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Chapter 6

Subscapularis Tendon Tears: Classification, Diagnosis and Repair

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Additional information is available at the end of the chapter

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Abstract

Rotator cuff tears include a panel of tendon lesions, and superior cuff tears are often combined with subscapularis lesions that are more difficult to repair. We propose in this chapter to describe the Lafosse subscapularis tears classification and to describe the arthroscopic repair that can be performed easily with a needle as shuttle. The advantages of these surgical techniques are simplicity, safety and quickness. The procedure is performed under general anaesthesia with the patient in beach chair position. A classic arthroscopic posterior portal is used to perform glenohumeral exploration, and cuff tendons are analysed. Once subscapularis tear is confirmed, the tendon must be released after repair with anterolateral portal. Then, a triple-loaded anchor is positioned at the edge of the bicipital groove to perform both biceps tenodesis and subscapularis repair.

Keywords: subscapularis tendon, rotator cuff tear, Lafosse classification, needle shuttle, biceps tenodesis

1. Introduction

The subscapularis (SSC) muscle is one of the four components of the rotator cuff along with the supraspinatus, infraspinatus and teres minor muscles. The first SSC tendon tears have been reported in 1834 by John Gregory Smith. In 1954, Hauser reported two cases of full-thickness tears repaired with an open approach using trans-osseous sutures [1]. In 1960, McLaughlin reported an SSC tear associated with recurrent anterior shoulder instability. More recently, the first major series with 16 patients including isolated SSC tears were described by Gerber in 1991 [2]. Early studies of rotator cuff tendon tears focused on the supraspinatus tendon. However, SCC tendon tears have garnered increasing attention over the last decade: clinical exam and

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radiographic imaging occurred in a better diagnosis of SSC tears, and recent improvements in arthroscopic instrumentation allow easier repair of the SSC tendon.

Misdiagnosed SSC tendon tears may result in rotator unbalanced force couple, leading to persistent shoulder pain and weakness after cuff repair. SSC tendon tears can be difficult to diagnose on clinical examination, and lesions may be hidden on arthroscopy, essentially in the presence of an intact biceps pulley or rotator interval [3]. The aim of this chapter is to update the classification of SSC tendon tears, better identify SSC tears on specific clinical exam and radiographic imaging, and their arthroscopic management. Even if lesions are well recognized, arthroscopic SSC repair is a technically demanding procedure with a long learning curve [4]. This could be linked to the narrow subcoracoid space making the repair difficult and to the close presence of neural structures at the anterior border of the muscle belly that should be preserved.

2. Anatomy

The SSC tendon is the only anterior tendon of the rotator cuff, and the SSC is the largest of the rotator cuff muscles. The SSC muscle is the major internal rotator of the shoulder and contributes more to shoulder elevation strength than the supraspinatus or infraspinatus tendons [5, 6]. It is important in passive and active stabilization of the glenohumeral joint [7]. The SSC is inserted between the scapula and the humerus.

The scapula attachment is a wide surface area of the subscapularis fossa. The directions of the muscle fibres are anteriorly and laterally towards the humeral lesser tuberosity medially to the bicipital groove. There are three distinct layers in the muscle belly that are well seen with ultrasound or magnetic resonance imaging (MRI) sagittal views. The SSC humeral insertion is tendinous in the two superior thirds and muscular in the lower third. The two superior thirds and the inferior third of the SSC muscle are innervated, respectively, by the upper and lower subscapularis nerves, which are both branches of the posterior chord of the brachial plexus. Electromyographic studies have shown differences in neural activity between the upper and lower portion of the SSC muscle, suggesting that they could work as two different muscular units during shoulder movements [8].

The SSC tendon contributes to the formation of an anatomical space called the rotator interval, which is a tendinous gap in the rotator cuff, exclusively covered by fibrous capsule made of blended fibres coming from the SSC and supraspinatus tendons. It is a triangular-shaped space bordered inferiorly by the superior edge of the SSC tendon and superiorly by the anterior edge of the supraspinatus tendon. The medial base is delimitated by the coracoid process, and the lateral apex is the intertubercular sulcus [9]. The coracohumeral ligament, the superior glenohumeral ligament and the superior fibres of the SSC tendon reinforce the lateral rotator interval and act as a pulley system for the long head of the biceps tendon (LHBT) to prevent its dislocation [10–12]. That may explain why pathologies of the SSC tendon and LHBT are intimately connected [13–18], and why SSC should always be assessed and repaired in patients with rotator cuff tears including the SSC tendon.

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3. Pathogenesis

The SSC tendon tears can have either a traumatic and/or a degenerative aetiology. In most cases, the two aetiologies are intricate: an acute traumatic event is reported, on a previous degenerate and fragile tendon. In young patients however, traumatic SSC tears are usually secondary to a forced external rotation in high-energy trauma, with or without combined posterosuperior cuff lesion. In more elderly patients, a SSC traumatic tear can be a consequence of a shoulder dislocation, and associated rotator cuff tears or neurologic injury must be assessed.

In cases with degenerative aetiology, two theories are classically described. The extrinsic aetiology is related to the subacromial impingement syndrome that is the most common disease of the shoulder joint after the sixth decade of life, particularly in overhead workers [19]. Even if its prevalence is high, the aetiology of this syndrome and the histologic and ultrastructural changes in the rotator cuff are not well known. The friction and pressure in the narrow subacromial space probably result in tendon micro-traumatism. In degenerative SSC tears, a subcoracoid impingement may injure the anterosuperior portion of the rotator cuff involving the SSC tendon, the LHBT or all the other rotator cuff tendons. Some anatomic studies reported the close relation of the medial glenohumeral ligament (MGHL) to the upper SSC near its humeral footprint [20]. Based on arthroscopic findings, the MGHL may abrade against the upper edge of the SSC medial to its insertion [21].

