Technical Note

The High Resistance Loop (H-Loop) Technique for Arthroscopic Repair of Subscapularis

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Abstract: The subscapularis tendon is more challenging and riskier to repair than the posterior upper rotator cuff. The knotless anchor suture in subscapularis repair simplified the repair process and had an excellent postoperative effect. We describe a new knotless anchor stitching method, the H-Loop technique. The simplicity and efficiency of the technique make it particularly suitable for small subscapular tendon tears.

The subscapularis is a powerful rotator cuff muscle that controls forward stability and maintains the humerus head in the dynamic center of the joint. After an injury, the humerus head loses forward stability, resulting in anterior-superior decentralization.[1-3] Subscapularis injuries were often overlooked in the past. However, with the increased understanding of subscapularis injuries and the continuous improvement of arthroscopic techniques, the rate of subscapularis muscle tears in patients with rotator cuff tears has reportedly reached 27.4% to 35%,[4,5] even as high as 49% in some cases.[6]

Both the traditional open surgery and the commonly used arthroscopic technique have shown excellent results for the repair of the subscapularis muscle.[7,8] The single- and double-row anchors have been widely used in the repair of posterosuperior rotator cuff and subscapularis tendon under the arthroscope, which have a remarkable repair effect.[9-11] Except for the anchor stitching technique, the knotless technique has been proposed as a new effective suture in supraspinatus muscle full-thickness tear.[12,13] Similarly, this technique has been applied to the subscapularis repair, and the clinical and imaging results are not significantly different from those of the single-row anchor repair. Meanwhile, it simplifies the operation and saves costs. Therefore it is an alternative technique for the repair of minor subscapularis muscle tears.[14,15]

In our previous study, a novel knotless method, the high resistance loop (H-Loop) technique, was applied to repair supraspinatus injuries. Compared with the traditional single- and double-row suture methods, the knotless H-Loop can improve the blood supply of the rotator cuff, increase the initial strength of the

Fig 1. Patient position and landmark identification (left shoulder). During the operation, the left shoulder was placed in the right decubitus position and suspended at 30° abductor and 20° forward flexion. The posterior viewing and anterior working portal were established.

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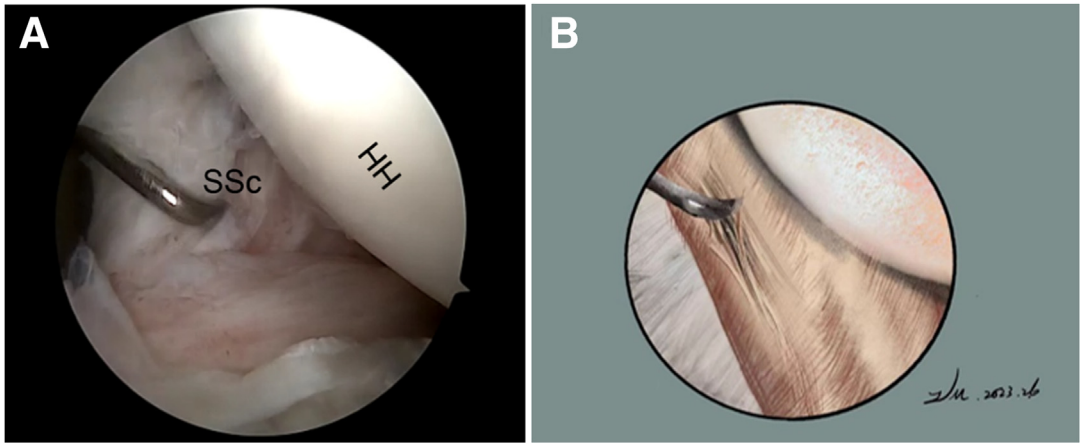

Fig 2. Arthroscopic image in lateral decubitus position. The left shoulder was viewed under arthroscopic from a posterior portal, and the images were 30° arthroscopy. (A) The subscapularis tear was investigated with a probe to identify the tear classifications. (B) An illustration summarizes the corresponding step. SSc, subscapularis; HH, humerus head.

suture, prevent the suture from cutting the rotator cuff vertically, and reduce the impact and irritation of the knot. It can also prevent tendon rupture, unlike other knot-free techniques.[16] This report aims to describe the applications of the H-Loop technique in the arthroscopic repair of the subscapularis tendon.

