Technical Note

Anterior Approach to Retracted Anterosuperior Cuff Tear With Biceps Superior Capsular Reconstruction and Subscapularis Release and Repair With Transosseous Equivalent Double-Row Repair

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Abstract: The incidence of a subscapularis tear combined with any other rotator cuff tear is around 19% to 49% among all rotator cuff lesions. On the contrary, less attention has been given to the treatment of anterosuperior rotator cuff tears, particularly by arthroscopic methods. Subscapularis lesions are hard to access and require advanced surgical technique along with optimum visualization to achieve an anatomic repair. Use of an anterior portal helps in obtaining a good visualization with a 30° arthroscope in viewing the tendon along its axis as well as the posterior, superior, and anterior sides. Incorporation of the biceps tendon along with supraspinatus repair helps strengthen the supraspinatus repair as well as preserve the acromiohumeral index. Double-row repair of both subscapularis and supraspinatus ensures an adequate bone bed for tendon healing.

Rotator cuff tears can be situated anteriorly, superiorly, posterosuperiorly, or anterosuperiorly.[1] Anterosuperior rotator cuff tear is defined as a full-thickness tear of the supraspinatus that extends to its anterior border as well as into the subscapularis tendon involving rotator interval structures.[2] The long head of the biceps is usually unstable or subluxates in these lesions due to loss of the biceps pulley, which is formed by the superior portion of the subscapularis.[3] These lesions usually progress to become massive tears without early intervention.[4] The incidence of a subscapularis tear combined with any other rotator cuff tear is around 19% to 49% among all rotator cuff lesions.[5] The comma sign is an important arthroscopic finding in anterosuperior cuff tears that present as a vertical band anterior to the superior glenoid labrum and can be found on magnetic resonance imaging (MRI) with a sensitivity of 68%.[6] A recent systematic review suggested that regardless of type of tear (isolated or combined) or type of repair (single or double row), there are significant improvements in all outcomes.[7]

Arthroscopic repair of these massive tears can produce durable reversal of proximal humeral migration and restoration of overhead function.[8] In isolated subscapularis tears, mobilization is generally not required as the muscle-tendon unit is usually not retracted compared with the massive combined tears, which involve the subscapularis tendon along with the supraspinatus and infraspinatus tendons. Arthroscopic repair of these anterosuperior rotator cuff tears often requires 2 different procedures along with addressing the associated biceps pathology.[9] Here we describe a technique of repair of a massive retracted anterosuperior cuff tear managed through anterior portals, which provided excellent visualization for the repair, and discuss various tips and concepts based on the repair that was performed (Video 1).

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Patient Evaluation, Imaging, and Indications

This technique is best used for patients with shoulder pain and pseudo-paralysis of less than 6 months with MRI showing a retracted supraspinatus and subscapularis tear, which can be classified as Patte type 3 as well as Lafosse type IV, indicating a complete tear of the subscapularis with retraction until glenoid and minimal fatty infiltration but with the humeral head remaining well centered.[10,11]

Surgical Technique

In retracted and combined rotator cuff tears that involve both the subscapularis and supraspinatus tendons, an extra-articular approach from the subacromial and anterior subdeltoid space provides better visualization (Fig 1). Three anterior/anterolateral portals are required to obtain appropriate visualization, ease of release, and tension-free repair. For severe retraction, we can use the double-row construct to maximize the surface area for healing.

Patient Positioning and Portal Placement

The patient is placed in a beach-chair position under general anesthesia and with an interscalene block, with the arm in 3 kg of traction in 45° of forward flexion and neutral rotation and abduction. Equipment includes a standard 30°, 4-mm arthroscope (Arthrex), shaver (Arthrex), radiofrequency ablator (Arthrocare; Smith & Nephew), suture-passing device (Scorpion; Arthrex), and oval burr (Arthrex). Portals used include the posterior portal, anterior portal, anterosuperior portal, anterolateral portal, and mid-axillary portal (Fig 2).

