

Surgical Technique for Superior Capsule Reconstruction With 6-mm Acellular Dermal Allograft and Knotless Glenoid Anchors



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Abstract: Superior capsule reconstruction (SCR) creates a humeral head depressor in the setting of a massive, irreparable rotator cuff tear. Recently, a 6-mm-thick acellular dermal allograft (ACD) has been shown to be noninferior to the standard fascia lata autograft in recreating native shoulder biomechanics. This paper outlines a reproducible means by which to perform an arthroscopic SCR using a 6-mm ACD. A standard diagnostic arthroscopy first assesses the integrity of the subscapularis and infraspinatus tendons. The glenoid anchors are then placed. Accessory anterior and posterolateral portals are made as well as a lateral portal by which to shuttle the graft. Suture management is paramount. Ideally allograft preparation occurs on the back table simultaneously to maintain efficiency. Suture passage through premade holes in the graft, and when the sutures have passed through and been tensioned, the graft is shuttled into place and tied down with medial and lateral row anchors in SpeedBridge fashion. The thickness of ACD has been shown to influence the ability of the reconstructed superior capsule to perform its role as a humeral head depressor. This technique describes the use of a 6-mm-thick ACD to perform an arthroscopic SCR that minimizes both donor-site morbidity and operative time.

The superior capsular complex of the shoulder has been shown to be a major contributor to humeral head stability by limiting superior displacement.¹ This native structure measures between 4.1 and 9 mm in thickness and spans from the medial glenoid to the greater tuberosity.^{2,3} Superior capsular reconstruction (SCR) is a viable, reproducible method by which to create a humeral head depressor in the setting of irreparable rotator cuff tears.⁴⁻⁷ Many techniques exist for creating this subacromial augment and include the use of both autograft and allograft tissues. Mihata

et al.³ have demonstrated successful restoration of superior stability using fascia lata with continued clinical success at 5-year follow-up.⁷ More recently, human acellular dermal allograft (ACD) has been used in place of fascia lata autograft to decrease donor-site morbidity as well as operative times.⁸ When using a 6-mm graft, this ACD been shown to be noninferior to fascia lata in restoring biomechanics of a native shoulder joint.⁹ A full list of advantages and disadvantages is provided in [Table 1](#). This technique article demonstrates a reliable and reproducible method by which to perform an arthroscopic SCR with a 6-mm ACD.

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Surgical Technique (With Video Illustration)

Indications

Patients indicated for SCR are those who have massive, irreparable rotator cuff tears with associated pain and/or dysfunction and who have not responded to a trial of nonoperative management.^{4,5,10} SCR is contraindicated in cases of rotator cuff arthropathy (Hamada Grade greater than or equal to 3), significant glenohumeral arthritis, severe deltoid dysfunction, or an irreparable subscapularis tendon.¹⁰ The graft functions as a humeral head depressor in the setting of an absent superior rotator cuff and thereby optimizes the biomechanical force couples of the glenohumeral joint.

Table 1. Advantages and Disadvantages of Superior Capsular Reconstruction With a 6-mm Acellular Dermal Allograft and Knotless Glenoid Anchors

Advantages	Disadvantages
<ul style="list-style-type: none"> • Avoids donor-site morbidity • Biomechanically equivalent to fascia lata graft • Easier recovery from arthroscopic surgery as compared to open 	<ul style="list-style-type: none"> • Potentially increased operative time • Learning curve associated with new technique • Increased cost as compared with autograft

Technique

A step-by-step surgical technique guide is provided in [Fig 1](#) with accompanying arthroscopic images and

video. In addition, pearls and pitfalls are outlined in [Table 2](#). The surgery begins with a standard diagnostic arthroscopy from a posterior viewing portal to assess

