reconstruction has been described as a surgical alternative to the aforementioned procedures. Superior capsular reconstruction is a technique that provides an anatomic reconstruction of the superior capsule of the glenohumeral joint, with the goal of restoring the normal restraint to superior translation that is lost with a deficient superior rotator cuff. The technique described in the present article highlights the pearls and pitfalls learned over the last several years of performing arthroscopic reconstruction of the superior capsule with dermal allograft.

Introductory Statement

Superior capsular reconstruction (SCR) is a technique that provides an anatomic reconstruction of the superior capsule of the glenohumeral joint, with the goal of restoring the normal restraint to superior translation that is lost with a deficient superior rotator cuff[1].

Indications & Contraindications

Indications

- Patients with a symptomatic massive irreparable supraspinatus and/or infraspinatus tear, an intact or repairable subscapularis tendon, an

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intact and functioning teres minor, and fully functioning deltoid and trapezius muscles with minimal to no glenohumeral arthritis are indicated for this procedure.

Contraindications

- Concomitant irreparable subscapularis tendon tears.
- Concomitant nonfunctional teres minor.
- Nonfunctional deltoid.
- Nonfunctional trapezius.
- Moderate to severe glenohumeral arthritis.

Step-by-Step Description of Procedure

The SCR procedure can be performed either open or arthroscopically with the patient in either the beach-chair or lateral-decubitus position. We prefer to perform this technique arthroscopically under both general and/or regional anesthesia (Video 1). After appropriate patient positioning and preparing and draping, a time-out is called to confirm the correct patient, side, and operative procedure to be performed. Intravenous antibiotics are administered, and the procedure is initiated with a diagnostic arthroscopy of the glenohumeral joint.

Video 1 Video demonstrating every step of the superior capsular reconstruction surgical technique. Video is performed on a right cadaveric shoulder in the lateral decubitus position.

Step 1: Diagnostic Arthroscopy and Subscapularis Tendon Repair (if Torn)

The first step of the SCR procedure is to perform a diagnostic arthroscopy, evaluating all pathology in addition to the rotator cuff tear, and to repair the subscapularis (if torn).

- The glenohumeral joint is thoroughly evaluated with a 30° arthroscope initially from the posterior viewing portal; lateral and anterior viewing portals can also be utilized.
- If the subscapularis is torn, perform a repair with use of standard arthroscopic techniques.
  - Pearl: in the setting of a torn subscapularis tendon, even retracted subscapularis tendon tears are nearly always repairable with the use of a 3-sided arthroscopic release and repair to a 5-mm-medialized bone bed.
- Evaluate the posterosuperior rotator cuff and prepare the tissue for repair.
  - Pearl: double interval slides are performed in an attempt to achieve a complete repair or to facilitate later partial repairs; even if repair is not possible following interval slides, this step facilitates performing the SCR by improving glenoid exposure. The surgeon should attempt to repair as much of the rotator cuff as possible, either prior to SCR or over the top of the SCR graft, in order to improve strength and to aid in balancing the force couples of the shoulder.
- Evaluate the long head of the biceps tendon, and if the tendon is either torn or unstable, a biceps tenodesis or tenotomy is performed.

Step 2: Prepare the Superior Glenoid and Greater Tuberosity Bone Beds

The second step of the SCR procedure is to prepare the superior glenoid as well as the greater tuberosity with use of a shaver or burr, establishing bleeding bone beds to improve healing potential.

- Use an arthroscopic motorized shaver and/or burr to prepare the bone beds. The superior labrum can be left intact, debrided, or removed, according to surgeon preference.
  - Pearl: the bone of the supraglenoid tubercle and the bone of the greater tuberosity are prepared to create bleeding bone beds that will improve the biologic environment for eventual healing of the dermal allograft.

Step 3: Glenoid Anchor Placement

The third step of the SCR procedure is to place 2 to 3 glenoid suture anchors along the superior aspect of the glenoid.