Surgical Technique

Patient Positioning and Arthroscopic Examination

After general anesthesia combined with a brachial plexus block, the patient was placed in the lateral decubitus position with arm abduction of 30° to 40° and forward flexion of 20° in a balanced suspension position. The surgical portals were marked: the posterior portal for observation and the anterior portal for manipulation. The subscapularis and biceps brachialis long head tendons and pully structures were observed through the posterior portal. The anterior portal was established with a lumbar puncture needle through the rotator cuff space at the anterior portal points under the direct view of the anterior portal, and an 8 mm cannula was placed (Fig 1). The mid-glenohumeral ligament and the significantly degraded tendon tissue were released, the rotator cuff interval was cleared with a planer, and the subscapularis tendon was fully exposed. The subscapularis tear was investigated with a probe to determine the injury classification (Fig 2, Video 1).

Subscapularis Repair

After arthroscopic exploration, the footprint area and part of the marginal cartilage at the subscapularis

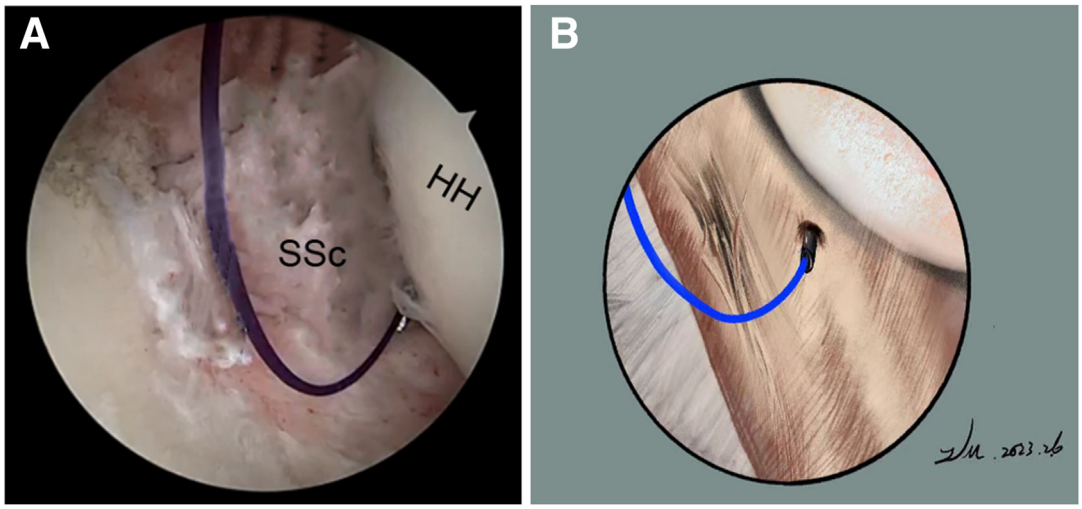

Fig 3. Arthroscopic image with the patient in the lateral decubitus position. The left shoulder was viewed from a posterior portal, and the images were 30° arthroscopy. (A) A PDS monofilament was threaded on the inferomedial side of the tear gap via the anterior portal using lasso. Then the PDS monofilament was threaded out of the cannula with ring grasper on the posterior side of the tendon. (B) An illustration summarizes the corresponding step. SSc, subscapularis; HH, humerus head.

