The Subscapularis Interlocking Stitch for the Arthroscopic Treatment of Subscapularis Tendon Tears at the Shoulder

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Abstract: Restoration of subscapularis function is essential for long-term maintenance of good clinical results for both traumatic and nontraumatic rotator cuff tears. The anatomic repair of partially and completely torn tendons from the footprint at the lesser tuberosity is the goal of surgical repair. The described technique, with a combination of an interlocking stitch and additional mattress sutures using a double-loaded suture anchor, provides reduction of the retracted tendon, sufficient pullout strength, and compression of the tendon to the footprint to facilitate healing.

Subscapularis tendon (SCP) tears are frequent and account for a high number of surgical rotator cuff repairs.[1-5] Restoration of SCP function is essential for the long-term maintenance of good shoulder function, especially for the so-called force couple with the infraspinatus tendon.[6]

In contrast to the supraspinatus tendon (SSP) and infraspinatus tendon, which are confluent at their insertion with each other at the posterior part of the greater tuberosity and the interval tissue anteriorly, thus forming the posterosuperior cuff, the SCP has a free upper tendinous end that inserts at the upper part of the SCP footprint at the lesser tuberosity and is part of the pulley system of the biceps tendon. The tendinous fibers are orientated more horizontally in the direction of pull in an upward position of the body (Figs 1 and 2A). The lower musculotendinous part of the SCP inserts with only few tendon fibers. Most of the traumatic and nontraumatic SCP tendon tears belong to the upper tendinous part (Fig 2B).[1-4,7]

Conventional vertical mattress sutures are likely to cut through the tendon because they are in line with and not perpendicular to the direction of forces and orientation of the fibers. The use of interlocking stitches has been shown to be biomechanically superior in comparison with conventional and other stitch configurations.[8-10] To increase the pullout strength of sutures in the tendinous part, a suture technique using double-loaded suture anchors has been developed and is described in this report.

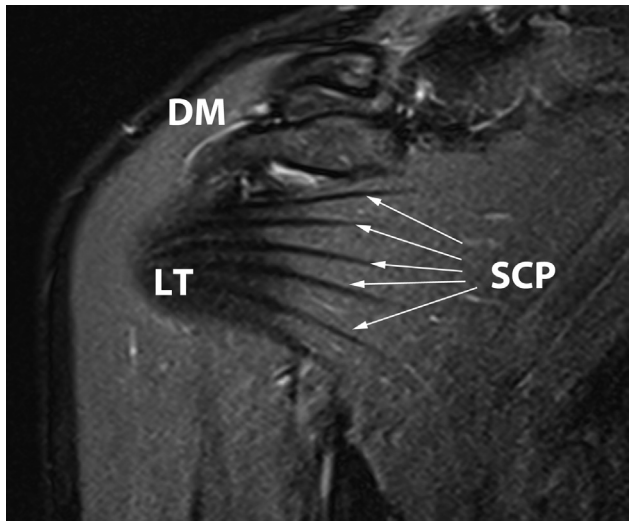

Fig 1. T2-weighted magnetic resonance imaging scan of a right shoulder in the frontal plane just at the level of the lesser tuberosity (LT). The subscapularis tendon (SCP) inserts with horizontally orientated strong fibers at the LT. (DM, deltoid muscle.)

