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Arthroscopic repair of the subscapularis

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Although first reported in 1834 by John Gregory Smith,[1] tears of the subscapularis tendon were not well recognized and largely excluded from the orthopedic literature until more recently. With the advent of arthroscopy, advancements in the clinical and radiographic detection of tears, and improvements in surgical instrumentation and technique, there has been a renewed focus on recognition and repair of the torn subscapularis tendon. Previously thought uncommon, these tears can occur in isolation or, more often, in conjunction with other shoulder pathology.[2–4] Surgeon awareness of subscapularis pathology and repair techniques is essential, as lesions are often identified on diagnostic shoulder arthroscopy for repair of the posterosuperior rotator cuff, or associated biceps pathology, having been overlooked on preoperative imaging.[5] The focus of this chapter is on arthroscopic management of subscapularis tears.

INDICATIONS

Indications for arthroscopic subscapularis repair include a patient with a painful shoulder with evidence of a full-thickness subscapularis tear or a partial-thickness tear who has failed non-operative treatment. Repair is also indicated in most circumstances for an acute tear. Contraindications to repair include pain free, grade 4 Goutallier fatty degeneration on magnetic resonance imaging (MRI), glenohumeral arthropathy, infection, the non-compliant patient, and significant medical comorbidities precluding anesthesia.[6]

There has been some debate over repair of chronic subscapularis tears. The tendon edge does retract further medially than in tears of the posterosuperior rotator cuff.[7,8] However, we have found the tendon to be mobile, aided by releases as necessary; therefore we believe that repair should be attempted if there is no contraindication, in particular in the dominant arm in a physically active individual. The subscapularis has been suggested to function as an anterior restraint and contribute to elevation of the arm. Thus, even in the setting of fatty degeneration an argument for repair can be made.[9,10] In addition, with combined tears of the rotator cuff, repair of the subscapularis facilitates repair of the posterosuperior rotator cuff and reduces tension on the complete repair construct.[11,12]

DIAGNOSIS

Typical patient demographics include both young and old patients and tend to occur more often in males versus females. The patient often reports a history of forced external rotation and describes pain located in the anterior shoulder. Isolated tears of the subscapularis are often traumatic tears, and can be associated with glenohumeral dislocation.[13] More commonly, patients present with subscapularis tears in conjunction with tearing of the anterior supraspinatus and structures compromising the rotator interval, or with large multi-tendon tears of the rotator cuff. Tendon degeneration has been shown to occur in the subscapularis at similar rates to the superior and posterior rotator cuff.[14,15] Subcoracoid impingement may also be a factor to a limited degree.[16]

Physical examination

Subscapularis pathology can often be diagnosed via clinical examination alone. The surgeon must assess the biceps tendon for pathology, as it nearly always occurs concomitantly with injury to the subscapularis due to the intimate nature of these anatomical structures. Assessing the posterosuperior cuff and acromioclavicular (AC) joint are included.

A directed physical examination includes inspection, tenderness to palpation, range of motion, internal rotation (IR) strength, and special tests (Table 21.1). The AC joint, coracoid, long head of the biceps tendon, and lesser tuberosity should be palpated for tenderness. The position of the biceps muscle is noted, which may be more distal if ruptured. Passive and active range of motion of the shoulder are assessed, including in IR, external rotation (ER), and forward elevation, noting any deficiencies relative to the contralateral shoulder. Patients with large full-thickness tears of the subscapularis often have increased passive external rotation versus the contralateral side, especially in chronic tears. IR strength is assessed as the patient is asked to place the hand on the abdomen while bringing the elbow forward. The examiner attempts to pull the hand off the abdomen while externally rotating the arm at the elbow as the patient attempts to internally rotate.

Several special tests are used to identify tears of the subscapularis. Gerber and Krushell[16] first described the lift-off technique, where the arm is internally rotated behind the torso with the elbow flexed (Figure 21.1). The patient with subscapularis tearing is unable to lift the dorsum of the hand off the back. A modified version of this special test requires the examiner to lift the hand off the back and then release.[17] The test is positive when the patient is unable to maintain positioning of the hand. In order to

Table 21.1 Physical exam findings.

Test	Positive findings
Passive ER	Increased ER versus contralateral normal shoulder
IR strength	Weakness
Belly-press	Inability to keep elbow in line with or in front of trunk
Napoleon's sign	The elbow falls behind the trunk and the wrist flexes
Lift-off test	Inability to lift the hand off the back
Modified lift-off test	Inability to maintain hand off the back when lifted away by the examiner

Note: ER: external rotation; IR: internal rotation.

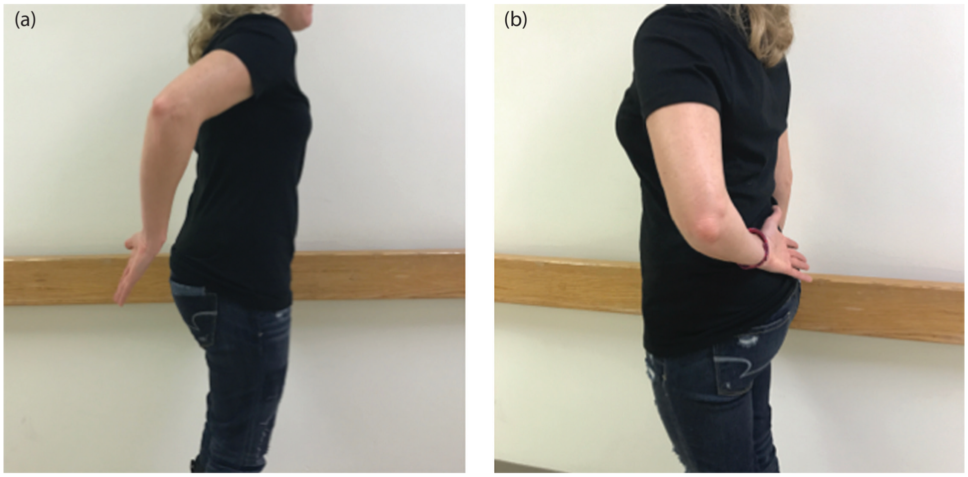

Figure 21.1 Lift-off test. (a) Normal lift-off test. (b) Positive lift-off test when the patient is unable to maintain the hand off the back.