- While still viewing from the posterior portal, place a large (typically 12 mm) flexible cannula through the lateral portal.
- Two or 3 anchors can be placed on the superior aspect of the glenoid. Place 3 anchors (anterosuperior, superior, and posterosuperior) in the glenoid to provide complete coverage of the graft over the glenoid[2].
- Use three 18-gauge spinal needles to simulate the trajectory of the anchors to ensure proper spacing of the glenoid anchors and to minimize the risk of anchor convergence and glenoid face perforation (Figs. 1 and 2).
  - Pearl: in smaller patients or in patients with less soft-tissue deficiency, 2 medial anchors may be all that is required.
  - Pearl: based on anatomic research by Schon et al., the glenoid anchors can safely be placed 3 to 5 mm medial to the labrum as long as the angle of approach is appropriate[2,3].
- An anterosuperior glenoid anchor percutaneous skin incision is typically made just anterior to the distal aspect of the clavicle, and the anchor is placed at the 2 o'clock position (for a right shoulder) on the glenoid.
- A superior glenoid anchor percutaneous skin incision is typically made in the Neviaser portal, and a central anchor is placed at the 12 o'clock position on the glenoid.
- A posterosuperior glenoid anchor percutaneous skin incision is either made through the Neviaser portal or just posterior to the acromion, depending on the anatomy of the patient, and is placed at the 10 o'clock position (for a right shoulder) on the glenoid.
- All of the glenoid anchors are anatomically placed medial to the glenoid labrum (similar to the native superior capsule); however, we recommend placing the 12 o'clock anchor 2 to 3 mm more medial than the other 2 glenoid anchors to maintain a safe angle of approach in relation to the articular surface and to avoid convergence on the other 2 anchors.
- The authors prefer to use knotless anchors (all-suture, push-in, or threaded) to achieve independent fixation with mattress suture configurations.

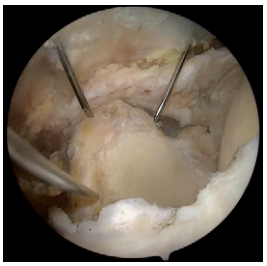

Fig. 1

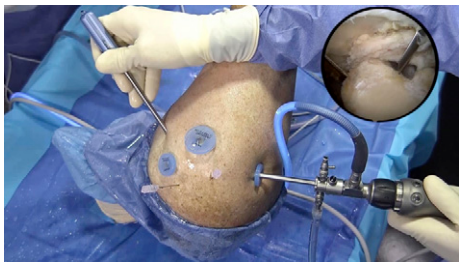

Fig. 2

Fig. 1 Arthroscopic view of the right shoulder (via the posterolateral viewing portal) following placement of 3 superior glenoid spinal needles to access anchor trajectory for placement of 3 glenoid anchors.

Fig. 2 External view of the right shoulder after placement of spinal needles (and in this case, a drill guide anteriorly to access anchor trajectory on the glenoid). The arthroscope is in the posterolateral viewing portal.

Step 4: Greater Tuberosity Anchor Placement

The fourth step of the SCR procedure is to place suture anchors along the greater tuberosity, beginning at the juxta-articular margin of the humeral head (i.e., the medial row of a double-row rotator cuff repair).

- Transfer arthroscopic instrumentation to the subacromial space.
- Place medial row anchors utilizing a technique similar to how one might perform a standard arthroscopic rotator cuff repair[4], including placement of 2 suture anchors (preloaded with high-strength nonabsorbable suture or tape material) into the medial row at the greater tuberosity, both anteriorly and posteriorly.
  - Pearl: if the anterior to posterior length of the rotator cuff tear exceeds 25 to 30 mm, then we recommend a third medial row anchor in the greater tuberosity.

Step 5: Preparation of Dermal Allograft

The fifth step of the SCR procedure is to prepare the dermal allograft with sutures from the previously placed glenoid and greater tuberosity suture anchors.

- The preferred thickness for the dermal allograft is 3.0 mm.
- Measure the distances between the anterior-most and posterior-most glenoid anchors, between the anterior-most and posterior-most greater tuberosity anchors, between the anterior aspect of the glenoid and anterior greater tuberosity anchors, and between the posterior aspect of the glenoid and posterior greater tuberosity anchors to prepare the proper size and appropriate tensioning of the dermal graft (Figs. 3 and 4).
  - Pearl: prior to measuring, it is important to ensure that the humeral head is centered on the glenoid, that the shoulder is in neutral rotation, and that the arm is in approximately 30° to 40° of abduction; shoulder malpositioning can result in improper tensioning of the graft, which can lead to suboptimal clinical results.