Fig 2. Patient in the beach-chair position with a 30° arthroscope, showing portal placement. Posterior portal (A), anterior portal (E), anterosuperior portal (AS), anterolateral portal (J), and mid-axillary portal (I).

Subscapularis Release

The rotator interval is opened above the subscapularis tendon by the anterior portal as a working portal and the posterior portal as a viewing portal. Then, using a needle introduced into the anterosuperior angle of the acromion to the superior part of the subscapularis insertion area, the anterosuperior portal is created as an accessory portal. Complete release of the coracohumeral ligament and the middle glenohumeral ligament is performed. The coracoid is released of soft tissue from the inferior and posterior aspect. We then shift our 30° arthroscope to the anterior portal for an inline view of the subscapularis tear along its tendon. Tendon retraction release and control of reduction are best performed with the arthroscope in the anterior portal, which allows good visualization of the subscapularis release performed via the anterolateral portal. A switching stick is introduced via the anterosuperior portal to elevate the pectoralis major, which provides space for release of the anterior aspect of the subscapularis (Fig 3). The systematic 3-sided release starts anteriorly by dissecting the soft tissue attachments between the subscapularis and the coracoid. The superior release comprises the lysis of adhesions between the lateral arch of the coracoid and the superior border of the subscapularis. The superior edge is then released between the subscapularis and the coracoid, avoiding the suprascapular nerve notch. Any adherences are released intra-articularly, between the subscapularis and the inferior glenohumeral ligament,

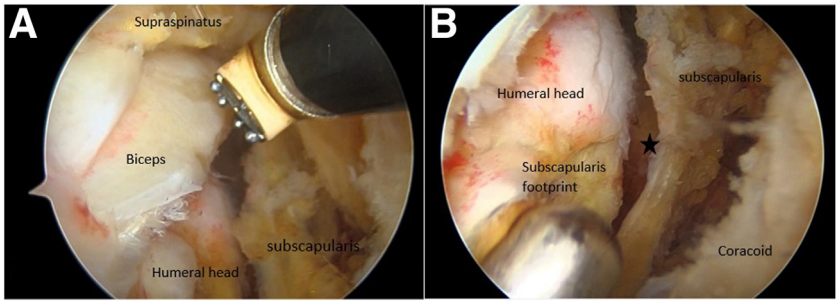

Fig 1. Arthroscopic image of right shoulder joint, viewing from the anterior portal in a beach-chair position showing anterosuperior cuff defect (A) and complete tear of the subscapularis retracted to the glenoid (B). Star represents the glenoid.

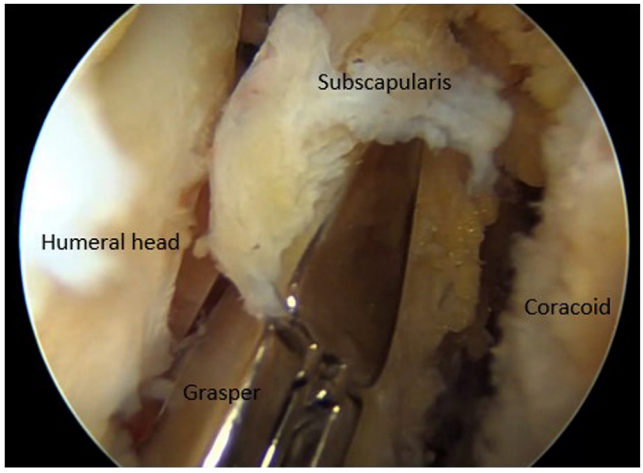

Fig 3. Arthroscopic image of the right shoulder joint, viewing from the anterior portal in a beach-chair position showing poor reducibility of the subscapularis.