The intrinsic theory is that the subacromial pain is multifactorial and could be attribute to the chronic inflammation and degeneration of the rotator cuff and the subacromial bursa [22]. Farfaras found that degenerative histological changes in the form of fibrils with smaller diameters were present in the SSC tendon in patients with subacromial impingement syndrome [23].

4. SSC tear classification

There is no consensus or clear classification regarding SSC tears. We used the classification of Lafosse to classify the SSC lesions into five types [24].

Type 1 is an isolated and partial separation of the SSC tendon fibres from the lesser tuberosity with a normal bicipital sling, regardless of the appearance of the LHBT.

Type 2 is a separation of the SSC tendon fibres from the lesser tuberosity and partial tear in the bicipital sling without involvement of the anterior LHBT pulley or tendinous slip. The probe introduced through the partial sling tear (consisting very often in a cleft in the anterior wall) can lift the superficial SSC layer separated from the lesser tuberosity.

Type 3 is a complete separation of the SSC tendon fibres from the lesser tuberosity and complete tear in the anterior wall of the bicipital sling. The anterior LHBT pulley is normal, distended or, rarely, completely torn. The tendon retraction is minor because the superficial

tendon layer is normally attached to the bicipital sling and connected to the superficial fibres of the supraspinatus (superficial layer of the rotator interval, which produces the comma sign after separation from the bony structures).

Type 4 is a complete separation of the SSC tendon fibres from the lesser tuberosity leaving a free edge that can remain continuous with the fibrous scar tissue attached either to the humerus or to the subacromial bursa. The degree of retraction varies, but the stump may reach the level of the glenoid labrum. At this stage, the comma sign is readily identified and connects the subscapularis to the supraspinatus if this last is torn.

Type 5 can be considered as a complete SSC tear combined with an anterior and superior humeral head translation, combined with coracoid impingement and SSC muscle fatty infiltration. This classification is useful to assess the reparability and the risk of retear.

5. Clinical assessment

The shoulder pain related to a SSC tendon tear may be more anterior compared to the typical pain observed in patients with superior rotator cuff tear, essentially when SSC tears are associated with biceps dislocation. Weakness in internal rotation and difficulty to touch the lumbar spine with the hand may also be reported by the patients but are nonspecific of a SSC tear. The three more sensitive and specific clinical tests to assess SSC tendon are the lift-off test, the belly-press test and the bear-hug test.

The lift-off test described by Gerber is performed by placing the hand behind the back at the level of the lumbar spine and asking the patient to lift the hand posteriorly from the back. It is positive when the patient is not able to raise the hand. The examiner can also place the patient's hand raised and ask the patient to maintain the position. The test is positive if the patient is not able to maintain the hand raised and beat up his back.

The belly-press test starts with the elbow slightly anterior to the body and flexed to 90°. The patient is asked to press the hand against his belly without elbow movement. The test is considered positive if the pressing force is weaker than contralaterally.

The bear-hug test is performed with the palm of the hand of the affected side on the opposite shoulder, the fingers extended and the elbow ahead of the body with the shoulder flexed to 90°. The patient is asked to keep the position while the examiner attempts to pull the hand of the patient away from the opposite shoulder by applying a force in external rotation perpendicular to the forearm. The test is positive when the patient cannot keep the hand on the opposite shoulder or the strength in internal rotation is impaired compared to the opposite side.

These tests are however subjective. The SSC strength can be assessed using a dynamometer, providing objective values and allowing force comparison with the contralateral shoulder.

6. Radiographic imaging

A full shoulder series of plain radiographs is useful to assess evidence of trauma (bony avulsion), acromioclavicular or glenohumeral arthritis, lateral acromial morphology (critical shoulder angle), humeral head subluxation and any changes at the SSC humeral footprint [25, 26].

Ultrasonography is a noninvasive diagnosis method allowing a dynamic exam. It is accurate and sensitive for detecting of rotator cuff tears but could be more limited for evaluation of the size of tears, in particular, for the detection of small tears [27]. Ultrasound is useful to assess muscle fatty infiltration, LHBT dislocation or degenerative biceps tendon and subcoracoid impingement.

MRI or computed tomography arthrogram is more reliable compared to ultrasonography for cuff assessment, LHBT (**Figures 1**–**3**) and fatty muscle belly infiltration (**Figure 4**). In some cases however, it could fail to diagnose the presence of SSC tears [28], indirect signs, as LHBT subluxation must be analysed (**Figure 5**). Diagnostic accuracy could be improved with MR

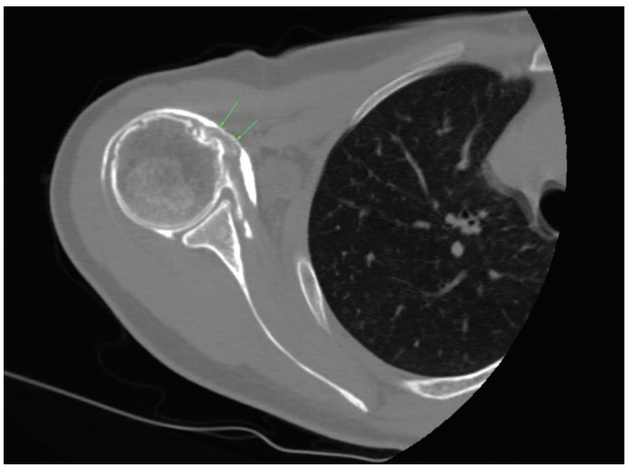


Figure 1. Axial view of computed tomography arthrogram showing the LHBT in the groove.