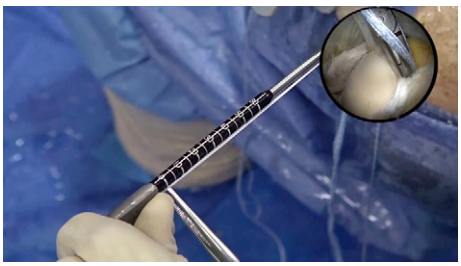

Fig. 3

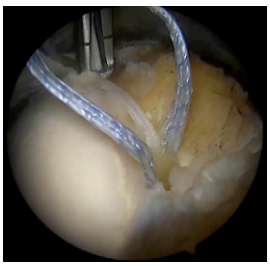

Fig. 4

Fig. 3 External view of the SCR measuring guide, demonstrating how to "zero-out" the guide.
Fig. 4 Arthroscopic view of the right shoulder (via the posterolateral viewing portal) showing the use of the SCR measuring guide to measure the distance from the posterior glenoid anchor to the 12 o'clock (middle) glenoid anchor.

- Cut the graft based on the arthroscopic measurements from the glenoid and greater tuberosity anchors, as described above (Fig. 5).
  - Pearl: to decrease the chance of suture cut-through and to ensure that the graft provides adequate soft-tissue coverage, we add 5 to 10 mm to the graft anteriorly, medially, and posteriorly; and laterally, we add 10 to 15 mm to cover the greater tuberosity.

    Therefore, the graft is often 5 cm from medial to lateral (e.g., 5 mm medial, 35 mm from medial glenoid anchors to tuberosity anchors, and 10 mm for greater tuberosity coverage).
- Following graft sizing, an optional "purse string" suture stitch configuration that utilizes a high-strength nonabsorbable suture or tape material can be placed around the periphery to act as a rip-stop (Fig. 6). This is performed with an antegrade suture passer.
- Place pilot holes (Fig. 5) for the suture tape at the lateral margin of the graft; these holes allow the sutures to slide through the graft without catching and twisting the graft.
  - Pearl: the blunt end of the driver from the suture anchor can be helpful as the graft tissue is often too thick to allow for smooth needle passage with an antegrade suture passer.

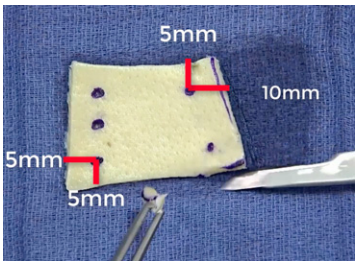

Fig. 5

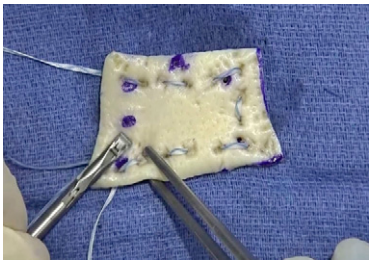

Fig. 6

Fig. 5 External view of initial measurements on the dermal allograft (in this case, ArthroFlex; Arthrex) prior to cutting the graft to size. The graft has been marked with a marking pen to designate where the sutures will eventually be passed. The 3 dots nearest to the ruler are for the sutures from the 3 medial anchors; the 2 dots nearest to the opposite side of the graft are for the sutures from the greater tuberosity medial row anchors.
Fig. 6 External view showing the construct with a "purse string" stitch configuration within the dermal allograft (in this case, ArthroFlex; Arthrex).

Step 6: Passage of Dermal Graft into Joint and Initial Fixation

The sixth step of the SCR procedure is to pass the prepared dermal allograft into the joint.