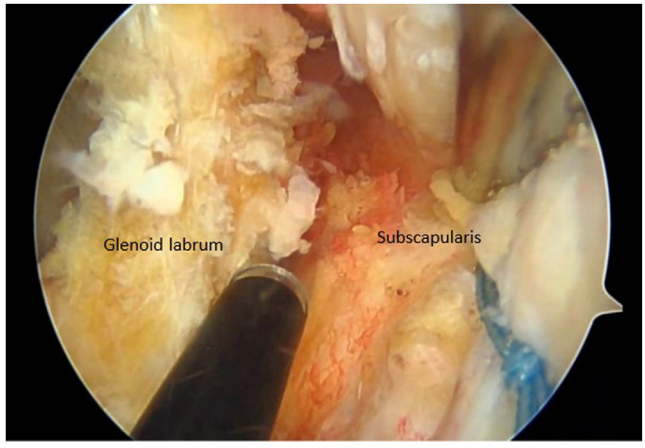

Fig 4. Arthroscopic image of the right shoulder joint, viewing from the anterior portal and working from the anterolateral portal in a beach-chair position for release of the posterior surface of the subscapularis using a traction suture applied on the subscapularis.

then on the superior edge of the subscapularis tendon, and finally forward of the subscapularis in the subcoracoid space, taking care not to go beyond the medial aspect of the coracoid, which is the outer limit of the vasculoneural structures. Lesion reducibility is then assessed by lateral traction from a grasper introduced via an approach to the anterosuperior portal, to check whether further tendon release is needed.

Further release is done by alternating anterior and posterior surface release and begins by placing a traction suture using the suture-passing device onto the subscapularis and applying traction in line with the subscapularis through the anterosuperior portal (Fig 4). The anterior side of the muscle is then exposed as much as possible, releasing the conjoint tendon from the pectoralis major by clearing the clavipectoral fascia until the superior side of the distal part of the coracoid. Dissection continues down and inward, to visualize the axillary nerve to avoid risk of neurologic damage. This part of the procedure is often hemorrhagic, requiring alternation between a shaver and a hemostasis device. Finally, the posterior release is performed to break up adhesions between the subscapularis and the glenoid neck. Frequently, the interval between the labrum and the capsule needs to be divided to allow for proper mobilization of the subscapularis tendon (Fig 4).

After mobilization for an adequate and tension-free reinsertion, we can medialize the attachment site up to 5 mm by creating a larger footprint. The subscapular insertion is cleared of soft tissue without decorticating the lesser tuberosity to preserve the pullout strength of future anchorages (Fig 5). For large complete tears that extend into the muscular insertion, we can use 1 triple-loaded tape anchor (Arthrex) through the anterior portal at an appropriate angle to the lesser tuberosity, and each suture strand is pulled out of the anterolateral portal through a cannula and shuttled through the tendon using a suture-passing device after achieving adequate lateral excursion of the subscapularis tendon using the tension suture. The sutures are tied using standard arthroscopic knot tying, typically through the anterolateral portal over the anterior aspect of the muscle to prevent cut-through, and the repair is completed by passing the sutures through a 5.5-mm SwiveLock (Arthrex) knotless anchor placed over the anterior aspect of the greater trochanter (Fig 6).

Biceps Superior Capsular Reconstruction

Biceps tenotomy is done at the suprapectoral level through the mid-axillary portal as a working and anterolateral portal for viewing after adequate

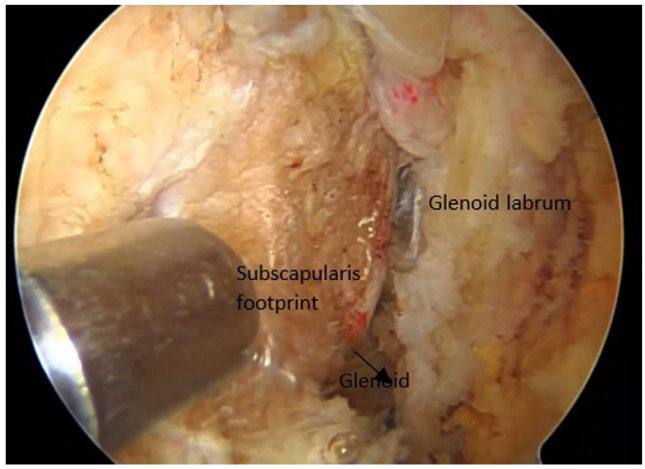

Fig 5. Arthroscopic image of the right shoulder joint, viewing from the anterior portal in a beach-chair position showing preparation of the subscapularis footprint. Black arrow shows the glenohumeral joint surface.