- Perform a diagnostic arthroscopy from a posterior viewing portal
- Make an anterior interval portal low and medial, perform biceps tenotomy as necessary
- Pass three SutureTapes through the remaining subscapularis tendon via the anterior portal
- Make a second anterior portal more superior and lateral to facilitate suture management
- Place three 3.0mm knotless SutureTak anchors at 10, 12, and 2 o'clock glenoid positions (Figure 3)
- Make a lateral portal off the lateral edge of the midpoint of the acromion, use a 12mm cannula
- Pass three SutureTapes through the infraspinatus tendon and pull through the lateral portal
- Simultaneous graft preparation should occur during the above steps
- Fold the graft in half with the crease facing posteriorly (Figure 2)
- Create holes in the graft using a fresh 11-blade scalpel as outlined below
- Use looped shuttle sutures in each hole with the loop inferior
- Place 1 hole in each corner of the graft, then pass and tie a number 2 FiberWire in each corner (Figure 2)
- Place 4 holes along the medial border of the graft (Figure 2)
- Place 3 holes along the anterior border of the graft (Figure 2)
- Place 3 holes along the posterior border of the graft (Figure 2)
- Place 2 holes along the lateral border of the graft (Figure 2)
- Move the camera to a posterolateral accessory portal and work through the posterior portal
- Place a medial row of SpeedBridge SwivelLock anchors in the humeral head
- Pass the subscapularis and infraspinatus SutureTapes through the graft using the shuttle sutures (Figure 4)
- Pass the glenoid knotless SutureTak sutures through the graft using the shuttle sutures
- Pass anterior mattress from A to P (Hole 1 to 2, Figure 2) and (Figure 5)
- Pass middle mattress from A to P (Hole 2 to 3, Figure 2)
- Pass posterior mattress from P to A (Hole 4 to 3, Figure 2) and (Figure 6)
- Use a KingFisher to pass a cigar-rolled acellular dermal graft through the 12mm lateral cannula (Figure 7)
- Complete the SpeedBridge repair by placing the medial row tapes into two lateral row anchors (Figure 8)
- Finish tying the subscapularis and infraspinatus side-to-side sutures in 30 degrees of abduction

Fig 1. Step-by-step instructions. A step-by-step surgical technique guide for performing superior capsular reconstruction with 6-mm acellular dermal allograft and knotless glenoid anchors.

Table 2. Pearls and Pitfalls Related to Superior Capsular Reconstruction With 6-mm Acellular Dermal Allograft and Knotless Glenoid Anchors

Pearls

- Mark graft appropriately to ensure correct medial/lateral orientation
- Ensure the graft fold is positioned posterior
- Simultaneously perform graft preparation on the back table during diagnostic arthroscopy
- Maintain coracoacromial ligament
- Use looped shuttle sutures with the loop inferior in the graft (or use looped-type suture passer)

Pitfalls (and how to avoid)

- Difficulty piercing the 6mm graft (use a fresh 11 blade for initial perforation)
- Glenoid knotless anchor suture management (snap and/or mark with a surgical marker)
- Graft passage (cigar roll the graft around a KingFisher clamp to ease entry through cannula)
- Graft passage (cigar roll the graft around a KingFisher clamp to ease entry through cannula)

the integrity of the remaining rotator cuff. Later, this portal will become a working portal while graft passage will be viewed from an accessory posterolateral portal. An anterior interval portal is made low and medial and is used to perform a biceps tenotomy as necessary. SutureTapes (Arthrex, Naples, FL) are used to create 3 side-to-side suture passages through the remaining subscapularis tendon via the low, anterior portal using a straight SutureLasso (Arthrex) passer. These 3 sutures will be passed through the allograft and tied in a simple, side-to-side fashion. A second, anterior portal placed more superiorly and laterally is also placed to facilitate traction and suture management. Subsequently, three 3.0-mm knotless SutureTak anchors (Arthrex) are placed in the glenoid at the 10-, 12-, and 2-o'clock positions (Fig 2).

A lateral portal is made off the lateral edge of the acromion at its midpoint and a 12-mm PassPort cannula is inserted. SutureTapes are passed through the infraspinatus tendon three times and these tapes are passed through the lateral portal cannula. These tapes will eventually be used to tie in a side-to-side fashion through the posterior aspect of the graft.