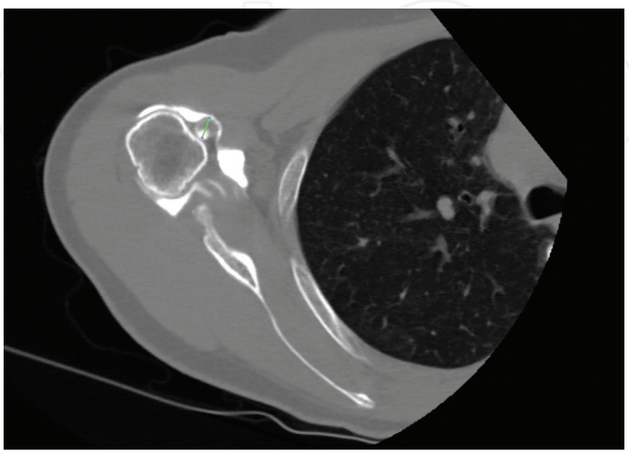


Figure 2. Axial view of computed tomography arthrogram showing a medial subluxation of the LHBT, related to a SSC tear.



Figure 3. Sagittal view of computed tomography arthrogram showing medial subluxation of the LHBT, related to a SSC tear. The LHBT is in front of the lesser tuberosity.



Figure 4. Axial view of computed tomography arthrogram with muscle analysis. No fat infiltration of the SSC belly muscle.

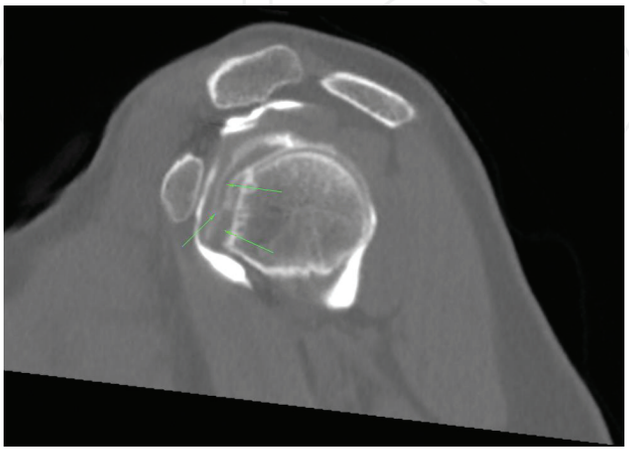


Figure 5. Sagittal view of computed tomography arthrogram showing medial subluxation of the LHBT (two upper arrows), related to a SSC superior third tear. The inferior part of the SSC tendon is well inserted (inferior arrow).

arthrography in assessing rotator cuff tendon tears [29], essentially in the evaluation of SSC tears [30]. Lee recently reported that T1 SPIR is a more sensitive and accurate imaging sequence compared to T2 TSE in detecting SSC tendon tear on 3 T MRA [31].

7. Indications of arthroscopic repair

Repair of a torn SSC tendon restores the internal rotation strength of the shoulder and could stabilize the joint providing a fine balance between internal and external rotator muscles. Indications for arthroscopic SSC repair include patients with a painful shoulder combined with evidence of SSC tear, without fatty muscle degeneration on imaging. In young patients with traumatic tear, there is no place for medical treatment: surgical repair (open or arthroscopic approach) should be quickly performed to avoid both tendon retraction and fatty infiltration that lead to lower clinical outcomes. In older patients with degenerative tear, the medical treatment must be first attempted with corticosteroid injections that are well known to be effective on pain [32]. Contraindications to repair are major glenohumeral arthropathy, fatty SSC muscle infiltration stage >2, active infection and significant medical comorbidities. Regarding patients with rotator cuff combined with frozen shoulder, the author recommends to not repair as long as the shoulder is stiff. The medical treatment should be first initiated with injections and rehabilitation until the complete range of motion is recovered. Once the shoulder has passive full motion, then SSC repair can be performed depending on the patient's complaints.

8. Arthroscopic repair procedure

The surgery may be performed in the beach chair or lateral position, under general anaesthesia in combination with interscalene regional nerve block, to decrease postoperative pain. The beach chair position allows mobilization of the arm during the procedure, as shoulder internal rotation or the Burkhart posterior lever push is applied (the assistant applies a lever from anterior to posterior). However, arm mobilization is not systematically required, and SSC repair may also be performed using a light superior limb traction, exactly as superior rotator cuff repairs.

Standard arthroscopic instruments are required to perform a successful repair of the SSC tendon: angled arthroscopic elevators, electrocautery, ablation wands, suture retrievers, knot pushers and shuttling instruments for passing of the suture through the tendon, like a spinal needle. The author prefers to use a 30° arthroscope; however, the use of a 70° arthroscope may improve the joint view in difficult cases. Instead of 70° arthroscope, switching sticks could be used during SSC repair procedures to change the viewing portal. This makes the visualization of the SSC tendon in subcoracoid space and its release easier, through an anterior-lateral viewing portal easier. Although the authors use no cannula during SSC repair, it can be helpful for young surgeons to manage all the sutures.

According to Burkhart, the author recommends to perform arthroscopic SSC repairs following a meticulous order of steps, whatever SSC tear patterns [33]:

1. Perform a glenohumeral diagnostic arthroscopy.
2. Perform biceps tenotomy or tenodesis, depending on surgeon's habit.
3. Clear the rotator interval.
4. If the subscapularis tendon has adhesions, perform a skeletonization of the coracoid process and perform a three-sided (anterior, posterior and superior) release.
5. Perform a coracoplasty if the subcoracoid coracohumeral distance is <7 mm.
6. Prepare the humeral SSC footprint.
7. Repair the subscapularis tendon.