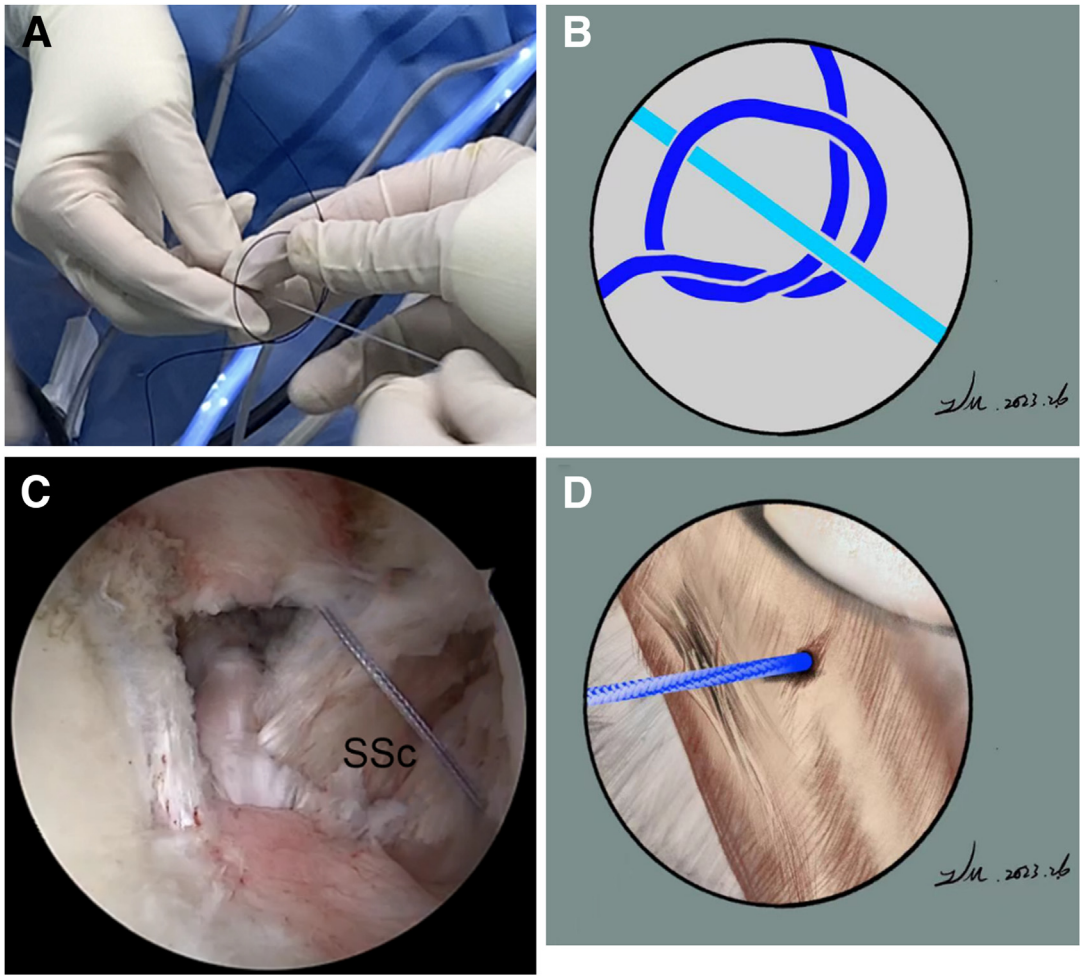

Fig 4. Arthroscopic image in with the patient in the lateral decubitus position. The left shoulder was viewed from a posterior portal, and the images were 30° arthroscopy. (A) A slipknot was tied at the end of the PDS line and a no. 2 Fiber Wire suture was brought in so that the suture across both ends of the tendon are equal in length. (B) An illustration summarizes the corresponding step. (C) The loose end of the PDS was retrieved from the same anterior portal, and the Fiber Wire suture formed a loop at the tear gap. (D) An illustration summarizes the corresponding step. SSc, subscapularis; HH, humerus head.

insertion of the lesser tuberosity were cleaned with a planer and radiofrequency. The bone bed was freshened by a bur, and a pilot hole was drilled.

A polydioxanone (PDS) monofilament (Ethicon, Bridgewater, NJ) was threaded on the inferomedial side of the tear gap via the anterior portal using a Reel Pass Suture Lasso (Arthrex, Naples, FL) and then exited the Lasso (Fig 3, Video 1). Then, through the anterior portal, the PDS monofilament was threaded out of the cannula with wire grasping forceps on the posterior side of the tendon to form a loop at the tear gap. A no. 2 Fiber Wire suture (Arthrex) was brought in so that the suture across both ends of the tendon was equal in length (Fig 4, Video 1). Then, through the anterior portal, the Lasso was used to cross a PDS monofilament again at the medial tear gap and the interior of the loop. Afterward, a knot was tied at the end and brought in the same no. 2 Fiber Wire suture.

The no. 2 Fiber Wire in the cannula was retrieved through the medial of the tear gap and located at the inner side of the ring (Fig 5, Video 1). The probe was used to pull the wire loop slightly inward, and then the wire was pulled to tighten the H-Loop (Fig 6, Video 1). A 4.75-mm SwiveLock anchor (Arthrex) was used to fix the tail of the line at the footprint area and fit the tendon injury area at the insertion point (Fig 7, Video 1).