subacromial decompression (Fig 7). An Ethibond (Ethicon) loop stitch is taken on the cut end of the medial segment of the biceps using the suture-passing device for applying traction. We can use 1 triple-loaded all-suture anchor (Smith & Nephew) and 1 double-loaded (Stryker) all-suture tape anchor as the medial row. Both medial row anchors can be placed just lateral to the articular margin, where pullout strength is more. Using an arthroscopic drill (oval), a trough is created in line with the anterior medial row anchor for incorporation of the biceps tendon (Fig 8).

One suture strand from the anterior anchor is used to make a cinch loop through the lateral end of the medial segment of the biceps (with intact attachment to the glenoid), and the other strand is passed horizontally/perpendicularly to the first strand, and both strands are knotted such that the biceps is placed flush in the trough created (Fig 8). The sutures from the biceps tendon are further passed to the supraspinatus, followed by passage of all other sutures from the medial 2 anchors to the anterior part of the supraspinatus (Fig 9).

Similarly, a second double-loaded tape anchor is placed 5 mm posterior to the anterior anchor, and tapes are passed through the posterior part of the supraspinatus using a suture passer. The bone bed medial-to-medial row anchors are decorticated, and a microfracture is done along with tuberoplasty. The supraspinatus footprint can also be medialized by 5 mm in case of retraction. All sutures from both anchors are knotted over the muscle, and anterior strands and posterior strands are grouped and crossed to fix into two 5.5-mm SwiveLock (Arthrex) lateral row anchors as in the transosseous equivalent double-row construct (Fig 10). Care is taken to place lateral row anchors 5 mm apart from each other as well as from the lateral row anchor of the subscapularis construct to prevent convergence of drill holes leading to fracture and loss of purchase, which can be a dreaded complication (Fig 11).

Postoperative Rehabilitation

Postoperatively, the patient is managed with immobilization in an abduction pillow for 6 weeks, after which there are passive range of motion exercises as well as active assisted forward flexion exercises. External rotation is restricted to 0° for 6 weeks, followed by an increase to 45° by the next 6 weeks. The patient is weaned from an abduction brace after 6 weeks and given a sling for the next 6 weeks. End-range stretching and joint mobilization techniques are started by end of 3 months, and strengthening exercises are started once sufficient glenohumeral and scapulothoracic kinematics have been achieved, along with sufficient rotator cuff strength (Fig 12).

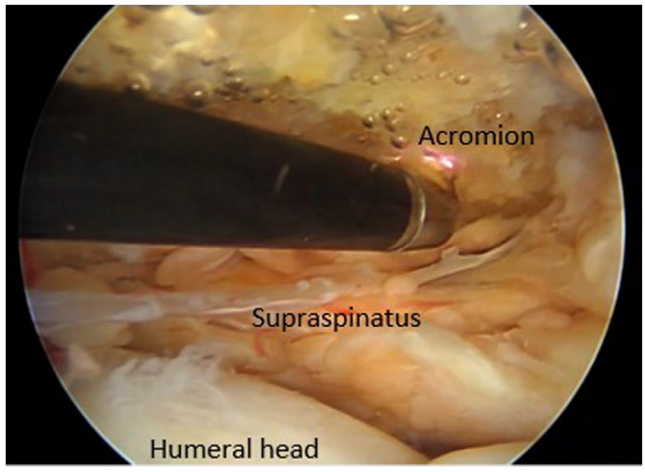

Fig 7. Arthroscopic image of the right shoulder joint, viewing from the anterosuperior portal in a beach-chair position showing the retracted supraspinatus tear during subacromial decompression done from the anterolateral portal.