8.1. Glenohumeral diagnostic arthroscopy.

To perform the glenohumeral diagnostic arthroscopy, a standard posterior viewing portal is first established. Then, two instrumental portals are planned with a spinal needle. An anterior-superior portal is performed by evaluating the optimal direction of the future suture anchor that will be positioned in the bicipital groove, using the needle. This portal is easily performed in patients with a full-thickness anterior supraspinatus tendon tear combined to the SSC tear. In cases with intact supraspinatus tendon, the needle may be inserted immediately anterior at the anterior border of the supraspinatus tendon through the rotator interval. This portal allows lateral-row suture of the SSC tendon and can be used as a viewing portal. Then, the anterior portal is performed along the lateral edge of the coracoacromial ligament using also the needlepointing (**Figure 6**). This instrumental portal allows access to the medial part of the SSC footprint and the SSC medial-row suture. Thus, three portals are enough to perform an arthroscopic SSC repair. The author recommends performing the two instrumental portals before the joint exploration that requires sometimes a shaver to wash or cauterization of a

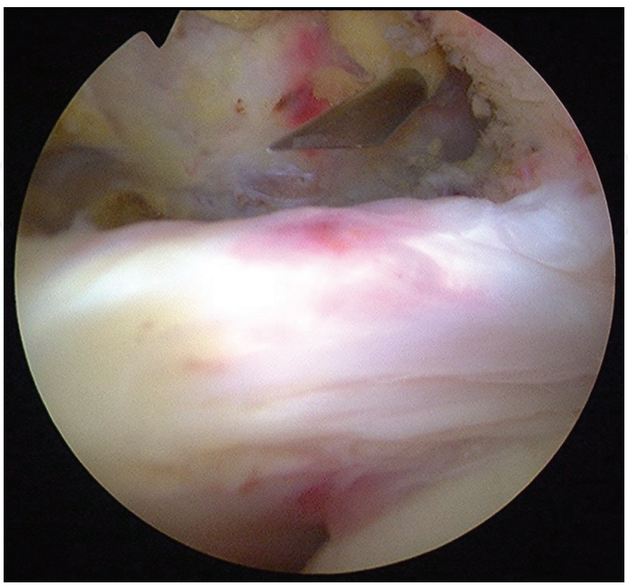


Figure 6. Preoperative view showing the anterior portal.

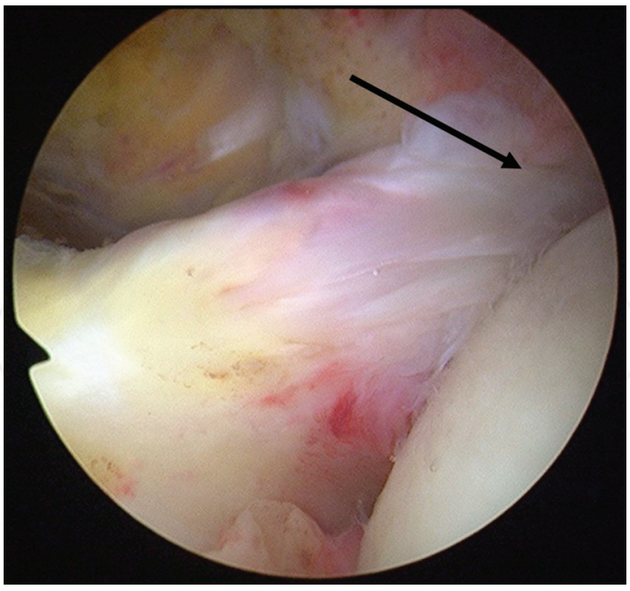


Figure 7. Preoperative view showing an SSC superior third tear.

bleeding vessel. The diagnostic arthroscopy allows analysing the glenoid and humeral articular surfaces, the shoulder ligaments, the labrum and the LHBT, the posterior and superior rotator cuff and the SSC tendon (**Figures 7** and **8**).

8.2. Long head of the biceps management

In patients with rotator cuff tears and particularly in cases with SSC tears, the LHBT requires a specific assessment. The viewing aspect of the LHB is analysed (normal, partial or complete

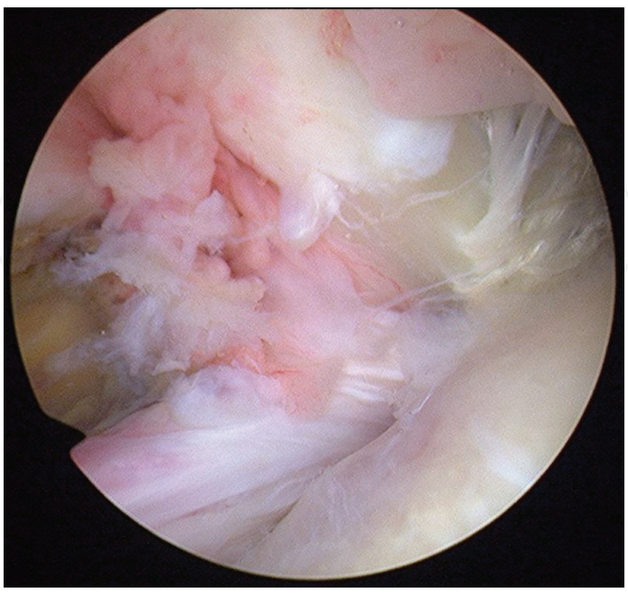


Figure 8. Preoperative view showing an SSC superior third tear combined with a medial subluxation of the LHBT that is delaminated.