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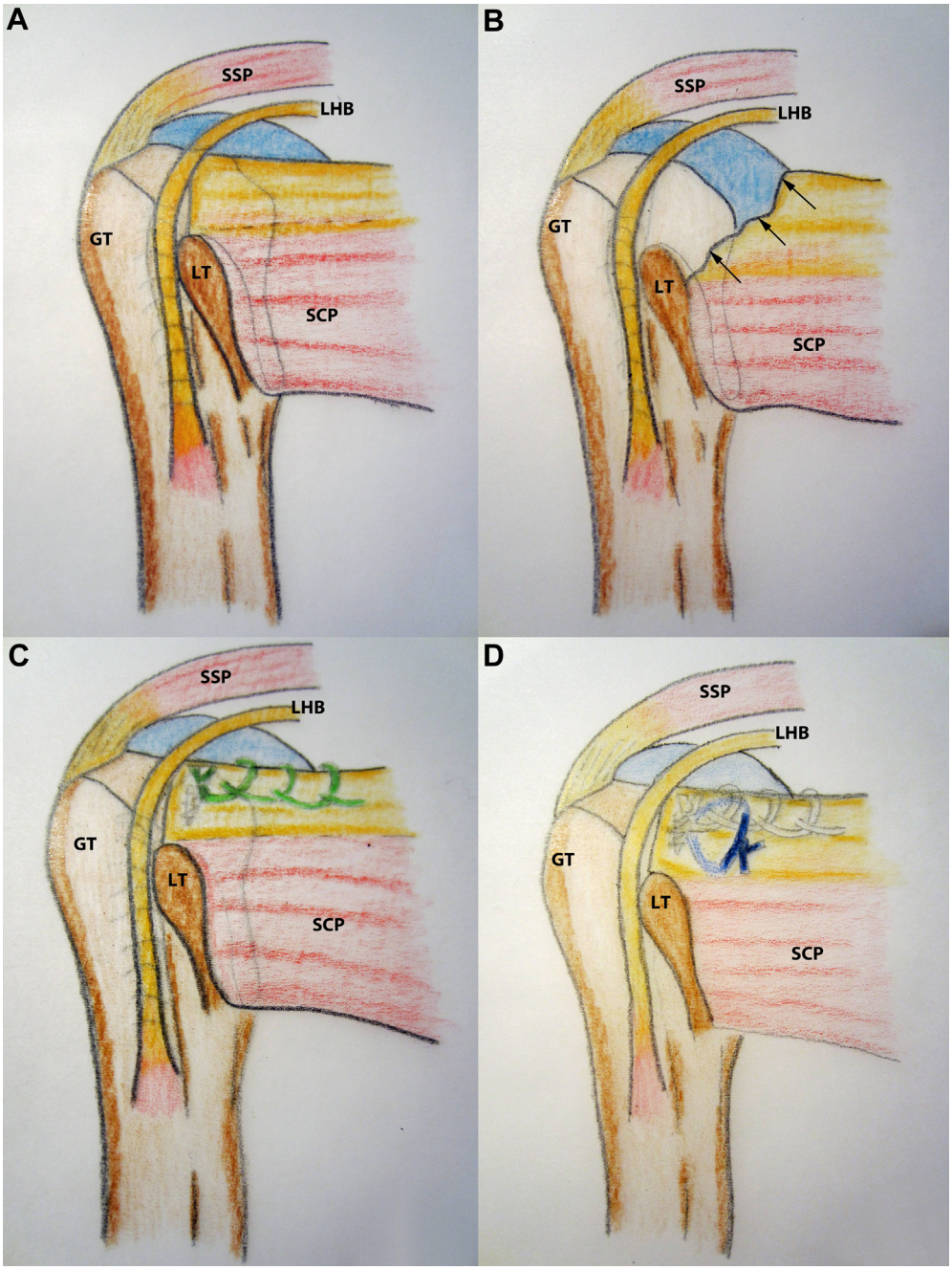

Fig 2. Right shoulder in the frontal view with the subscapularis tendon (SCP) insertion at the lesser tuberosity (LT) of the humerus. The long head of the biceps (LHB) runs in the interval between the supraspinatus tendon (SSP) inserting at the greater tuberosity (GT). (A) The intact SCP is part of the biceps pulley system. (B) The torn SCP retracts medially (arrows) and results in a violation of the biceps pulley system. (C) The interlocking stitch (green) is placed at the upper border of the SCP; tightening of the knot leads to reduction of the tendon to the suture anchor (gray) and closure of the gap at the LT. (D) The second suture pair (blue) is placed as a vertical mattress suture with the knots anterior to the SCP and the interlocking stitch.