Discussion

The subscapularis muscle tendon unit is of great importance for normal shoulder function, and it pulls the humeral head posteriorly as well as causes internal rotation of the humerus on the glenoid, thereby acting as an important dynamic and static anterior stabilizer of the glenohumeral joint.[12] The arthroscopic repair of subscapularis tears is demanding and can be very challenging, even for experienced surgeons. Subscapularis lesions are hard to access and require

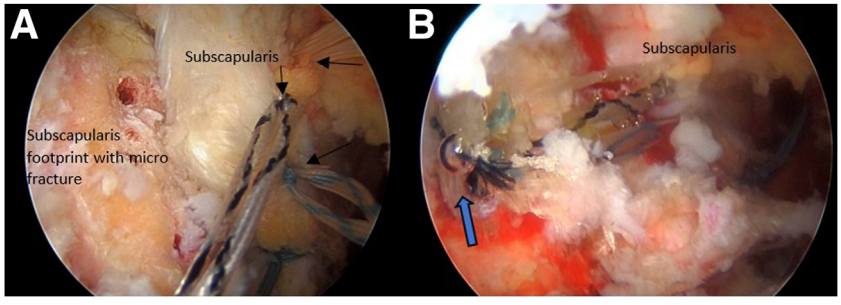

Fig 6. Arthroscopic image of the right shoulder joint, viewing from the anterior portal in a beach-chair position showing the final subscapularis repair. (A) After medial row. (B) After lateral row. Black arrows show knotted sutures from the medial row over the anterior surface of the subscapularis. Blue solid arrow shows the position of the lateral row knotless anchor.

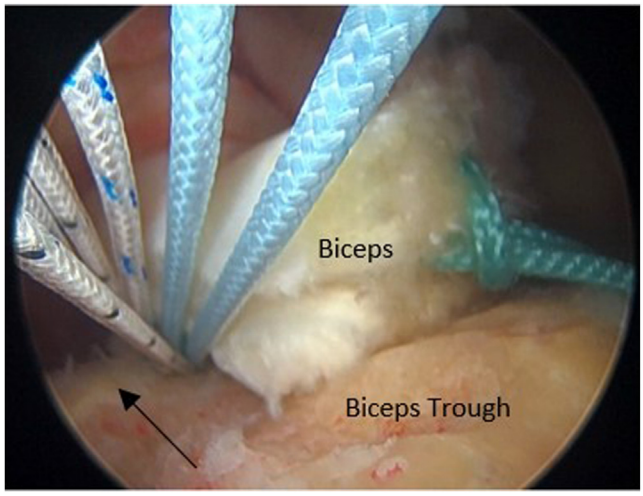

Fig 8. Arthroscopic image of the right shoulder joint, viewing from the anterolateral portal in a beach-chair position showing medial anchor placement with the biceps trough prepared over the greater trochanter. Black arrow shows articular margin of the humeral head.

advanced surgical technique along with optimum visualization to achieve an anatomic repair. Most often, a 70° arthroscope may be needed for adequate visualization of the tear and the subscapularis footprint on the lesser tuberosity.[13] Use of the anterior portal helps in obtaining a good visualization with the 30° arthroscope in viewing the tendon along its axis as well as the posterior, superior, and anterior sides.[14] Traction exerted on the subscapularis by means of traction sutures in the axis of the tendon through anterosuperior portal and an arthroscopic elevator through the anterolateral portal helps to mobilize the anterior and posterior aspects of the subscapularis, as well as helps assess the reducibility during the process of elevation. Release of the inferior border of the tendon was avoided to minimize the chance of neurovascular injury. By freeing all except the inferior border, traction on the tendon would effectively disrupt any adhesions inferiorly.[8]