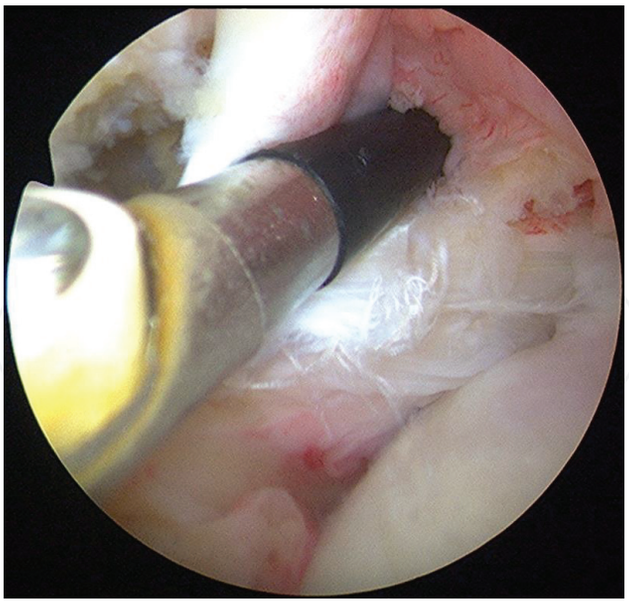


Figure 9. Preoperative view showing an SSC superior third tear combined with a medial subluxation of the LHBT that is degenerative.

degeneration), and then using a stick, the stability at the pulley is assessed by pushing a medial force to dislocate the tendon from the groove above the SSC tendon (**Figure 9**). Sometimes the tendon is already torn. LHBT tenotomy or tenodesis at the groove is indicated in most patients before the SSC tendon repairs to increase the SSC view and make repair easier. The author performs the biceps tenodesis using a triple-loaded anchor that is impacted at the top of the bicipital groove in order to reattach the LHBT in its anatomical position. Thus, one of these sutures is used for the biceps tenodesis with a loop suture technique (the two other sutures will be used later for the lateral row of the SSC repair) (**Figure 10**). In younger patients, the biceps tenodesis should be performed with an interference screw [34]. Some authors described other techniques of biceps tenodesis according to the bone fixation: the tendon can be tenodesed beneath the pectoralis tendon and removed entirely from the bicipital groove [35]. Controversies still exist regarding the best localization for the biceps tenodesis [36–42].

8.3. Rotator interval debridement and SSC release.

Using an ablation wand through the instrumental anterior and anterior-lateral portals, the rotator interval is cleared: first the anterior capsule is resected, then the MGHL, and more medially until the coracoid process. It is easy by following the superior border of the SSC tendon to find the lateral and inferior borders of the coracoid process. There is no danger of nervous injury when the dissection is performed laterally to the pectoral minor tendon. If the SSC tendon is retracted, it can be loaded with a traction wire that may temporarily favour the reduction and assess the tendon reducibility. The three-sided release corresponds to an anterior, posterior and superior release. The superior release is performed during the coracoid process exposition (**Figure 11**). The anterior release is performed using an ablation wand between the SSC tendon and the conjoint tendon (**Figure 12**). It exposes to neurologic injury (axillary and musculocutaneous nerves) if performed too medially. The posterior release is safe

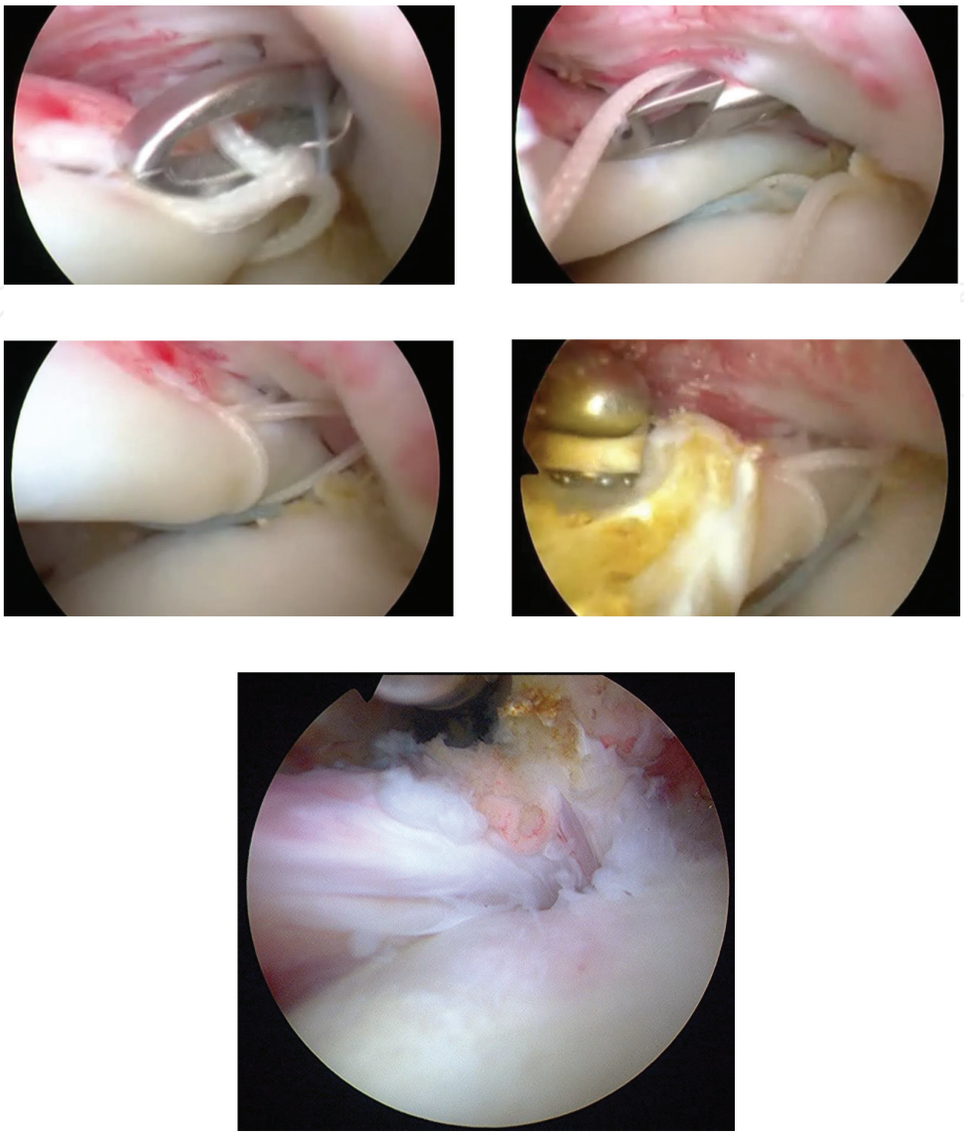


Figure 10. (a) Biceps tenodesis using lasso loop technique; (b) biceps tenodesis using lasso loop technique; (c) biceps tenodesis using lasso loop technique; (d) biceps tenodesis using lasso loop technique. The section before the fixation allows undertension of the biceps; and (e) final aspect after biceps tenodesis.