Operative Technique

Patients are operated on in the beach-chair position starting with a standard posterior portal for diagnostic arthroscopy. An apparent SCP tear can be visualized without additional portals (Video 1). Larger tears with retraction of the tendon in conjunction with the interval tissue typically present with a comma sign.[11] Small partial tendon tears and avulsions from the uppermost insertion can be brought into view by slight internal rotation of the humerus, which can easily be achieved by lifting the elbow of the patient's resting arm a few centimeters.

If no other additional pathologic condition needs further treatment, 2 additional portals are created with the arm in neutral rotation and mild flexion of about 60°. The anteroinferior (AI) standard portal is used for anchor placement and suture passage through the SCP. An anterosuperolateral portal enters the joint in the interval between the SSP and SCP, with the rotator cable and biceps tendon intact being left intact. In many cases of biceps tendon (long head of the biceps) disease and combined SSP lesions, a tenodesis of the long head of the biceps is desired, which can be performed using the same portals before SCP repair.[12]

The first step is mobilization of the SCP and trial reduction into the footprint. The free part of the footprint at the lesser tuberosity is debrided and freshened until mild bleeding is achieved with curettes or a shaver (or both). The suture anchor (5.5-mm titanium Corkscrew; Arthrex, Naples, FL) is placed through the AI portal in mild internal rotation or through the ALS portal in mild external rotation to provide some degree of the dead-man angle to prevent pullout, depending on the preference of the surgeon and the individual anatomy and portal placement. Sutures are shuttled through the ALS portal. The use of working cannulas can facilitate suture passage and prevent problems but usually is not necessary and can be omitted in favor of more workspace.

The most medial and upper part of the torn SCP is punched from the AI portal with a yellow 20-gauge spinal needle (Braun, Melsungen, Germany). A No. 1 PDS II suture (Ethicon, Norderstedt, Germany) is passed and grasped with a KingFisher device (Arthrex, Naples, FL) from the ALS portal. Some fine-tuning of the rotational position is usually required to achieve the best angulation for tendon penetration. In an ideal case the portal ends above the upper border of the SCP and penetration can be made in a slightly oblique direction from top to bottom. The spinal needle is pulled out, and the PDS suture is subsequently shuttled through the ALS portal (Fig 3). By use of a suture loop, the first strand of anchor sutures is passed through the SCP by a retrograde shuttle technique through the AI portal. By use of the KingFisher device, the same strand is grasped from the ALS portal and brought outside again to prepare the next tendon penetration maneuver.

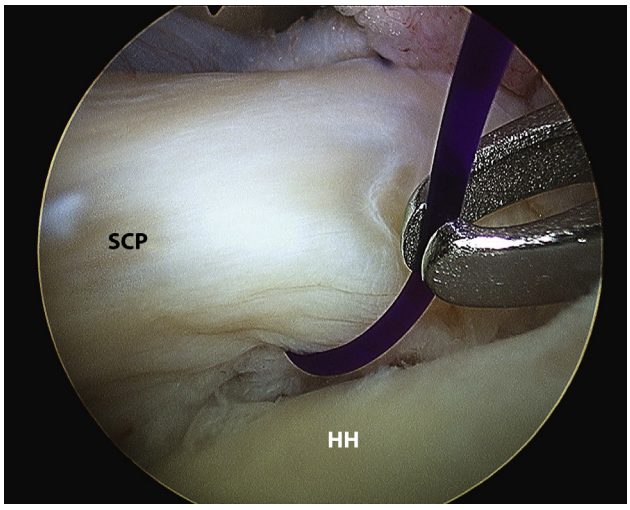

Fig 3. Arthroscopic view from the posterior portal in a right shoulder to the horizontally orientated subscapularis tendon (SCP), which has been perforated from anteriorly with a 20-gauge spinal needle. A PDS II suture is grasped by an arthroscopic device just above the humeral head (HH).

Difficulties in finding the suture in the anterior capsule can be overcome by using a knot pusher from the AI portal (Table 1).