Postoperative Rehabilitation

The patient wore a shoulder abductor brace, and the exercises, such as clenching and elbow bending, were performed within 2 weeks after surgery; passive forward bending and upward lifting were also performed during that time. Passive shoulder range of motion training was performed after 6 weeks, and shoulder strength training was performed with a tension band

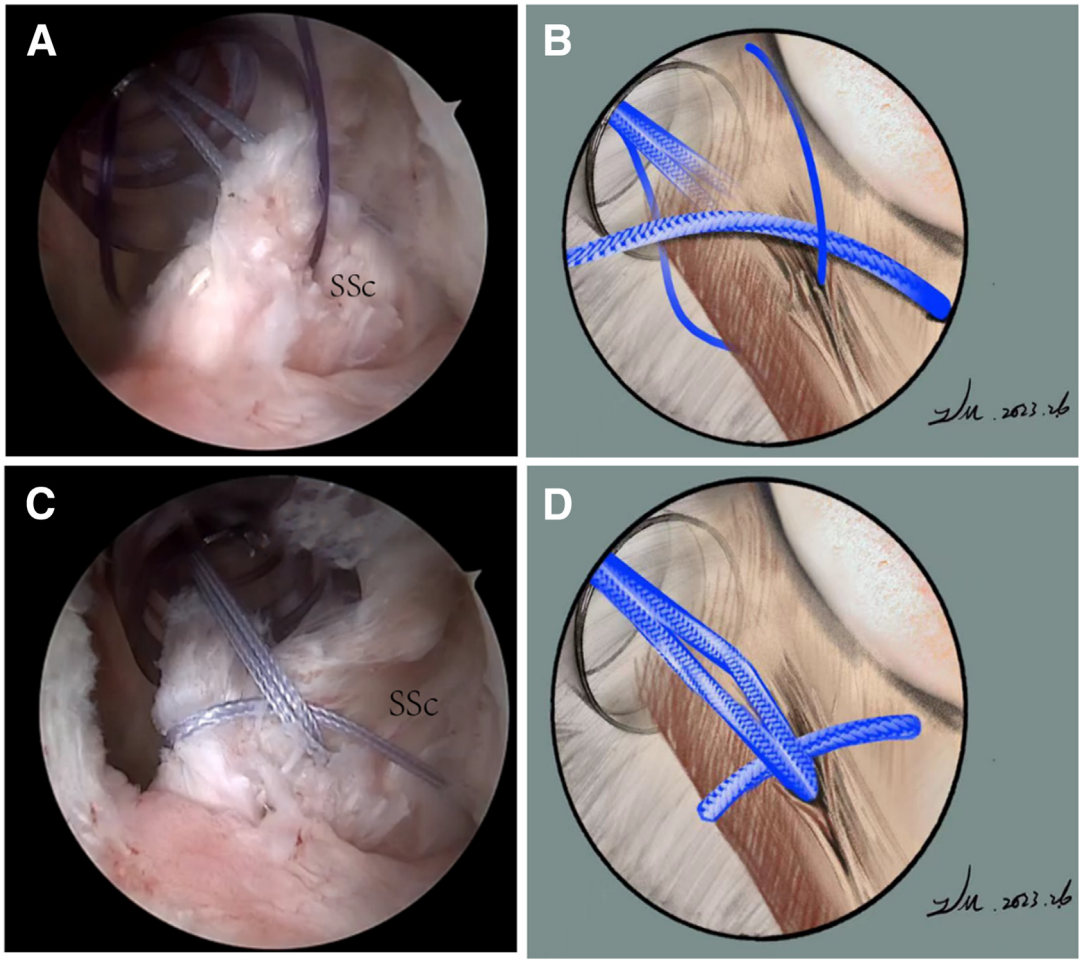

Fig 5. Arthroscopic image with the patient in lateral decubitus position. The left shoulder was viewed from a posterior portal, and the images were 30° arthroscopy. (A) Through the anterior portal, the lasso was used to cross a PDS monofilament again at the medial of the tear and interior of the loop, then a knot was tied at the end and the same Fiber Wire suture was brought in. (B) An illustration summarizes the corresponding step. (C)The Fiber Wire in the cannula was retrieved through the medial of the tear gap and located at the inner side of the loop. (D) An illustration summarizes the corresponding step. SSc, subscapularis.

after 3 months. The movement gradually resumed at 6 months after surgery.