and performed by introducing a 15° elevator between the posterior SSC tendon and the anterior glenoid neck. If there are combined SSC and supraspinatus tears, it is important to preserve the comma sign [43]. It corresponds to tissue composed of the humeral attachments of the superior glenohumeral and coracohumeral ligaments that concomitantly tear and remain attached to the superolateral corner of the subscapularis. The comma sign is pathognomonic of a combined SSC and supraspinatus tear [44]. Once the SSC is repaired, this tissue helps to reduce and suture the posterosuperior rotator cuff.

8.4. SSC suture

A single-row technique or a double-row technique can be used. The author recommends that type 4 lesions require a double-row technique that could be biomechanically advantageous

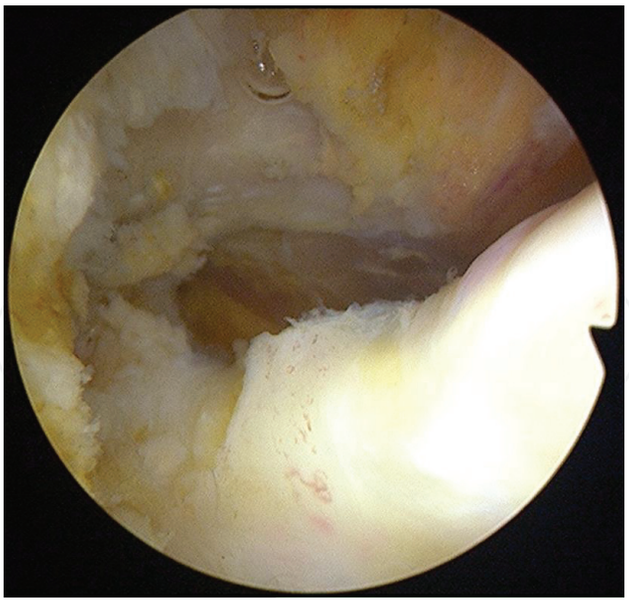


Figure 11. SSC superior release, with exposition of the coracoid process.

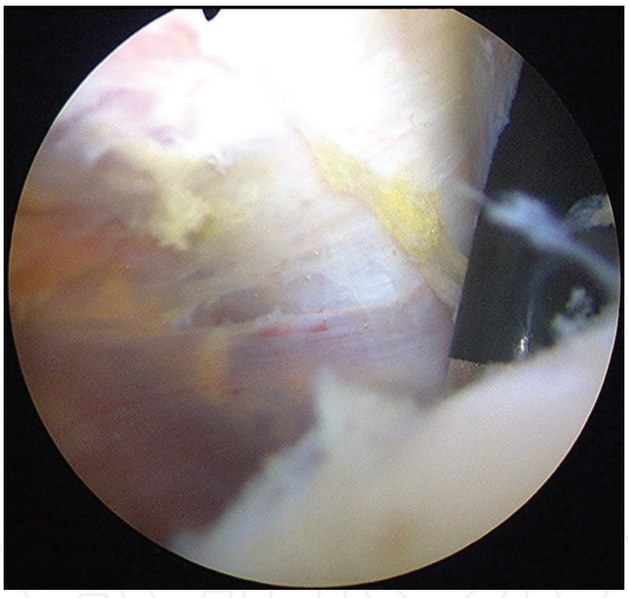


Figure 12. SSC anterior release, with exposition of the conjoint tendon.

regarding postoperative strength and iterative tears [45]. In most cases with SSC tear stages 1–3, a single-row repair may be enough. The principles are similar as for all cuff repairs: decortication of the footprint using a burr through anterior and/or anterior-superior instrumental portals to create a bleeding base (**Figures 13** and **14**). The lateral border of the lesser tuberosity corresponds to the bicipital groove within the biceps tendon previously tenotomised or tenodesed. If the SSC tendon release does not create enough lateral excursion for an anatomic repair, a 5–7 mm medialization of the footprint may be performed without decrease in functional outcomes [46]. Knotless anchors or bridging sutures can be alternatively used; the number of anchors may vary



Figure 13. Decortication and exposition of the SSC footprint.

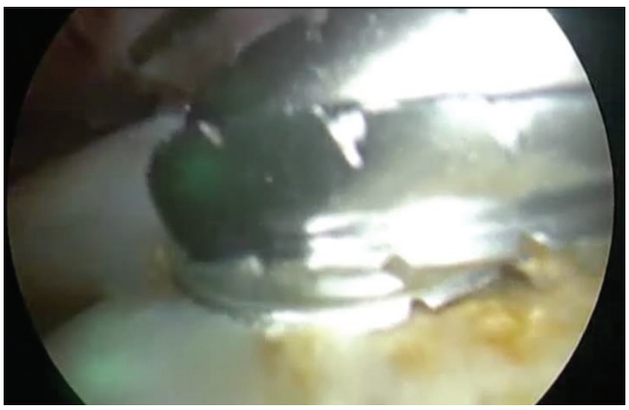


Figure 14. Decortication and exposition of the SSC footprint using a burr.

from 1 to 4 depending on the extent of the lesion and the type of repair procedure. In patients requiring a double-row suture, the author inserts the medial anchor through the anterior portal in the medial part of the SSC footprint and the lateral anchor through the anterosuperior portal in the bicipital groove. Thus, the same anchor can be used for both the biceps tenodesis and the lateral row of the SSC repair. The same tools used to repair the rotator cuff may be used to pass the sutures, using small instruments, which pass within the tendon itself. Considering the narrow subcoracoid space, it is not easy to pass the sutures through the SSC tendon. The author performs the double-row sutures with 5.5 mm BioComposite Corkscrew FT, Arthrex. The medial suture is passed through the SSC tendon with a shuttle needle with a loop inside, which seems to be a noninvasive technique compared to BirdBeak (**Figure 15**). The lateral suture can be performed with a classic suture pass (FastPass Scorpion, Arthrex).