The next step is a repetition of passing the PDS suture through the SCP in the same way but more medially, leaving a sufficient tendon bridge of a few millimeters. After pulling out through the AI portal, a single loop around the upper tendon end of the SCP is the result. Instead of simply repeating the previous steps of suturing, the free end of the suture at the AI portal is shuttled through the existing suture loop at the SCP using the KingFisher device from the ALS portal (Fig 4A). The first suture limb is now crossing the first loop lying closest to the tendon while the free end of the suture is at the ALS portal. As a result, an interlocking stitch configuration with 1 loop has been created. Mild pulling on the second strand of the first pair of sutures, which run free in the anchor eyelet, can already achieve a lateral repositioning of the torn tendon into the bone bed. This maneuver can facilitate further suture placement more medially. The described steps are repeated until 2 or 3 interlocking loops are created (Fig 4B). Simply tying the knot at this point from the ALS portal results in repositioning of the tendon and mild shortening of the same degree as the last stitch is placed medially away from the lateral vertical tendon border because of the sliding free end of the second suture limb. Using 2 interlocking loops usually results in acceptable pullout strength without substantial compromise of external rotation. If, for some reason (e.g., substantial retraction of a large tear), the suture passage through the SCP is not possible, another penetrating device, such as a 45° SutureLasso (Arthrex), can be used in favor of the spinal needle (Table 1).

Table 1. Tips and Pitfalls

Tips
In the case of very retracted SCPs with a positive comma sign, placement of a pair of stay sutures with lateral traction can facilitate orientation and suture placement.[13]
If the penetration of the SCP from anteriorly is not satisfactory, alternative penetration devices can be used from the lateral portal.
The use of working cannulas can help to avoid tissue bridges and sutures becoming entangled.
Pitfalls
If the interlocking stitches are completed and the free suture end is not brought back to the insertion site of the suture anchor, the SCP will be reduced by a distance corresponding to the length of the interlocking stitch. This could result in a remarkable loss of external rotation.
Partial SCP lesions can easily be overlooked using a posterior portal with the arm in external rotation. Slight internal rotation during diagnostic inspection (lifting the elbow in the beach-chair position) unfolds the tendon from the lesser tuberosity.
Scarring of the interval tissue or tissue bridges in the SCP repair sutures can lead to loss of external rotation.

SCP, subscapularis tendon.

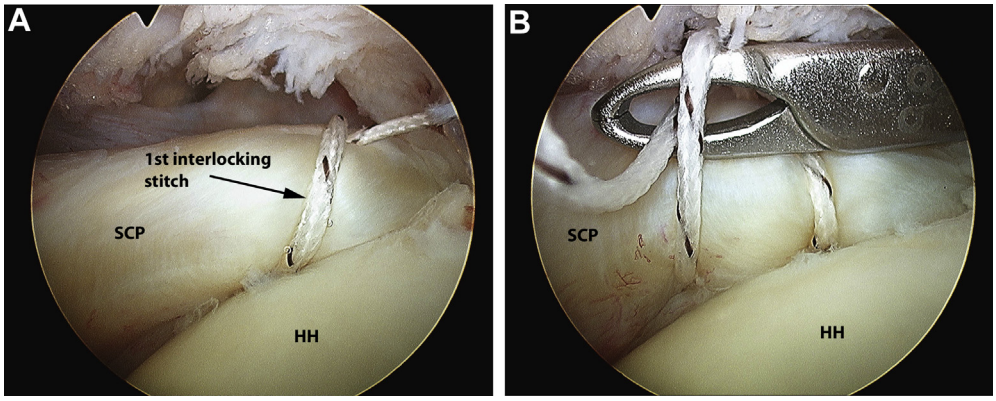

Fig 4. Same view as in Figure 3 with (A) 1 interlocking tendon stitch in place (tiger suture, arrow) and (B) the suture grasper pulling the free suture end through a loop of the simple stitch, which results in the second interlocking tendon stitch. (HH, humeral head; SCP, subscapularis tendon.)