- Graft passage and initial fixation can be accomplished simultaneously by carefully retrieving and passing all of the sutures through the graft outside of the shoulder.
  - Pearl: to improve the margin of safety for avoiding incarceration of larger grafts, bivalve the cannula prior to starting suture retrieval (Video 1).
- Bring the medial row suture-anchor sutures through the lateral cannula and pass them through their corresponding pilot holes in the dermal allograft (Fig. 7), with an assistant applying tension to the sutures inferiorly to decrease the chance of the sutures getting tangled.
  - Pearl: hemostat clamps can be placed on the suture/tape ends to prevent the dermal allograft from sliding toward the cannula while passing the sutures through the graft.
- Bring the sutures from the glenoid anchors out through the cannula, 1 anchor set at a time.
  - Pearl: pull the sutures out in the following order: posterior glenoid, middle glenoid, and anterior glenoid, while maintaining tension on the humeral sutures to avoid tangling.
- Through the lateral portal, the blue repair suture and the looped striped passing suture are retrieved from the posterior knotless anchor; we prefer to pass the blue repair suture in an inverted oblique horizontal mattress suture configuration with the antegrade suture passer posteromedial on the graft (Fig. 8).
- Use the striped shuttling suture to pass the repair suture back through the anchor.
- The process is subsequently repeated for the middle and anterior glenoid anchors.

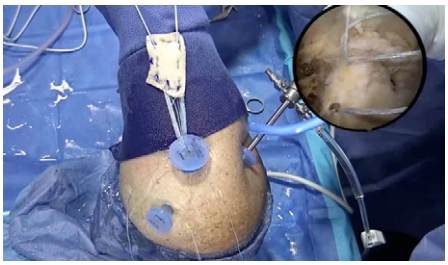

Fig. 7

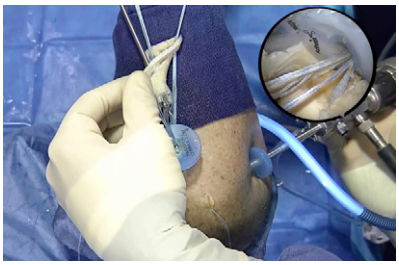

Fig. 8

Fig. 7 External view of the right shoulder demonstrating the medial row swedged sutures (in this case, FiberTape sutures; Arthrex) passed through corresponding pilot holes in the dermal allograft (prior to graft passage through the cannula within the lateral portal, performed in this case with a PassPort cannula; Arthrex).

Fig. 8 External view of the right shoulder showing the passage of an inverted horizontal mattress suture with an antegrade suture passer (in this case, Scorpion FastPass; Arthrex) at corresponding points on the dermal allograft.

- Introduce the dermal allograft through the lateral cannula and into the subacromial space using a grasper in a folded fashion (Fig. 9).
  - Pearl: if the graft will not easily pass through the cannula, the split cannula can simply be removed from around the sutures and the graft brought in percutaneously.
- The dermal allograft is inserted into the subacromial space while sequentially pulling tension on the excess suture from the 3 glenoid anchors in short intervals and pushing the graft medially with the grasper (Fig. 10).
  - Pearl: the graft is introduced by pushing it in with the grasper and not by pulling on the glenoid sutures, which could result in excessive stress on the glenoid anchors and ultimately pull the anchors out of the glenoid if the bone is deficient.
- Once the graft is in the subacromial space, the remaining slack can be removed from the medial sutures in order to secure the graft to the glenoid; these limbs are then cut short with use of a suture/tape cutter.

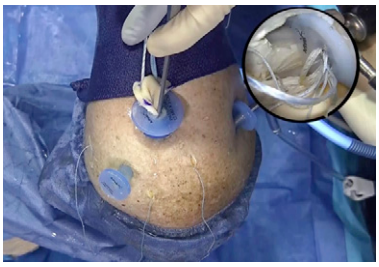

Fig. 9

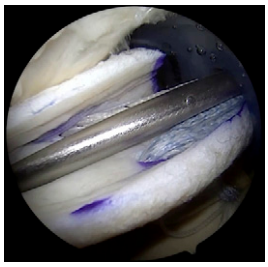

Fig. 10

Fig. 9 External view of the right shoulder showing the utilization of the grasper (in this case, Back Grasper; Arthrex) for graft introduction to the cannula within the lateral portal (in this case, PassPort cannula; Arthrex).
Fig. 10 Arthroscopic view of the right shoulder (via the posterolateral viewing portal) showing introduction of the dermal allograft.