The graft preparation should be performed by an assistant in conjunction with the aforementioned diagnostic arthroscopy, biceps tenotomy, and glenoid anchor placement to optimize efficiency. It should be noted that during debridement of the remaining rotator cuff, the coracoacromial ligament should be maintained. The graft is folded in half to achieve a 6-mm thickness with its crease facing posteriorly (Fig 3). Hole creation in the graft is performed with a fresh 11-blade scalpel to ensure precision, leaving approximately 3 to 5 mm of graft at its corresponding edge, except where otherwise indicated. If desired, it is helpful to leave looped shuttle sutures through each of the holes



Fig 2. Glenoid anchors. Glenoid as viewed from the lateral portal. Three 3.0-mm knotless SutureTak anchors are placed at the 10-, 12-, and 2-o'clock positions.

with the loop inferiorly; alternatively, a Hewson suture passer is used later to pass sutures through the previously created holes.

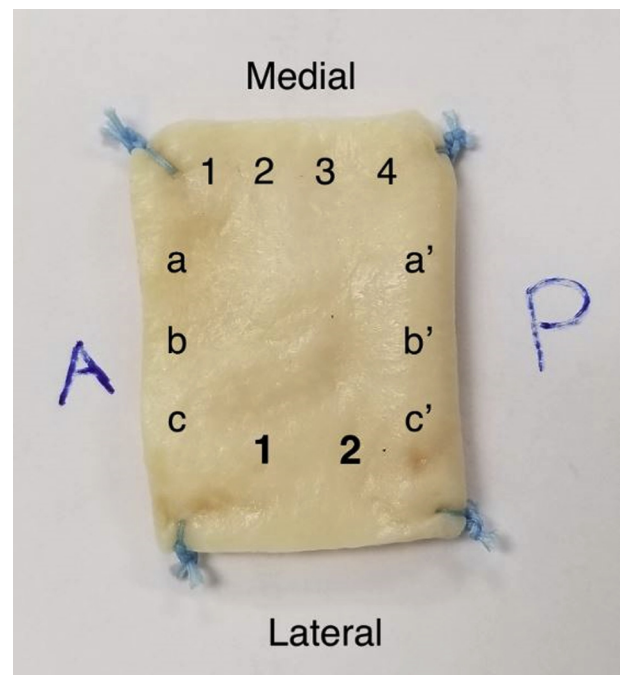


Fig 3. Graft preparation. An acellular dermal allograft has been folded in half to create a 6-mm-thick graft with the fold facing posteriorly. The corner sutures have been placed and tied. Four holes will be made along the medial side of the graft as numbered 1-4 to be placed on the glenoid side. Three posterior holes will be placed as labeled a-c for side-to-side suturing to the remaining infraspinatus. Three anterior holes will be placed for side-to-side suturing to the remaining subscapularis (a', b', c'). Finally, 2 holes labeled 1 and 2 (in bold) are placed 1 cm from the lateral edge of the graft for the humeral-sided medial row anchors. (A, anterior; P, posterior.)

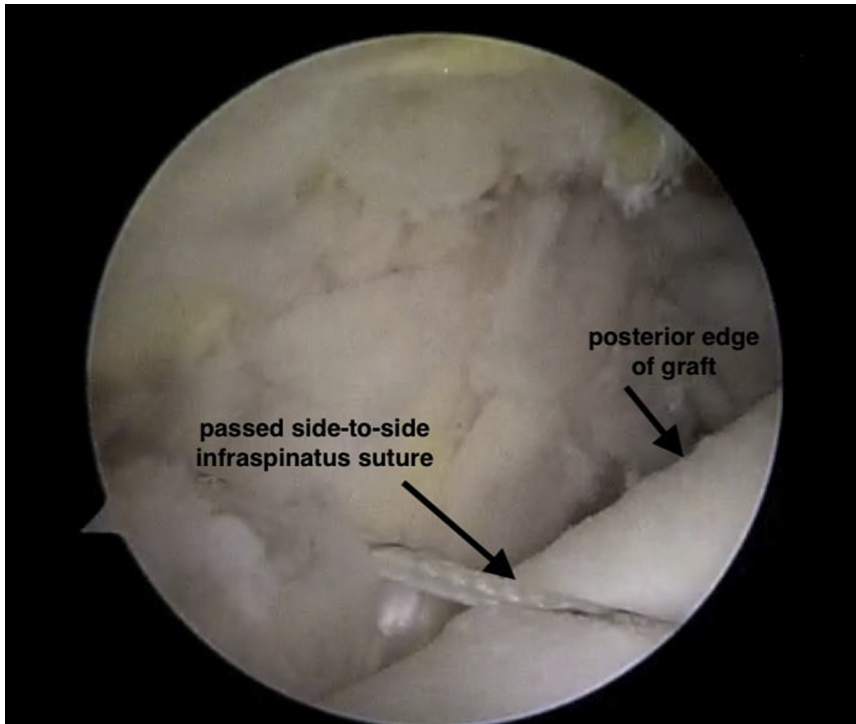


Fig 4. Infrapinatus sutures. Graft as viewed from the lateral portal. The SutureTapes passed through the infrapinatus are visible prior to being tied.