Figure 21.2 Belly-press test. The patient's right arm demonstrates the normal belly-press test. The patient's left arm demonstrates a positive belly-press test, when the patient is unable to maintain the elbow at or in front of the mid-coronal plane of the trunk.

adequately assess patients with limited IR, or extreme pain limiting the utility of the lift-off test, Gerber[17] described the belly-press technique. The patient presses the abdomen with the hand flat, keeping the shoulder in IR and maintaining the elbow at or in front of the mid-coronal plane of the trunk (Figure 21.2). A positive test is when the elbow drops back behind the trunk. The examiner can elicit a positive sign with a posteriorly directed force on the elbow. The Napoleon sign is when the elbow falls back and the wrist flexes, the position where Napoleon Bonaparte held his arm during pictures.[18] Lastly, the bear-hug test has proved sensitive for tears of the upper third of subscapularis.[19] The patient's hand is placed across the body on top of the opposite shoulder with the elbow elevated, and the examiner attempts to pull the hand off of the shoulder. The test is considered positive if the examiner is able to lift the patient's hand off the shoulder.

Imaging

Although a full shoulder series of plain radiographs should be obtained in each patient specifically to assess for evidence of trauma, AC and glenohumeral arthritis, coracoid as well as acromial pathology, humeral subluxation, and any bony or cystic changes at the lesser tuberosity, MRI remains the standard for radiographic assessment and diagnosis. Using a combination of axial and sagittal planes, MRI has a high sensitivity and specificity for diagnosing lesions of the subscapularis.[20,21] It has recently been suggested that tear size correlates to MRI sensitivity, with larger tears having higher sensitivity than smaller tears.[22,23]

We recommend a systematic review of all MRI planes and sequences. Axial imaging is most easily used to identify tearing of the subscapularis (Figure 21.3). However, examination of coronal and sagittal images aids in characterization of tears, including PASTA-type and intra-substance variants, limited detachment of the superolateral portion of the tendon, full-thickness tearing of a portion of the tendon, and full-thickness tearing of the entire tendon insertion. Coronal imaging can help identify the extent of tearing in the cranio-caudal direction. Furthermore, fluid signal medial to the coracoid on coronal imaging is suggestive of tearing of the subscapularis (Figure 21.4). Narrowing of the coracohumeral interval <7 mm can be indicative of tearing of the subscapularis. Lastly, degree of muscle atrophy, retraction, or the presence of edema should be carefully evaluated, and are best seen on axial and sagittal images.

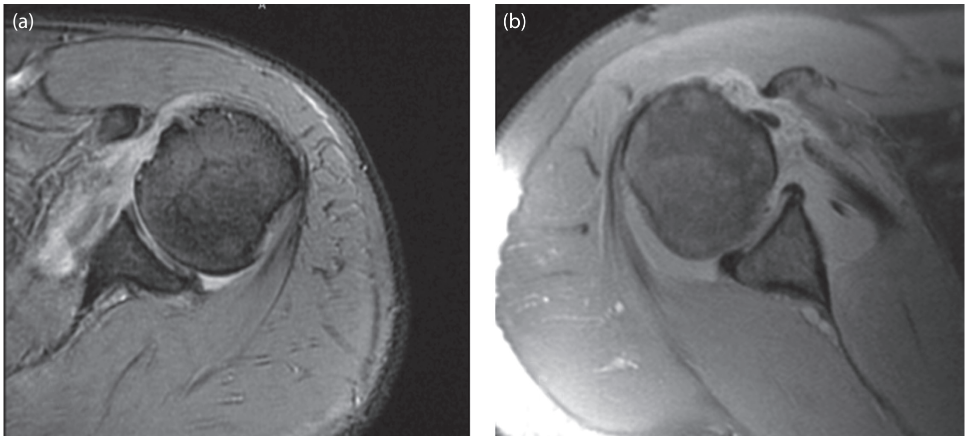

Figure 21.3 Axial magnetic resonance imaging of a tear of the subscapularis. (a) Full-thickness tearing of the subscapularis in a left shoulder. (b) Full-thickness tearing of the subscapularis with biceps tendon subluxation.

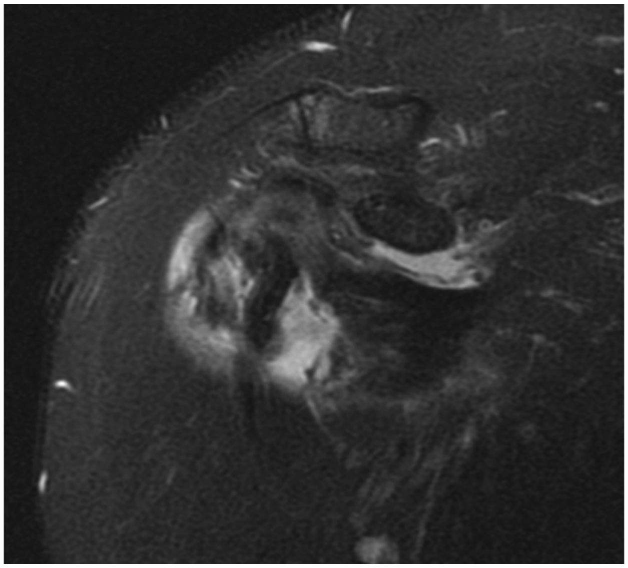

Figure 21.4 Coronal magnetic resonance imaging of a tear of the subscapularis in a right shoulder. A full-thickness tear can be seen, as well as fluid signal inferior and medial to the coracoids, which is suggestive of tearing. The biceps is displaced medially from the groove.

Biceps subluxation, dislocation, and/or tearing are consistently found as a result of the intimate association of the subscapularis, biceps sheath, and coracohumeral ligament.[24] Medial dislocation of the biceps tendon (Figure 21.4) is considered by many to be diagnostic of tearing of the subscapularis,[20] although there are rare circumstances of the biceps dislocating anterior to an intact subscapularis tendon. MRI will characterize biceps pathology as well as associated tearing of the superior and posterior rotator cuff, to aid in preoperative planning. Lastly, any cystic changes or defects in the lesser tuberosity that could compromise anchor fixations should be identified. Computed tomography arthrogram or ultrasound may be indicated under certain circumstances and useful in the diagnosis.