Step 7: Secure the Dermal Allograft

The seventh step of the SCR procedure is to secure the dermal allograft in place with the sutures from the previously placed suture anchors.

- Secure the suture/tape limbs from the medial tuberosity anchors laterally with 2 suture anchors in a knotless suture-bridging construct.
  - Pearl: use the eyelet sutures from the medial anchors to create a medial double mattress suture adjacent to the articular margin.
- Double-loaded suture anchors at the medial and lateral rows of the humerus also allow the surgeon to perform partial rotator cuff repair over the top of the graft.
- In the case of a tenuous complete repair (revision or poor tissue quality), we have had excellent results with a complete rotator cuff repair over the top of the SCR graft.

Step 8: Repair the Remaining Rotator Cuff Tissue to the Allograft

The 8th step of the SCR procedure is to repair the remaining rotator cuff tissue (i.e., the infraspinatus) to the dermal allograft.

- Posterior side-to-side margin convergence sutures are passed through the remaining posterior rotator cuff and dermal allograft tissue, advancing the supraspinatus as much as possible to the infraspinatus, which covers the graft when possible and potentially promotes biologic healing of the graft.
- Perform margin convergence between the posterior rotator cuff and the dermal allograft, with 2 and 3 posterior side-to-side sutures typically being utilized (Fig. 11).
  - Pearl: posterior margin convergence is necessary to prevent subluxation of the humeral head and to allow restoration of the rotator cable.
- When necessary, anterolateral side-to-side sutures are also placed to restore the anatomic anterior cable attachment.
  - Pearl: the posterior and anterolateral side-to-side sutures increase the graft rigidity, strengthen the repair, and restore "capsular continuity" in the shoulder (Fig. 12).

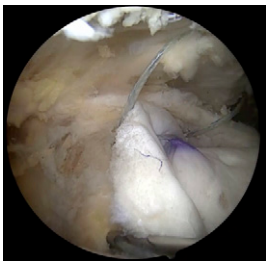

Fig. 11

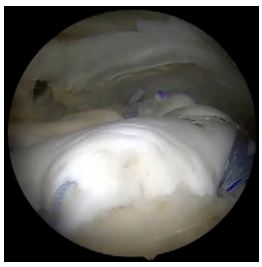

Fig. 12

Fig. 11 Arthroscopic view of the right shoulder (via the posterior viewing portal) showing the technique of margin convergence with high-strength #2 nonabsorbable suture with the infraspinatus in the foreground and dermal allograft in the distance.

Fig. 12 Arthroscopic view of the right shoulder (via the posterior viewing portal) showing final placement of the dermal allograft and posterior margin convergence with a supported suture construct.

Step 9: Perform Any Necessary Concomitant Procedures

The final step of the SCR procedure is to perform any additional necessary procedures, including biceps tenodesis and/or distal clavicular excision.

- When appropriately indicated, subacromial decompression is typically performed prior to initiation of the SCR.
- The biceps tenodesis anchor is either incorporated as the anteromedial anchor for the SCR or placed at the conclusion of the procedure, depending on the condition of the biceps tendon and surgeon preference.
- Following all procedures, the shoulder joint and any open wounds should be irrigated and cleared of all osseous and/or soft-tissue debris.
- Standard closure techniques are utilized based on surgeon preference.
- The shoulder is placed into a standard postoperative sling with abduction pillow.
- The patient is discharged the same day unless there is any indication for inpatient admission.

Results

In the original description of the procedure, Mihata et al. reported that the technique was safe and reproducible, with excellent short-term results and far lower rates of the complications associated with more invasive procedures, such as reverse total shoulder arthroplasty[1]. Other authors have shown similarly favorable results[3,5-9].

Pitfalls & Challenges

- Failure to organize sutures (suture management) within and outside the joint.
- Failure to prevent bowstringing of the medial row sutures.
- Oversizing the graft and increasing the chance that graft gets stuck in the cannula during graft passage.
- Progressing too aggressively with physical therapy and causing early failure.
- Failure to diagnose and/or repair concomitant subscapularis pathology.

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