1. One hole is created in each corner (4 holes total), and number 2 FiberWire (Arthrex) sutures are passed and tied at each corner. Using a Hewson

suture passer may aid in suture passage through the thickened graft if the FiberWire needle is not following the trajectory made by the 11-blade.

Fig 5. Anterior mattress. Graft as viewed from the lateral portal. The glenoid knotless Bio-SutureTak sutures have been incorporated into the graft, and the anterior corner suture from the initial graft preparation is visible.

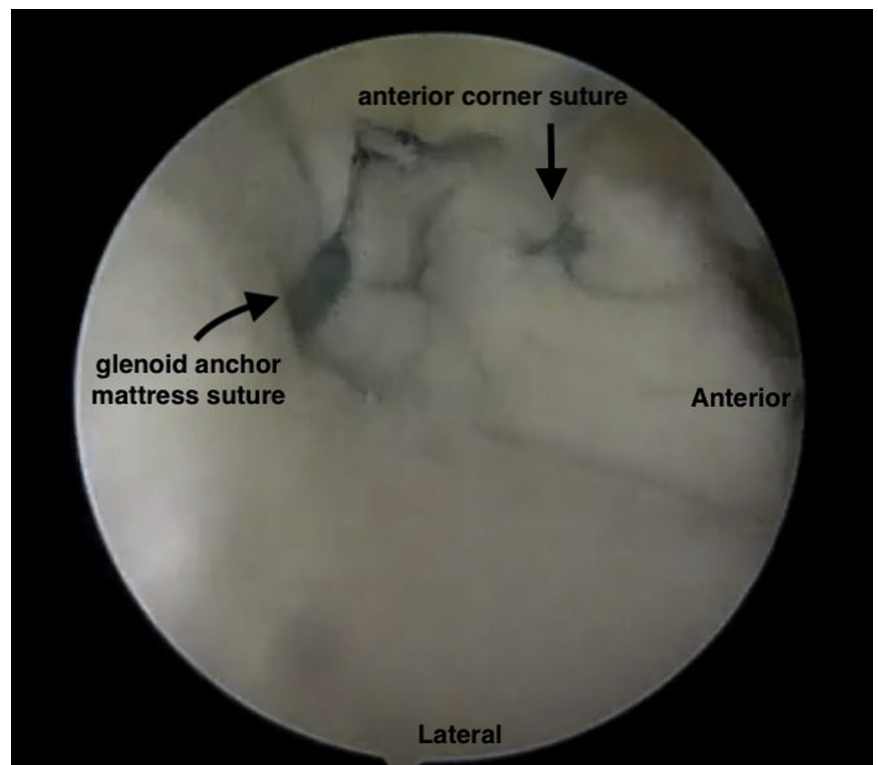
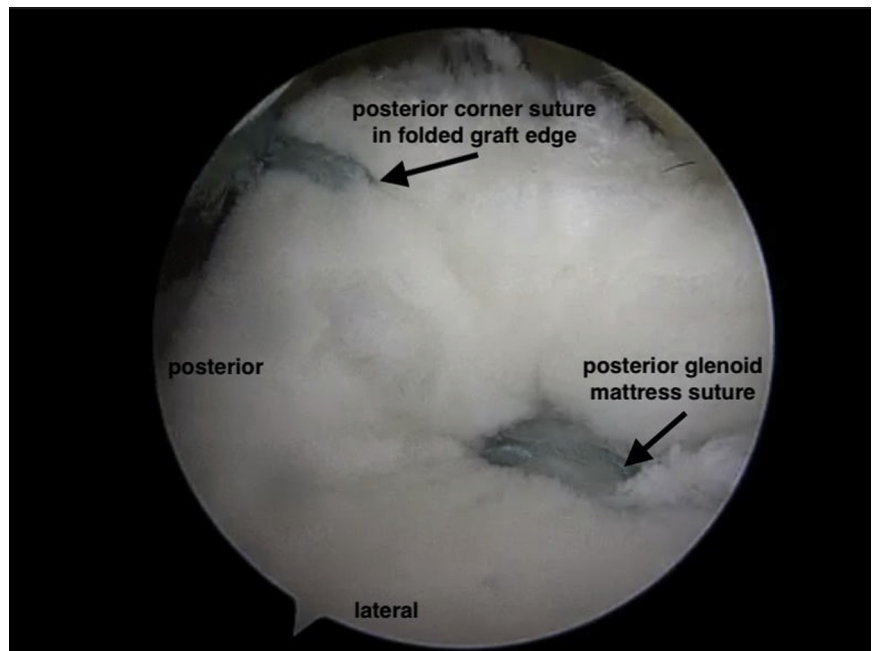