As a result, after tying of the first pair of sutures, the SCP is fixed at the lesser tuberosity with sufficient pullout strength to allow healing in a resting position with a sling and early mobilization (Fig 2C). To increase the contact area and to avoid unfolding of the tendon from the bone bed in internal rotation, an additional mattress suture is placed on top of the existing interlocking stitch configuration. To achieve this, the area of the interlocking stitch configuration is penetrated slightly medial to the free end of the tendon to ensure that the suture does not cut through the tendon but locks itself into the existing, already passed suture limbs of the first pair of sutures. The second and last free suture limb is passed through the tendon more inferiorly, thus creating a vertical mattress suture. Shuttling both of the free ends through the ALS portal results in a knot that is outside the glenohumeral contact area but inside the joint, leaving the anterior capsule and interval unviolated (Fig 5). The result is a minimal compromise of external rotation and irritation of the capsule that leads to superior early functional results (Fig 2D). In clinical practice patients treated with this interlocking stitch configuration present with significantly fewer problems regarding external rotation deficits and usually have a free range of motion in the axial plane at 6 weeks' follow-up.

Discussion

The described technique of SCP repair with a suture anchor and an interlocking stitch configuration is safe and easy to perform and results in improved pullout strength and tendon-to-bone contact compared with conventional vertical mattress sutures. The theoretical advantages (Table 2) need to be further confirmed by both biomechanical and clinical studies. Since 2013, the first author (J.K.) has used this SCP interlocking stitch in more than 40 patients without any complications, no retears of the reconstructed tendon, and very promising clinical results.

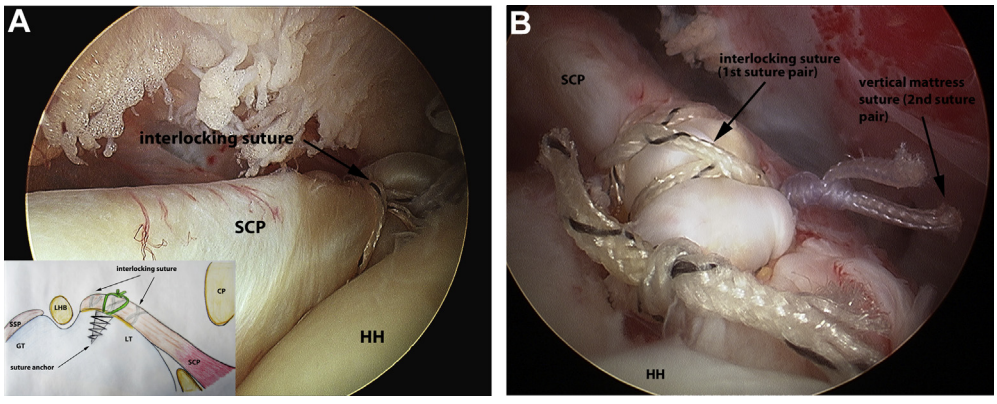

Fig 5. (A) Arthroscopic view from the posterior portal in a right shoulder to the horizontally orientated subscapularis tendon (SCP) from very medial to lateral, showing the reduction of the SCP to the footprint at the lesser tuberosity (LT). The inset shows the stitch configuration in the axial plane with the vertical mattress suture (green) on top of the interlocking suture (gray). (B) Arthroscopic view from the lateral portal in a right shoulder to the subscapularis tendon (SCP), with complete reduction to the footprint at the humeral head (HH) after tying of the first interlocking suture (tiger suture) and the second vertical mattress suture (blue suture). (CP, coracoid process; LHB, long head of biceps tendon; SSP, supraspinatus tendon.)

Table 2. Pros and Cons

Pros
The risk of sutures cutting through the tendon is reduced by the interlocking stitch.
The technique can be performed arthroscopically and in an open manner.
The combination of an interlocking stitch and a vertical mattress stitch increases contact pressure and reduces the risk of gap formation and unfolding from the lesser tuberosity during internal rotation.
Cons
Proper visualization of the defect from posteriorly can make the use of a 70° arthroscope necessary.
Skillful suture management is necessary to avoid inadvertent knots and save time.

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