CLASSIFICATION

There is no consensus classification system for tears of the subscapularis. Many authors have described variants of anatomically-based classification systems, with tears progressing from the superior portion of the tendon and extending inferiorly. The most commonly reported are variants of a classification that divide the tendon insertion into three equal parts—a superior third, middle third, and an inferior third—or those that classify tears based on the relationship to the biceps sling and superior glenohumeral ligament[25–30] (Table 21.2).

OPERATIVE TECHNIQUE

Instrumentation

A standard set of arthroscopic instruments is required to perform a successful repair of the subscapularis. Key instruments used for mobilization include straight and angled arthroscopic elevators and electrocautery and ablation wands. Shuttling instruments for retrograde passing of suture through the tendon include straight and curved suture hooks, as well as piercing instruments. Although not utilized by the authors, anterograde suture passing instruments may also be used, when inserted through a separate anterolateral approach. An atraumatic suture retriever is essential. Knot tying tools are used, although the approach described below is amenable to a knotless repair—single-row for example. The authors prefer to use a 30° scope with adjusting arm position as needed for visualization, and have found little need for a 70° scope.

Table 21.2 Classification of subscapularis tears.

	Fox et al.[25]		Lyons et al.[26]		Lafosse et al.[27]		Toussaint et al.[29]
I	Partial thickness	I	Partial thickness, partial length	I	Partial superior 1/3rd lesion	1	Partial tendon tear with intact bicipital sling
II	Complete tear of upper 25%	II	Full thickness, partial length	II	Complete superior 1/3rd lesion	2	Partial tendon tear with partial bicipital sling injury with intact SGHL
III	Complete tear of upper 50%	III	Full thickness, full length without retraction	III	Complete superior 2/3rd lesion	3	Complete tendon tear with complete bicipital sling injury, minimal tendon retraction
IV	Complete rupture of entire tendon	IV	Full thickness, full length with retraction	IV	Complete lesion, centered HH, fatty infiltration ≤ grade 3	4	Complete tendon tear with complete bicipital sling injury, with retraction
				V	Complete lesion, subluxated HH, coracoid conflict and fatty infiltration ≥ grade 3		

Note: HH: humeral head; SGHL: superior glenohumeral ligament.

However, the latter may be used to aid visualization in difficult cases.

Implants

Absorbable biocomposite or PEEK anchors in diameters and lengths available for posterosuperior rotator cuff repair may be used. These anchor types require two to three steps for insertion, including punching of the hole in the lesser tuberosity and sometimes tapping of that hole before anchor insertion. This location is one which may benefit from the use of metal anchors, which require only one step for insertion, as this avoids potential angle mismatch, widening of punch or tap hole, and loss of fixation created by a two or three step insertion. These anchors also have the advantage of a pointed tip which helps prevent skiving on the lesser tuberosity. Anchors which are double- or triple-loaded with No. 2 high tensile suture are available; however, the authors often use double-loaded anchors in repair of the subscapularis to simplify suture management, passing and tying where space can be a limiting factor.

In addition to the type of anchor utilized, the number of anchors used is determined more by the amount of tendon torn, than any other factor. For example, a full-thickness tear of approximately 33% of the subscapularis—thus the upper third—is repaired with a single double-loaded anchor. A tear of 100% of the subscapularis is repaired with two anchors, often double-loaded, especially the more inferior of the two anchors. A tear of 50%–66% of the subscapularis may be repaired with two double-loaded anchors, or a single triple-loaded anchor, dictated by the tear configuration and the local anatomy. These sutures are passed in a simple fashion and tied, though the second suture limb can be passed through lateral tissue in a horizontal mattress fashion if the circumstances present. Single-row knotless techniques are described, and rarely employed by the authors. Double-row techniques have not been found necessary in our more than 16-year experience repairing subscapularis tendon tears in an arthroscopic manner.

Patient positioning and anesthesia

Although the surgery may be performed in the beach chair or lateral position, the author’s preference is the beach chair position. This position allows movement of the arm to facilitate repair, familiarity with orientation, and anatomic visualization. For the novice arthroscopist or the unusual case, this position also allows for easy conversion to an open procedure, if needed. Use of an intraoperative sterile arm holder is recommended. We prefer laryngeal mask or general endotracheal tube anesthesia in combination with interscalene regional nerve block,[31] the latter helping to reduce time spent in the recovery room and to reduce opioid usage in the immediate postoperative period. Before incision is made, an examination under anesthesia should be performed to identify shoulder range of motion and stability. Any prior surgical scars, if present, are accounted for.

Portal placement

A standard posterior portal is established and is used throughout the repair, primarily as a viewing portal. An anterior portal is planned with a spinal needle, the incision is made, and a cannula is inserted. This portal will be used for suture passing and tying and, in some cases, can be used for anchor insertion. It is often slightly more medial than the standard anterior rotator interval portal, and slightly more inferior. The portal will be along the lateral edge of the coracoacromial ligament. When there is a full-thickness defect in the supraspinatus, a lateral subacromial portal can be made about 1 cm inferior to the edge of the acromion, at a line bisecting the anterior to posterior length of the acromion or anterior to that line in the setting of smaller posterosuperior cuff tears. This portal will facilitate suture management and is used as a viewing portal when performing medial release of the subscapularis. Anchor placement is often achieved via placement of a percutaneous anterolateral portal, and is planned with a spinal needle to allow for anchor insertion at the desired location in the lesser tuberosity. If a two-anchor repair is required, this portal can be more inferior, at a midpoint between the sites of planned anchor insertion, to allow for placement of both anchors through one percutaneous approach. In the event of an isolated repair of the subscapularis, the anterolateral portal can be used for suture management, with a cannula in lieu of the lateral subacromial portal. Lastly, an accessory anterolateral portal is made percutaneously under direct visualization with a spinal needle in line with the subscapularis and tangential to the lesser tuberosity. This portal is used to retrieve a traction stitch, when utilized, which is placed in the superolateral aspect of the subscapularis to reduce the tendon during suture passing and tying (Table 21.3, Figure 21.5).