Fig 6. Posterior mattress. Graft as viewed from the lateral portal. The glenoid knotless Bio-SutureTak sutures have been incorporated into the graft, and the posterior corner suture from the initial graft preparation is visible in the folded posterior edge of the graft.



2. Four holes are punctured at the medial border for mattress-type knotless suture passage of the glenoid sutures.
3. Three holes are punctured along the anterior border. Repeat at the posterior border; these holes will connect to the subscapularis and infraspinatus suture tapes, respectively.
4. Finally, 2 holes are made on the lateral border, 1 cm from the edge of the graft, and equidistant from each other and the anterior/posterior borders of the graft for the tapes from the SwiveLock humeral medial row anchors (Arthrex). **Fig 3** depicts the graft with prepared corner sutures and shuttle sutures.

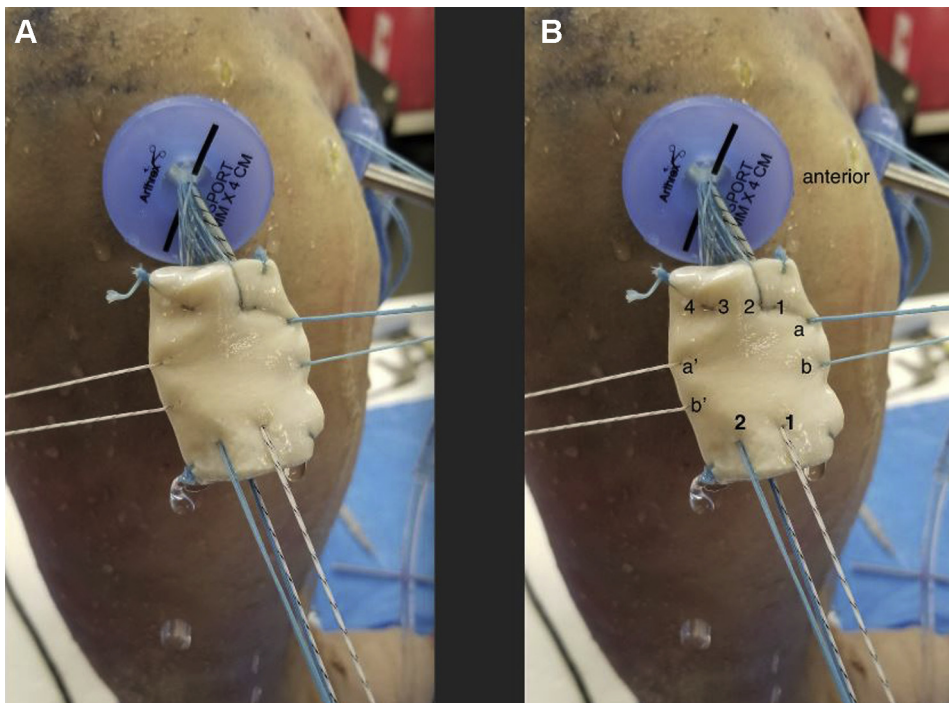


Fig 7. Graft insertion. An acellular dermal allograft is being placed in a cadaveric right shoulder. (A) The sutures from the glenoid anchor have been passed in a mattress fashion. (B) The graft is marked with its holes as labeled in **Fig 1**, with 1-4 being the medial side, a-b as the posterior side, a'-b' anteriorly, and 1 and 2 (in bold) laterally for the medial row anchors.