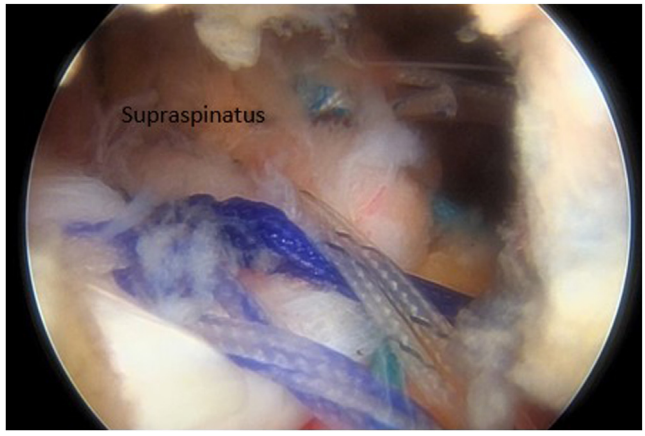

Fig 10. Arthroscopic image of the right shoulder joint, showing a final supraspinatus repair construct using transosseous equivalent double-row repair.

The subscapularis tendon footprint at the lesser tuberosity of the humerus is broad proximally and tapered distally, which is of significance when attempting to repair the tendon. The mean height of the insertion is 25.8 mm and the mean width 18.1 mm. The rectilinear medial edge is more or less parallel to the longitudinal axis of the humeral shaft.[15] A more recent anatomic cadaveric study by Yoo et al.[16] described the footprint in facets and concluded that the first 2 facets (the superior facets) together represent approximately 60% of the tendon's insertion area. As such, repairs should be made with these considerations in mind.

The rotator cable has been described as a thick, fibrous load-bearing structure spanning transversely as a crescent-shaped arc across the supraspinatus and infraspinatus tendons.[17] The anterior cable links the supraspinatus and subscapularis tendons together. Hence, repairing both is essential for a stable repair and optimum function. Incorporation of the biceps tendon along with the rotator cuff provides superior stability with preserved acromio-humeral index similar to that of anterior cable reconstruction.[18] For the supraspinatus, we used transosseous equivalent double-row

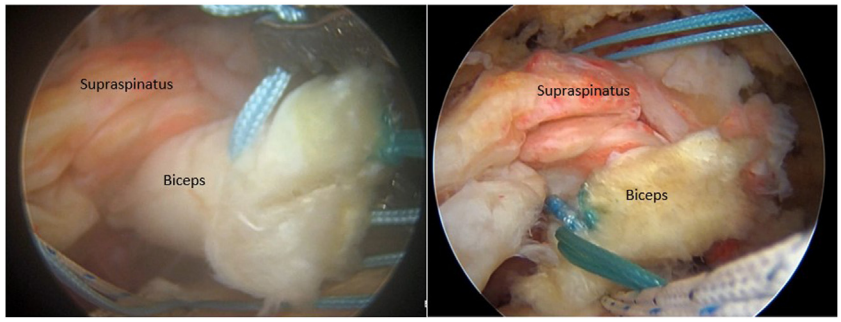

Fig 9. Arthroscopic image of the right shoulder joint, viewing from the anterolateral portal in a beach-chair position showing biceps incorporation to the cuff using a cinch suture passage through the biceps followed by passage of the same suture threads through the supraspinatus after knotting.

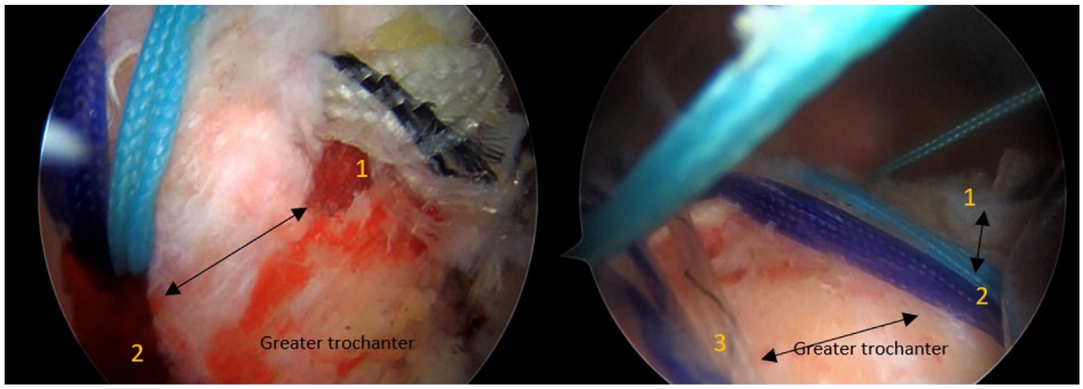

Fig 11. Arthroscopic image of the shoulder joint, viewing from the anterolateral portal in a beach-chair position showing the spacing (double arrow) of all 3 lateral rows: (1) subscapularis lateral row, (2) anterior lateral row of the supraspinatus, and (3) posterior lateral row of the supraspinatus repair construct.