Diagnostic arthroscopy

Once the posterior viewing and anterior working portals have been established, diagnostic arthroscopy is performed. Careful evaluation of the glenoid and humeral articular surfaces and anterior and posterior labrum is performed to identify any degenerative changes or tearing requiring treatment. The posterosuperior rotator cuff is inspected to identify any concomitant pathology that may affect portal placement during repair. At this time, a full evaluation of the long head of the biceps tendon for instability and tearing should be undertaken, as well as at the superior labrum biceps anchor, with any treatment initiated before repair of the subscapularis. With partial

Table 21.3 Arthroscopic portals, with approximate locations based on individual anatomy and function.

Portal	Placement	Function
Posterior	2 cm inferior, 1 cm medial to posterolateral corner of acromion	Viewing
Anterior	Lateral to coracoid, slightly more medial and inferior than standard anterior rotator interval portal	Suture passage, suture tying, tendon mobilization, anchor insertion
Lateral	1 cm inferior to lateral edge of acromion, anterior to line bisecting acromion, through a posterosuperior cuff tear	Viewing during tendon mobilization, suture management
Anterolateral	2 cm superior and 2 cm lateral to standard anterior portal, just off tip of anterolateral edge of acromion for isolated subscapularis tear repairs	Suture management
Accessory anterolateral	Localized with a spinal, tangential to the lesser tuberosity	Traction suture in tendon

tears of the subscapularis, there should be a high index of suspicion for hidden lesions, defects of the biceps pulley in the biceps groove (Figure 21.6).[32] Early tenotomy or tenodesis removes the biceps from obstructing later repair of the subscapularis. With advancement of the arthroscope to the anterior glenohumeral joint, the subscapularis is evaluated. The tendon is viewed for discontinuity across the anterior joint extending from the lesser tuberosity, keeping in mind only a portion of the tendon is visible arthroscopically.[33] The middle glenohumeral ligament (MGHL) and anterior band of the inferior glenohumeral ligament (IGHL) are intimately associated with the tendon and cover the articular surface (Figure 21.7, normal subscapularis tendon). The subscapularis tendon is probed for any intra-substance or articular-sided tearing and integrity of the superolateral upper rolled border. The medial wall of the biceps groove denotes the lateral aspect of the lesser tuberosity and, thus, the subscapularis tendon. Full-thickness tears typically occur here, and progress inferiorly through the length of the tendon. With full-thickness and complete tears, the tendon retracts medially. In some cases where scar tissue may conceal a tendon stump, identification of the superior glenohumeral ligament (SGHL) and coracohumeral ligament complex, the “comma” tissue, can aid in identification of the subscapularis tendon, as it commonly remains attached at its superolateral corner.[34] The position of the MGHL, normally at, or lateral to, the glenoid joint line with an intact subscapularis, is often noted medial to the glenoid joint line with retraction of a subscapularis tear. Treatment of the biceps tendon pathology, by tenodesis or tenotomy, or, rarely, reconstruction of the pulley, is carried out early in this procedure to remove the tendon from the field. The technique chosen for the biceps is beyond the scope of this paper.

Figure 21.5 Patient positioning and portal placement in the left shoulder. The patient is placed in the upright beach chair position with the operative arm held in an arm holder (lower right inset). The skin markings identify the posterior viewing portal and the anterior and lateral working portals. The lateral and inferior skin marking is the location for the stab incision for the traction suture, parallel to the direction of the subscapularis.

Tendon debridement and mobilization

A glenohumeral approach to repair of the subscapularis is utilized. We have not found a subacromial approach particularly useful. With identification of the subscapularis tear and confirmation to repair the tendon, a larger anterior portal screw-in cannula, 8 mm or more in diameter, is inserted. This can accommodate the instruments and devices necessary for tear preparation and repair. Using an ablation wand, the rotator interval is cleared and the coracoid is visualized. The area anterior to the lateral aspect of the subscapularis is cleared for subsequent work in this space. This will include suture passage and, especially, suture tying. The MGHL is resected, and releases are carried out anterior, superior, and posterior to the subscapularis. This includes releasing a portion of the IGHL. The arm can be externally rotated to facilitate these releases. The lesser tuberosity can be better visualized with some forward flexion of the arm. The lesser tuberosity is denuded of soft tissue to expose the bone from lateral to

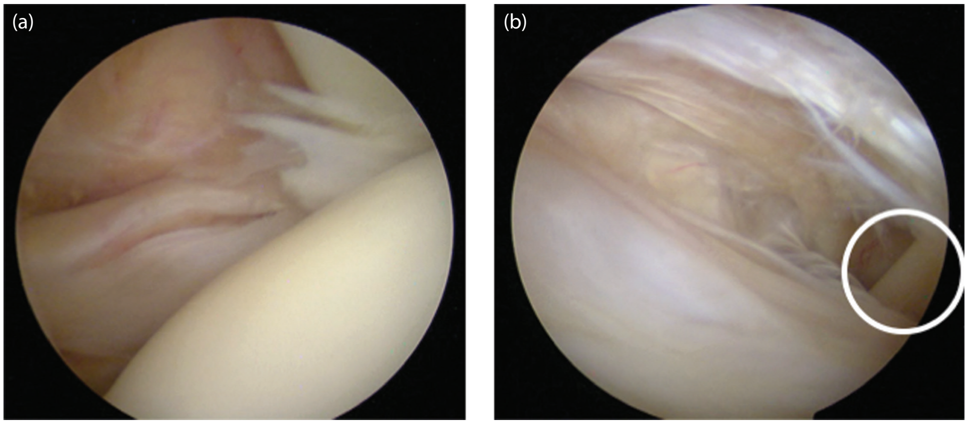

Figure 21.6 (a) Arthroscopic image of a seemingly simple partial tear of the subscapularis in a right shoulder. (b) With internal rotation of the arm and advancement of the arthroscope into the shoulder, a hidden lesion is seen with appearance of the biceps tendon on the right side of the image in the white circle.

the articular margin to just medial to the biceps groove. A shaver can be inserted through the lateral portal when the tear includes the supraspinatus, or through the anterolateral portal in an isolated subscapularis tear. If a traction suture is deemed advantageous, this is placed with a curved or crescent hook device inserted via the anterior cannula and passed through the superolateral corner of the subscapularis (Figure 21.8). A No. 1 PDS is used as the color is easily visualized, and is retrieved percutaneously as described above. With retracted tendon tears, the traction suture is usually necessary to aid with many stages of the technique. With traction of the PDS, while viewing from a lateral vantage point, the releases around the subscapularis to the base of the coracoid are completed. While a wand is most often used, and elevator can be utilized.