Chernchujit recently described arthroscopic SSC repair by a double-row knotless technique performed with an extra-articular SSC view [47]. The patient is placed in the beach chair position with an assistant to hold the arm. He uses a standard arthroscopic posterior portal with a 30° scope for glenohumeral diagnostic, and the arthroscope is shifted to the subacromial space. Through an anterior-superior portal, subacromial decompression, acromioplasty and

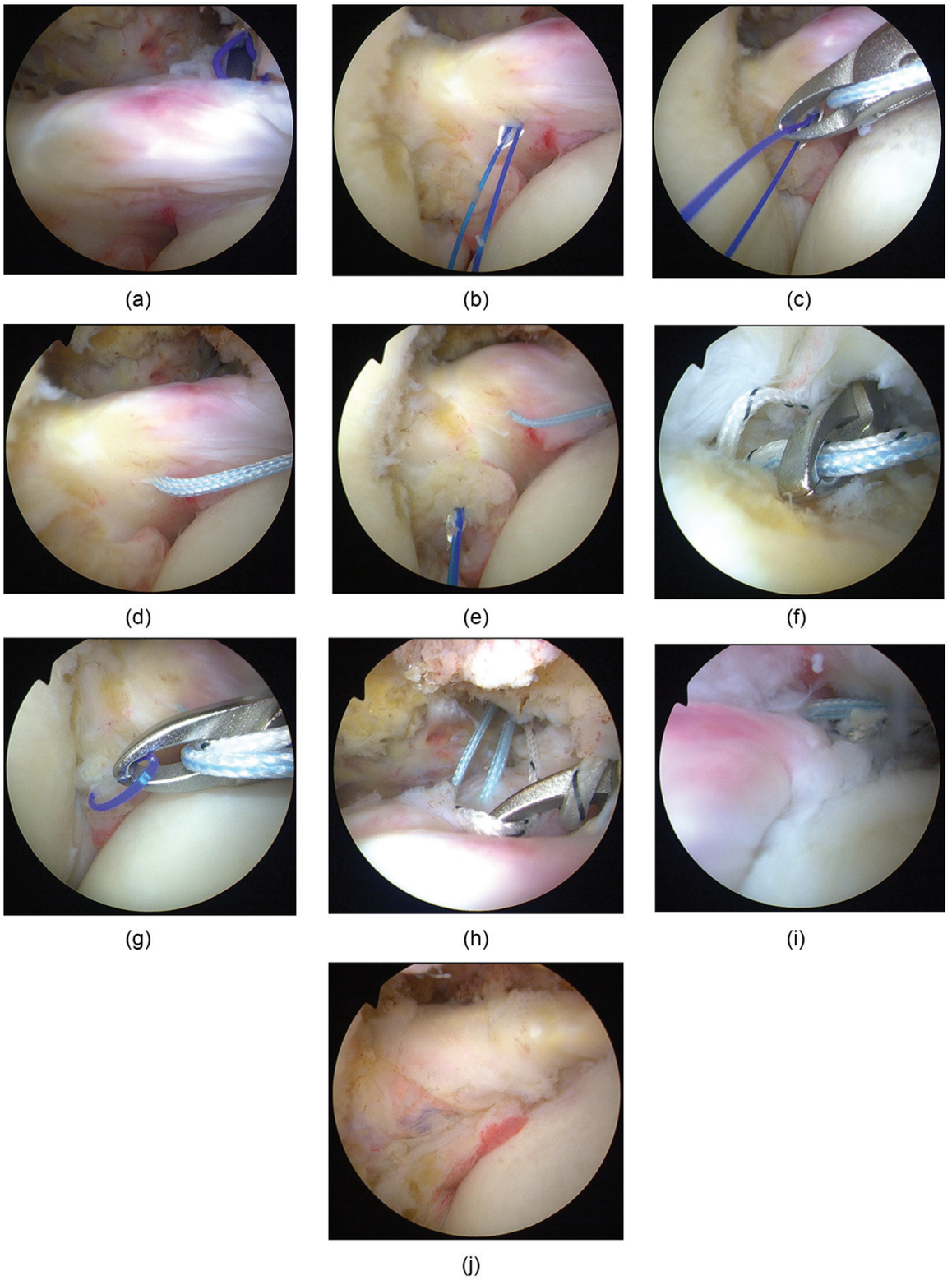


Figure 15. (a) (b) A shuttle needle with a loop inside is introduced from anterior to posterior through the SSC tendon; (c) one suture of the anchor is retrieved with the loop through the anterolateral portal; (d) outside, the surgeon passes the suture inside the loop, and the loop is pulled from posterior to anterior. The suture goes through the SSC tendon; (e) this technique is repeated as many times as required; (f) (g) two sutures of the anchor can be retrieved at the same time; (h) SSC suture; (i) (j) final aspect.

bursectomy are performed to improve visualization and make the SSC suture easier. The anterior portal is established in the rotator interval region. A cannula is inserted through the anterior portal, and a 70° arthroscope is used for the SSC repair. The rotator interval is cleared, the biceps tenotomy is performed, and SSC tendon is released to obtain a good reduction. The SSC footprint is prepared by microfracture, and two anchors are inserted to form the medial row. Suture loops are passed through the SSC tendon using a specific device. The suture bridge technique is then performed, with arm rotated externally. Knotless anchors are inserted on the lesser tuberosity to form the lateral row of the SSC repair. Special attention will be devoted to adequate tensioning.