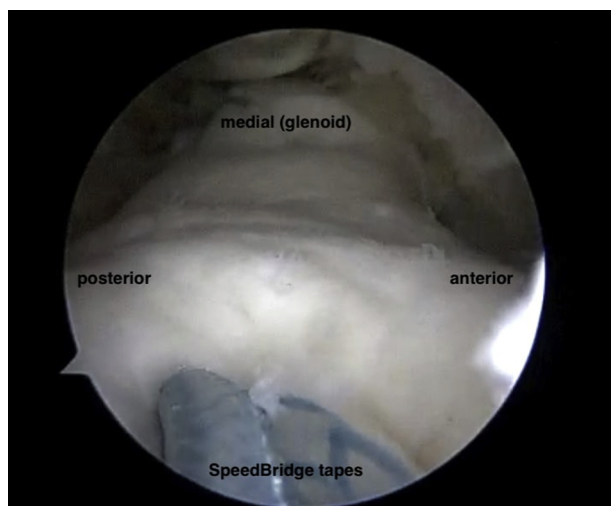


Fig 8. Final graft visualization. Finalized graft as viewed from the lateral portal. The medial glenoid sutures are visible, as well as the SpeedBridge tapes which have been incorporated into the lateral row SwiveLock anchors.

Next, the camera is moved to a posterolateral accessory portal and the posterior portal becomes the working portal. At this point, a medial row of SpeedBridge SwiveLock anchors (Arthrex) are placed in the humeral head just lateral to the articular margin. These tapes will be passed through the graft using previously placed shuttling sutures and are tensioned appropriately through the lateral portal. The subscapularis and infraspinatus SutureTapes are passed through the graft using the shuttle sutures (Fig 4).

Attention is then turned to the glenoid knotless Bio-SutureTak sutures. These are also passed through the graft using shuttle sutures (alternatively using a Hewson suture passer) in the following fashion: pass anterior mattress from A to P (hole 1 to 2, Figs 3 and 5; then pass middle mattress from A to P (hole 2 to 3, Fig 3); last pass posterior mattress from P to A (hole 4 to 3, Figs 3 and 6). Once all sutures are passed and tensioned, pass a cigar-rolled acellular dermal graft with a KingFisher through the 12-mm PassPort using the 3 glenoid SutureTaks to control the passage (Fig 7). Once the graft is secured to the glenoid these sutures may be cut.

Lastly, pass a tape retriever down to take slack out of the medial row tapes passed through the graft. Then, complete the SpeedBridge repair with placement of these medial row tapes in a crossed fashion into 2 lateral row SwiveLock (Arthrex) anchors (Fig 8). Finish tying the anterior subscapularis and posterior infraspinatus side-to-side sutures tensioned with the arm in 30° of abduction and neutral rotation.

Rehabilitation

The patient is discharged in an abduction sling. Phase 1 encompasses the first through fourth postoperative week, and the goals are to protect the reconstruction

and decrease pain. The patient should maintain sling immobilization at all times with the exception of daily hygiene activities and gentle, passive range of motion. Active range of motion of the hand, wrist, and elbow is encouraged to decrease postoperative swelling. Physical therapy may begin for gentle, passive exercises, activities of daily living retraining, and to begin a home exercise program consisting of supine active-assisted scapular elevation.

Phase 2 begins after the fourth postoperative week and lasts until approximately 8 weeks postoperatively. The goals are, again, to protect the repair and decrease pain. In addition, range of motion is encouraged as well as strengthening and stabilizing periscapular musculature. Only active-assisted range of motion is allowed until the sixth postoperative week, when controlled, active range of motion is begun. By the end of this phase, the patient should be able to tolerate their arm out of the sling and activate their cuff and deltoid without pain.

Phase 3, after week 8, aims to restore the patient's full passive range of motion and improves strength. Ideally, the patient should be able to achieve full, painless passive range of motion and avoid a shoulder "shrug" when initiating active range of motion. During this phase, the patient may return to light activities of daily livings below 90° of forward elevation. Overhead activities are not allowed. Strengthening continues with periscapular and cuff strengthening, i.e., side-lying external rotation exercises and resistance band exercises for internal and external rotation.