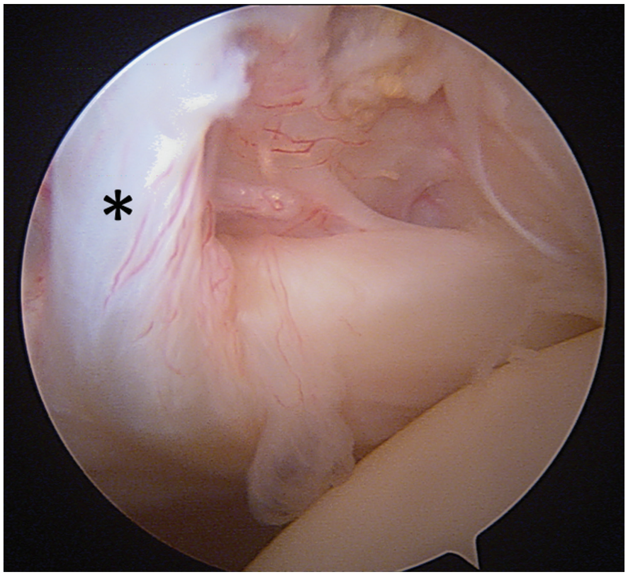

Figure 21.7 Arthroscopic image of a normal subscapularis tendon viewed from the posterior portal in a right shoulder. The asterisk (*) marks the MGHL, which is lateral to the glenoid.

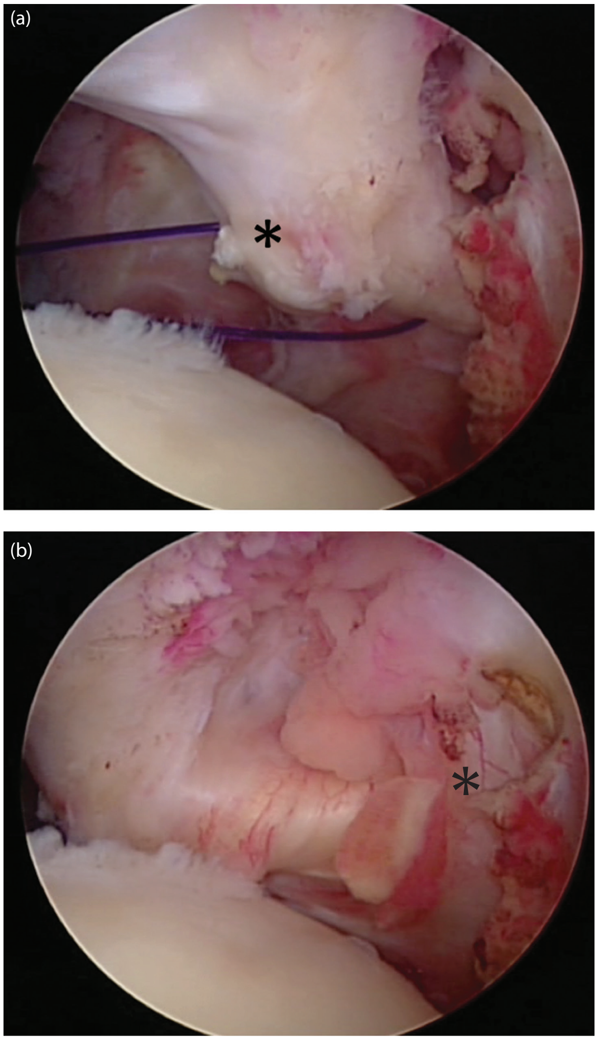

Figure 21.8 (a) Arthroscopic image of a traction stitch placed in the upper border of the subscapularis tendon in a left shoulder. The asterisk (*) marks the lower part of the "comma" tissue. (b) Reduction of the subscapularis with traction on the traction suture. The MGHL can be seen on the right side of the image, marked by the asterisk (*).

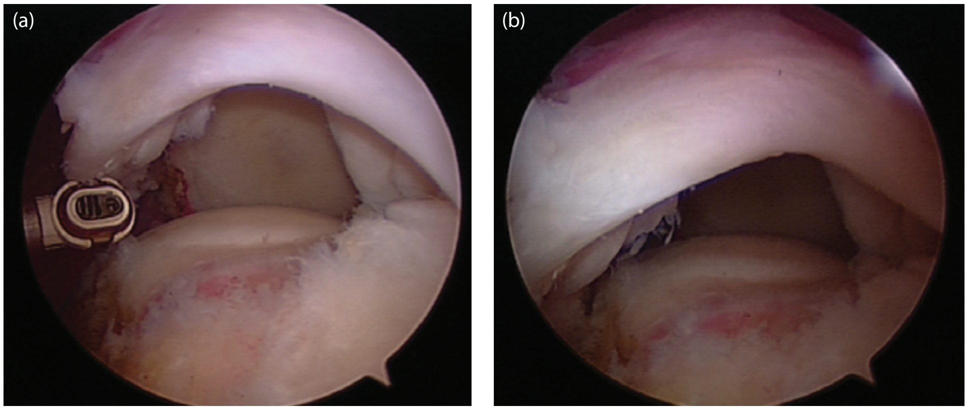

Figure 21.9 Arthroscopic image of a posterosuperior rotator cuff tear before (a) and after (b) repair of the subscapularis tendon to the lesser tuberosity in a left shoulder. The "comma" tissue link to the posterosuperior cuff will translate the posterosuperior rotator cuff tear more lateral, facilitating repair.