Fig 12. Three-month postoperative period rehabilitation. (A) Forward flexion. (B) External rotation with arm by side. (C) External rotation with arm at 90° of abduction.

repair, in which after the medial row has been placed and tied, the sutures from the medial row are crossed and fixed with knotless anchors placed 1 cm lateral to the footprint, compressing the tissue to the anatomic footprint without causing tissue strangulation by the knots and thereby preserving better tendon vascularity.[19]

Advantages of this technique of the anterior approach are that it provides better visualization and orientation to address the concomitant supraspinatus and subscapularis tear as well as any associated biceps pathology. Medialization of footprint helps in tension-free repair and aids in biological tendon to bone healing. Concomitant biceps superior capsular reconstruction provides more stability to the weak interface between the supraspinatus and the subscapularis and helps maintain the continuity of the rotator cable. Patient selection is very important as severely atrophied and retracted tissues cannot be mobilized to footprint, and in such cases, conversion to an open procedure is warranted. Accurate and precise anchor insertion is advised as these kinds of tears are accompanied with osteoporosis, and anchor loosening or convergence of anchor holes can be disastrous. A disadvantage is that this approach is technically demanding and needs advanced arthroscopy training. The risk of neurovascular injury while mobilizing the subscapularis is high. Advantages, pitfalls, and limitations are summarized in Tables 1 and 2. The surgical procedure is demonstrated in Video 1.

Table 1. Pearls and Pitfalls of Technique

Pearls:
1. Adequate visualization by subacromial decompression and clearance of anterior gutter is essential for performing the technique.
2. Adequate mobilization of rotator cuff needs to be achieved for tension-free repair.
3. Strict adherence to follow-up and postoperative rehabilitation is mandatory for optimum results.
Pitfalls:
1. It is technically demanding and requires advanced arthroscopic skills.
2. Only a rotator cuff that can be mobilized to a footprint can provide an optimum result.
3. Fatty infiltration of muscle can cause suboptimum results.
4. Osteoporosis can compromise anchor placement.

Table 2. Advantages and Disadvantages of the Procedure

Advantages:
1. Provides better visualization and orientation to address the subscapularis tear
2. Biologically superior construct and provides ab adequate bone bed for healing
3. Addresses the concomitant supraspinatus, subscapularis, and biceps pathology
Disadvantages:
1. Limited to rotator cuff tissue, which can be mobilized to the footprint
2. Additional portals required to address posterior based cuff pathology
3. Potential risk of injuring neurovascular structures during subscapularis mobilization
4. Scarring can limit its use for revision cases
5. Technically demanding

The key point in massive subscapularis repair is to apply traction on the subscapularis by means of traction sutures in the axis of the tendon through the anterosuperior portal while visualizing through the anterior portal, and mobilizing the tendon using an arthroscopic elevator through the anterolateral portal helps to mobilize the anterior and posterior aspects of the subscapularis as well as assess the reducibility during the process of elevation. Use of the anterosuperior portal for elevating the pectoralis major as well as for traction suture application also helps in easing out subscapularis mobilization. Incorporation of the biceps tendon along with supraspinatus repair helps strengthen the supraspinatus repair as well as preserve the acromiohumeral index. Double-row repair of both the subscapularis and the supraspinatus ensures an adequate bone bed for tendon healing.

Disclosures

All authors (A.V.N., ST.J. M.R., B.B. P.S.K) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

During the preparation of this work, the authors used the TTS maker website (text-to-speech website) for giving a voiceover for the video.

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