When performed at early stages, arthroscopic repair is highly successful [48], whereas in patients with irreparable tears (tendon retraction to the level of the glenoid with grade III or IV fatty muscle infiltration) tendon repair is not indicated. To restore shoulder mechanics, some nonanatomic techniques have been reported in the literature such as pectoralis major or latissimus dorsi tendon transfers [49, 50]. These procedures have, however, a high rate of iterative ruptures and complications [51]. Allograft used to repair SSC irreparable tear has also shown fair clinical outcomes and tendon healing on postoperative imaging [52]. More recently and on the model of irreparable supraspinatus tear, superior capsule reconstruction was used in patients with irreparable SSC tears. Anterior capsule reconstruction technique using a human acellular dermal patch requires an open approach, eventually after an arthroscopic diagnosis confirmation of SSC irreparable tear [53, 54]. A standard delto-pectoral incision is made starting to the coracoid process tip. The cephalic vein is exposed and retracted laterally or may be ligated if necessary. The conjoint tendon is identified, and its lateral border is dissected. The subscapularis muscle and anterior capsular deficiency are exposed. After vertical arthrotomy, a Fukuda retractor may be placed into the joint to retract laterally the humeral head exposing the glenoid and the anterior glenoid rims. After anterior labral debridement, three 3.0 mm knotted anchors are inserted into the anterior glenoid rim at the 5-, 3- and 1-o'clock positions. On the humeral footprint, a double-row bridging repair may be performed using four anchors. A 3.5 mm thick human acellular dermal patch is then prepared at the matching size of the SSC tear and then sutures to the glenoid and humeral anchors. Marking several parallel lines perpendicular to the length of the graft for reference could be useful to ensure that the final graft shape is still rectangular.

Cartaya and Valenti described an alternative technique for irreparable tears of the upper two-thirds of the SSC tendon, an arthroscopic-assisted pectoralis minor transfer with a bone chip from the coracoid process [55]. The patient is positioned in the beach chair position, without upper limb traction, to easily mobilize the arm during the procedure. A shoulder diagnostic examination through the standard posterior viewing portal confirms the presence of an irreparable SSC tendon tear. The SSC is released by clearing the rotator interval and excising the coracohumeral ligament; the MGHL and the LHBT are tenotomised. Compared to arthroscopic Latarjet, the coracoid process with conjoint tendon, coracoacromial ligament and pectoral minor are dissected. This stage requires switching the arthroscope from posterior to anterior-superior portal to increase pectoral minor visualization and to create a superior coracoid expanded portal. This instrumental portal allows performing the osteotomy

of the medial wall of the coracoid process with the PM tendon using a 10 mm chisel. The bone chip is exteriorized through the same portal and sutured to a double-button device. The footprint is prepared with a burr to create a concave zone matching the shape of the bone chip. An eyelet drill pin is positioned at the centre of the SSC footprint from anterior to posterior until the posterior subcutaneous tissue. The pin is then drilled across all the humeral head, through the posterior humeral cortex to create a complete bone tunnel. After the sutures are loaded in the eyelet of the drill pin, the pin is then retrieved posteriorly through a small skin incision. The sutures are carefully pulled to apply the button over the humeral posterior cortex and to obtain a good compression of the bone chip on the lesser tuberosity, under arthroscopic control. Clinical outcomes after this procedure could be better compared to other techniques according to the use of bone-to-bone fixation. Nevertheless, the author advises to have extensive knowledge of the anatomy to avoid nervous injury (musculocutaneous or axillary nerves).

8.5. Open approach SSC repair

In some patients, particularly in young 12–14 year-old patients, during traumatic event with forced external rotation, a bony avulsion of the lesser tuberosity occurs without tendon tear. Clinical exam finds positive SSC test, and radiographic imaging confirms this isolated SSC lesion. In that case, the author recommends an open delto-pectoral approach. The avulsed fragment is found below the coracoid process, released and removed from the soft tissue and synthetized on humerus after bone decortication. Needle anchors or screw may be used, depending on the bone fragment size. Arthroscopic management is quite possible in these cases, but the author does not recommend this approach, because it is technically demanding, with difficult exposure and repair.

9. Postoperative care and rehabilitation

The patient is usually discharged on the same day after recovering from anaesthesia. Cryotherapy is initiated in the immediate postoperative period. Rehabilitation of subscapularis tears follows the same principles of rotator cuff rehabilitation, using brace for 6 weeks. However, pendulum exercises are immediately initiated, as well as early passive- and active-assisted motion, first performed in supine position and progression to the sitting and standing position. Strengthening activities are authorized after 3 months, and return to manual work or to sports intensively are not allowed before 6 months, to avoid iterative SSC rupture. In general, the rehabilitation program should carefully consider the extent of the tissue retraction and the tendon condition in terms of resistance and elasticity.

10. Conclusion

When a SSC tendon tear is clinically suspected with specific tests, surgeons should confirm and assess its reparability on preoperative MR imaging or arthro-CT. During arthroscopic cuff

repair, the concept of "à la carte" surgery is applicable, meaning that surgeon may repair all tendon torn in the same procedure to restore anatomy. The clinical outcomes of recent studies confirm that successful arthroscopic repair of the tendon can lead to an improvement in shoulder function and strength, as well as a reduction in pain. We recommend arthroscopic single or double-row repair using spinal needle as shuttle, after biceps tenotomy or tenodesis.

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