The muscle of the subscapularis is often visualized when the tendon is retracted laterally.

It is important to maintain the "comma" tissue in continuity between the subscapularis and the supraspinatus. When the subscapularis is repaired to the lesser tuberosity, the "comma" tissue link to the posterosuperior cuff will translate the supraspinatus tendon tear more lateral and aid this aspect of the repair (Figures 21.9 and 21.10). By pulling on the traction suture with the arm in neutral rotation, the extent of the releases can be assessed from the posterior and lateral portals. If the releases are complete, the point to which the lateral edge of the tendon translates is the approximate position for the planned anchor placement on the lesser tuberosity. The amount of lateral translation of the supraspinatus, if involved, can be further assessed at this time.

Tendon repair

The stages of preparation are completed at this point, though these steps are no less important than those of the repair. With the arthroscope in the posterior portal, anchor placement in the lesser tuberosity is planned. This can be achieved through the anterior cannula, if the angle allows, or via a percutaneous approach identified by a spinal needle. The arm can be flexed to improve visualization inferiorly on the lesser tuberosity. In addition, the arm can be rotated to permit an optimal anchor insertion angle, including external rotation for most percutaneous approaches. The position of the anchor is where the lateral edge of the tendon translates to when the traction suture is tensioned. A 45° angle of insertion may be achieved, but a lesser angle may lead to skiving of the anchor or poor placement. The anchor trajectory must be clearly into the bone of the lesser tuberosity, and lateral to the articular surface. The example below will be for a 100% subscapularis tear with an associated supraspinatus tear.

After the first anchor is inserted into the inferior portion of the lesser tuberosity and laterally as able, it is tested to ensure secure fixation. One limb of one suture is retrieved through the lateral portal cannula. Often it is apparent that one suture is more inferior, and the medial

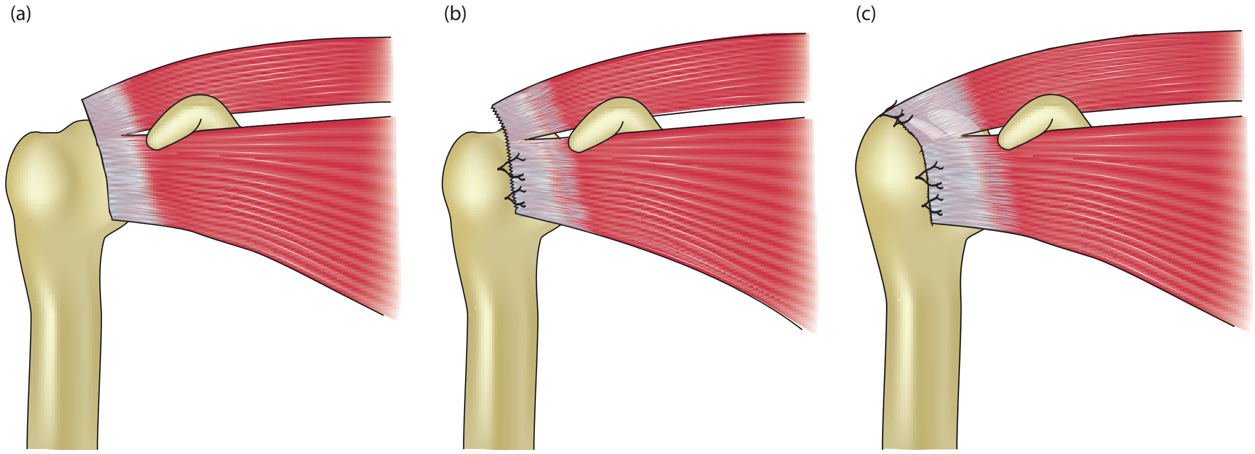

Figure 21.10 Schematic representation of a full-thickness subscapularis and posterosuperior rotator cuff tear as seen from anterior (a). Repair of the subscapularis helps reduce the posterosuperior rotator cuff (b) and facilitate its repair (c).

limb is retrieved. A crescent hook is introduced through the anterior cannula for a retrograde suture passage technique. For this 100% tear of the subscapularis tendon and the four suture limbs planned to be passed through the tendon in a simple fashion, the first suture is passed at about 2 cm inferior to the superior edge of the subscapularis, with the additional sutures passed at about 1.5, 1, and 0.5 cm inferior to the superior edge. With traction on the PDS suture and the arthroscope advanced forward to see over the rolled edge of the subscapularis, the hook is passed into and through the tendon. As this is an oblique line of passage through the tendon (Figure 21.11a), it often starts approximately 1.5 cm medially on the anterior side and can exit almost 2 cm medially on the posterior side