Phase 4, after week 12, aims to restore strength to the best of the patient's ability and to normalize scapula-humeral rhythm throughout the entire range of motion. Once proper proximal stability is demonstrated, the patient may progress to overhead activity as tolerated. Patients should be actively participating in exercises with their therapist and maintaining strength and range of motion with a home exercise program. As with all postoperative rehabilitation regimens, adjustments are made based on individual patient factors. The patient advances to each subsequent phase only when he or she demonstrates all of the required components from the previous phase are met.

Discussion

Irreparable rotator cuff tears are a challenging surgical problem and lead to superior migration of the humeral head. SCR is a method by which to recreate a humeral head depressor, and success has been demonstrated with both autograft and allograft tissues.^{4,7} Furthermore, the thickness of ACD has been shown to influence the ability of the reconstructed superior capsule to perform its role as a humeral head depressor. Recently a 6-mm thick graft, double the normal thickness of a traditional 3-mm acellular dermal allograft, has been

shown to be noninferior to recreating native shoulder biomechanics.⁹ While performing this technique, care should also be taken to preserve the remaining coracoacromial ligament, as transection of the CA ligament has been shown to increase strain on the scapular spine.¹¹ This description demonstrates the use of a 6-mm-thick ACD to perform an arthroscopic SCR via a consistent, reproducible technique that minimizes both donor-site morbidity and operative time.

References

1. Pouliart N, Somers K, Eid S, Gagey O. Variations in the superior capsuloligamentous complex and description of a new ligament. *J Shoulder Elbow Surg* 2007;16:821-836.
2. Adams CR, DeMartino AM, Rego G, Denard PJ, Burkhart SS. The rotator cuff and the superior capsule: Why we need both. *Arthroscopy* 2016;32:2628-2637.
3. Mihata T, McGarry MH, Kahn T, Goldberg I, Neo M, Lee TQ. Biomechanical role of capsular continuity in superior capsule reconstruction for irreparable tears of the supraspinatus tendon. *Am J Sports Med* 2016;44:1423-1430.
4. Burkhart SS, Denard PJ, Adams CR, Brady PC, Hartzler RU. Arthroscopic superior capsular reconstruction for massive irreparable rotator cuff repair. *Arthrosc Tech* 2016;5:e1407-e1418.
5. Burkhart SS, Franckun JJ, Hartzler RU. Superior capsular reconstruction for the operatively irreparable rotator cuff tear: Clinical outcomes are maintained 2 years after surgery. *Arthroscopy* 2020;36:373-380.
6. Burkhart SS, Hartzler RU. Superior capsular reconstruction reverses profound pseudoparalysis in patients with irreparable rotator cuff tears and minimal or no glenohumeral arthritis. *Arthroscopy* 2019;35:22-28.
7. Mihata T, Lee TQ, Hasegawa A, et al. Five-year follow-up of arthroscopic superior capsule reconstruction for irreparable rotator cuff tears. *J Bone Joint Surg Am* 2019;101:1921-1930.
8. Hirahara AM, Adams CR. Arthroscopic superior capsular reconstruction for treatment of massive irreparable rotator cuff tears. *Arthrosc Tech* 2015;4:e637-641.
9. Shah SS, Kontaxis A, Jahandar A, et al. Superior capsule reconstruction using a single 6 mm thickness acellular dermal allograft for massive rotator cuff tears: A biomechanical cadaveric comparison to fascia lata allograft [published online January 5, 2010]. *J Shoulder Elbow Surg*. <https://doi.org/10.1016/j.jse.2020.11.015>.
10. Frank RM, Cveticanovich G, Savin D, Romeo AA. Superior capsular reconstruction: Indications, techniques, and clinical outcomes. *JBJS Rev* 2018;6:e10.
11. Taylor SA, Shah SS, Chen X, et al. Scapular ring preservation: Coracoacromial ligament transection increases scapular spine strains following reverse total shoulder arthroplasty. *J Bone Joint Surg Am* 2020;102:1358-1364.