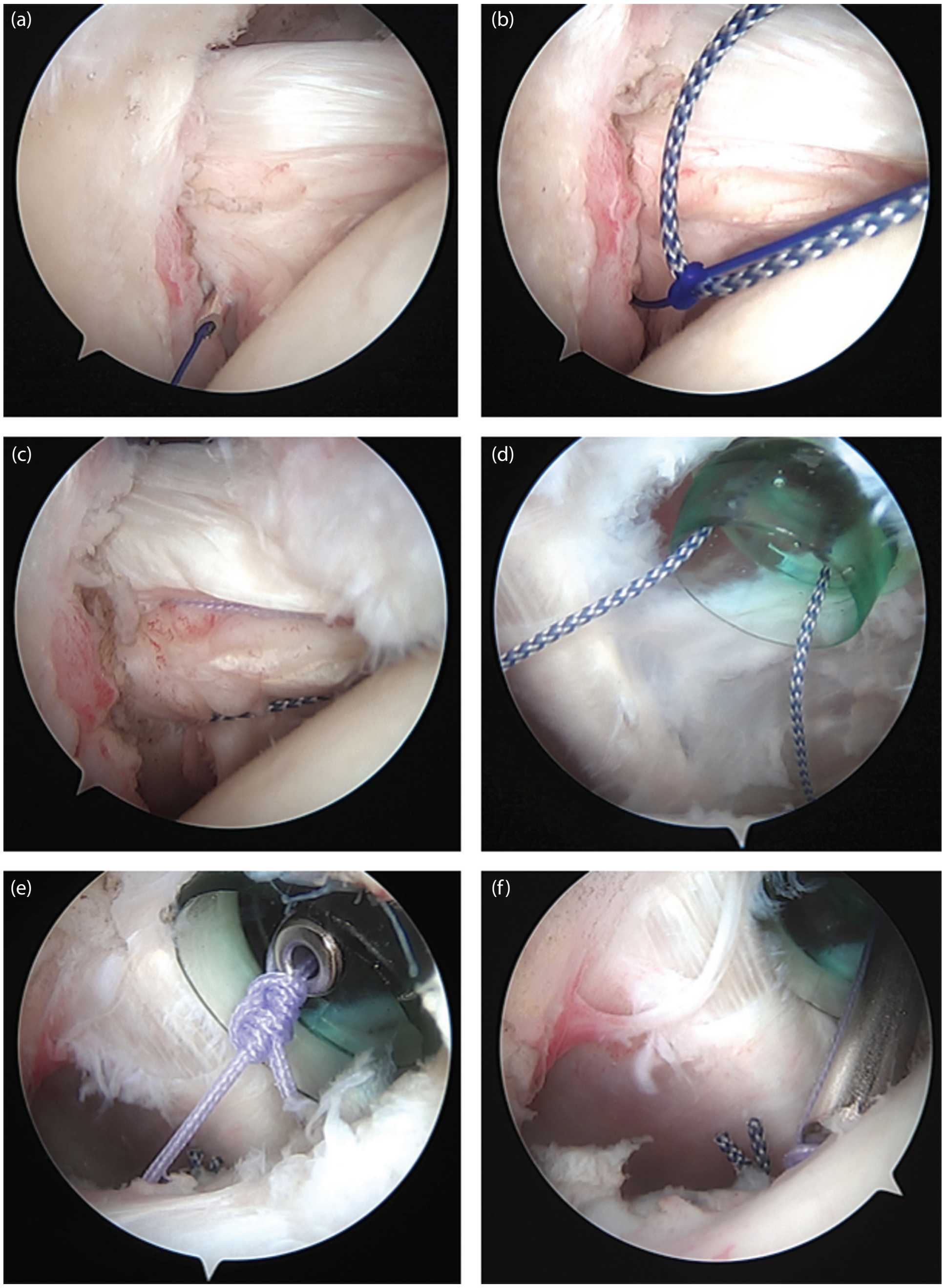

Figure 21.11 Suture passing, management and knot tying in an arthroscopic subscapularis repair in a right shoulder: (a) Using a suture shuttling device inserted in the anterior cannula, the inferior portion of the subscapularis tendon is pierced and a No. 0 Prolene is shuttled into the joint to be retrieved laterally. (b) The medial limb of the anchor suture is also in the lateral portal and is shuttled through the tendon by a loop in the Prolene stitch as the hook device is withdrawn anteriorly. (c) The solid blue and violet suture limbs can now both be seen passing through the tendon. (d) Both limbs of the first suture are in the anterior cannula for knot tying. (e) A sliding–locking knot of the second suture is advanced. (f) With the medial limb as the post, the knot is secured onto the tendon by the knot pusher.

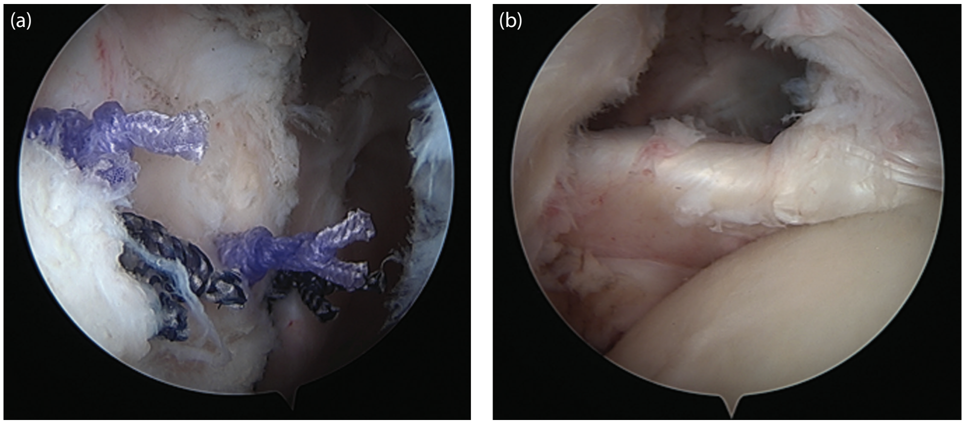

Figure 21.12 (a) Arthroscopic image of a typical repair of the subscapularis, showing the anterior surface viewed from the lateral portal in a right shoulder. (b) Arthroscopic image of the subscapularis tendon showing the repair in ER, viewed from the posterior portal.

of the subscapularis tendon, for example. A No. 0 Prolene is shuttled through the device into the joint and retrieved through the lateral portal cannula, which has the limb of suture from the anchor. Outside the cannula, a half-hitch is tied in the Prolene, creating a loop, and the anchor suture limb is secured in the tightened loop. The hook device is withdrawn from the anterior cannula and the first suture limb is shuttled through the tendon (Figure 21.11b). The second limb from the first anchor is now passed through the tendon with the same steps (Figure 21.11c).

We prefer to tie the two sutures from the first anchor at this point, which simplifies suture management and the overall technique. Both limbs of the second suture are retrieved through the lateral portal cannula to leave the first suture pair in the anterior cannula for tying (Figure 21.11d). The arm is placed in neutral or slight internal rotation, and the traction suture is tensioned to translate the subscapularis tendon toward the anchor position. The arthroscope in the posterior portal is advanced further into the joint anteriorly to view the knot-tying steps. The limbs of the first suture are tied in the surgeon's preferred manner with the medial limb as the post. The knot is advanced down the cannula onto the tendon and secured. A sliding–locking knot is preferred for a secure loop, with three alternating half-hitches for knot security. The suture limbs are trimmed, and the second suture pair is retrieved back into the anterior cannula and tied in a similar manner (Figure 21.11e and f). The two knots can be viewed via the anterior cannula to assess knot placement, tendon indentation, and suture spread. The traction suture is usually removed at this point.

The second anchor is inserted into the superior portion of the lesser tuberosity, and laterally as able. The same steps as for the first anchor and sutures are followed, including some ER for anchor insertion and some IR for knot tying. There are circumstances where the sutures from the second anchor are passed in a horizontal mattress fashion, based on the tear configuration and repair. If this is chosen, the second, more lateral, limb of a suture is passed through the lateral aspect of the subscapularis tendon, maintaining an approximately 1.5 cm soft-tissue bridge between the medial and lateral suture limb passes. Knot tying is carried out in the same manner described above.

The completed subscapularis repair is viewed to insure a complete and secure repair (Figure 21.12). With the arthroscope in the posterior portal and the arm in a neutral position, the arm is then externally rotated to assess the stability of the repair. If the forearm externally rotates past 50°, this is noted for the postoperative rehabilitation limits. The next steps to finish the procedure include repair of the posterior superior component of the tear and any other related steps. These are described elsewhere in the text.

POSTOPERATIVE MANAGEMENT

The patient is discharged home the same day, after recovering from anesthesia. The extremity is kept in a sling with no range of motion (ROM) to the shoulder. Cryotherapy is initiated in the immediate postoperative period. Wrist and hand active ROM are allowed immediately, and elbow motion is not allowed when the biceps has been tenodesed. Shoulder extension is avoided, with support under the elbow. The outpatient physical therapy protocol is influenced by the tendon and bone quality, the degree of tendon involvement, the repair security, and the patient's medical comorbidities as the major considerations. When combined pathology with posterosuperior cuff repair, we follow our subscapularis protocol when a small to medium posterosuperior component is involved. When the posterosuperior component is large or massive, this aspect of the repair will tend to dictate the rehabilitation protocol.

Typically, with full-thickness tears of the entire subscapularis tendon insertion, ROM is delayed until 6 weeks postoperatively, with only pendulums and table slides initiated at the 4th week postoperatively. After 6 weeks, gentle pain-free forward elevation and external rotation are initiated in the supine position. At 8–9 weeks post-operatively, progression of ROM to the sitting and standing positions is begun. Active ROM in internal rotation is initiated at 9 weeks, strengthening of the scapula and posterior shoulder is initiated at 10 weeks, with strengthening in IR delayed until 12 weeks postoperatively. Patients with a sedentary job can return to work, in a sling within 1 or 2 weeks after surgery, while those with manual labor jobs are allowed return to work light duty by approximately 16 weeks. At 6 months postoperatively, most patients are allowed to return to work without restriction, and return to upper extremity sport as able.

Complete week-by-week rehabilitation protocols for tears of 50% and 100% of the subscapularis tendon length can be found at www.*LI*shoulder.com.

RESULTS

Early reports consisted mostly of open repairs.[16,17,35,36] In the past decade, there has been an increase in publication of case series on arthroscopic repair of the subscapularis. Burkhart and Tehrany[3] published the first series of arthroscopic repair of the subscapularis. Twenty-five patients with partial or complete tears underwent consecutive arthroscopic repair. At short term follow up, good to excellent results were found in 92% of patients based on UCLA scoring. Half of the patients had biceps tendon pathology and were treated with debridement, tenotomy, or tenodesis. Bennett reported on two separate case series, one being 35 patients with arthroscopic repair of combined subscapularis and supraspinatus tendon tears at minimum 2-year follow up,[37] and the second being a small series of 8 patients with isolated tears of the subscapularis.[38] In both studies, ASES (American Shoulder and Elbow Surgeons) and Constant scores significantly improved with repair. Biceps tenotomy or tenodesis was not routinely performed, as the author believed that repair of the subscapularis tendon along with reconstruction of the medial wall of the bicipital sheath with the coracohumeral ligament could restore biceps function. The subscapularis tendon was repaired with one or two fixation devices and involved simple or mattress suture configurations, the latter for repair of the inferior portion.

Several more recent series of arthroscopic repairs of isolated subscapularis tears[27,39–41] and combined repairs of the subscapularis with supraspinatus[7,28,42–50] have shown comparable results. Re-tearing of the tendon reported via MRI or computed tomography arthrography ranges from 8% to 35%, with multi-tendon tears, higher patient age, greater tear size, and tear retraction correlating to recurrent tearing.[27,38,40,41,46–50] The largest long-term series of 79 patients showed good to excellent results in 83.3% of cases at an average of 104.7 months follow-up after arthroscopic repair.[44] Few series have shown the success of double row suture bridge and transosseous equivalent constructs, a significant improvement in outcomes scores or failure rate over traditional single row repair has yet to be shown.[49] Identification and treatment of biceps pathology is not consistently reported in these studies. Thus, the impact of biceps tenotomy or tenodesis remains unclear.

TIPS, TRICKS, AND PEARLS

Early diagnosis and treatment are essential, so a high index of suspicion for subscapularis tears should be maintained. A directed physical examination, including the lift-off, belly-press, and increased passive ER, can help identify tears of the subscapularis. All planes on MRI should be carefully evaluated to identify tears of the subscapularis, retraction, atrophy, and biceps pathology. Arthroscopic repair can be performed in the beach chair position using a 30° arthroscope in a reproducible manner. Biocomposite or PEEK anchors are used, although metal anchors allow for a one-step insertion. While viewing from the posterior portal, a lateral portal or an anterolateral portal is used to facilitate suture management, and an accessory anterolateral portal is used for placement of a traction suture to aid reduction during suture passing and knot tying. Repair is performed from an inferior to superior position, with a simple or mattress suture configuration. Repair of the subscapularis can facilitate reduction and repair of the posterosuperior rotator cuff. Timing of postoperative rehabilitation is dictated by the size of the repair and the security of the repair construct, and typically involves a period of immobilization followed by ROM, with a delay in active IR and strengthening in IR.

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