Discussion

In upper rotator cuff repair, the knots created by the knotted suture technique can harden the suture, causing impact wear in the healing area of the tendon-bone, leading to a retear.[17] Hotta et al.[18] recommend avoiding knots exposed on the upper rotator cuff to prevent impact. In the repair of the subscapularis tendon, clinical and radiological outcomes do not significantly differ between knotless and knotted repair techniques. However, the knotted technique could place more strain on the subscapularis muscle.[15] The knotless technique is an improved suture method that used a single-row anchor. For the upper third of the subscapular tendon injury, the knotless technique sufficiently satisfies the biomechanical stability of the tendon repair.[19]

Compared to the repair of the upper rotator cuff, arthroscopic repair of the subscapularis muscle is more difficult because of the restricted space and greater difficulty of knotting.[20] The subscapularis muscle is adjacent to the axillary artery, axillary nerve, and lateral cord of the brachial plexus. The anatomical relationship and narrow space of the subscapularis muscle greatly influence the arthroscopic repair. In particular, chronic injuries may further affect subscapularis exposure because of tendon atrophy and adhesion. The difficulty of subscapularis muscle repair is a challenge to surgeons. Easier arthroscopic debridement is often chosen for small tears. However, a good repair is significant for the prognosis of subscapularis injuries with dysfunction. The subscapularis unrepair can result in decreased function, make it more difficult to repair the combined posterosuperior rotator cuff injuries, and increase tension after repair.[21] We believe that for subscapularis tears with dysfunction, especially when combined with a

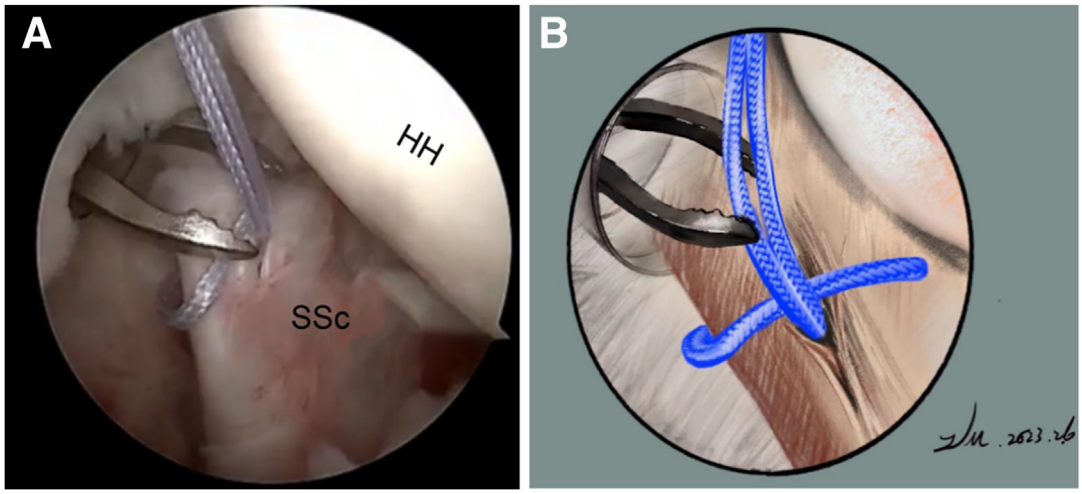

Fig 6. Arthroscopic image in lateral decubitus position. The left shoulder was viewed from a posterior portal, and the images were 30° arthroscopy. (A) The ring grasper was used to pull the loop slightly inward, and then the wire was pulled to tighten the H-Loop. (B) An illustration summarizes the corresponding step. SSc, subscapularis; HH, humerus head.

posterosuperior rotator cuff injury, priority repair of the subscapularis can restore the forward coupling of the shoulder and function and improve the stability of the posterior upper rotator cuff repair. Technique-related tips and tricks are summarized in Table 1.

The H-Loop technique requires only a posterior observation and an anterior operational portal. A single approach reduces surgical risk, surgical time, and postoperative pain and swelling for patients, and has the advantages of efficiency, simplicity, and repeatability, which can reduce the learning curve for beginners. The superior 2/3 of the subscapularis is a tendinous part, and tears often start from the upper part, and the upper part often causes the muscle fibers to separate longitudinally.[22] Compared with simple suture and modified Mason-Allen and other suture methods, the H-Loop forms a closed loop and tightens the tear at the medial and lateral edges of the tear. Its stitching and tension directions are perpendicular to the laceration, which is especially suitable for small longitudinal lacerations(Lafosse I, II). In addition, this technique uses a small-diameter spine needle for suturing, which can avoid damage during suturing to a great extent and improve the precision of the suture.[23] However, this technique is unsuitable for large subscapularis tears because of the knotless single-row suture. A double-row suture is recommended for large Lafosse III and IV tears because of retraction tension and atrophy. Table 2 lists the advantages and disadvantages of our technique. This technical note describes the use of the H-Loop knotless technique in subscapularis injury. The simplicity and efficiency of this technique make it reliable for minor subscapularis muscle tears, especially the longitudinal ones.

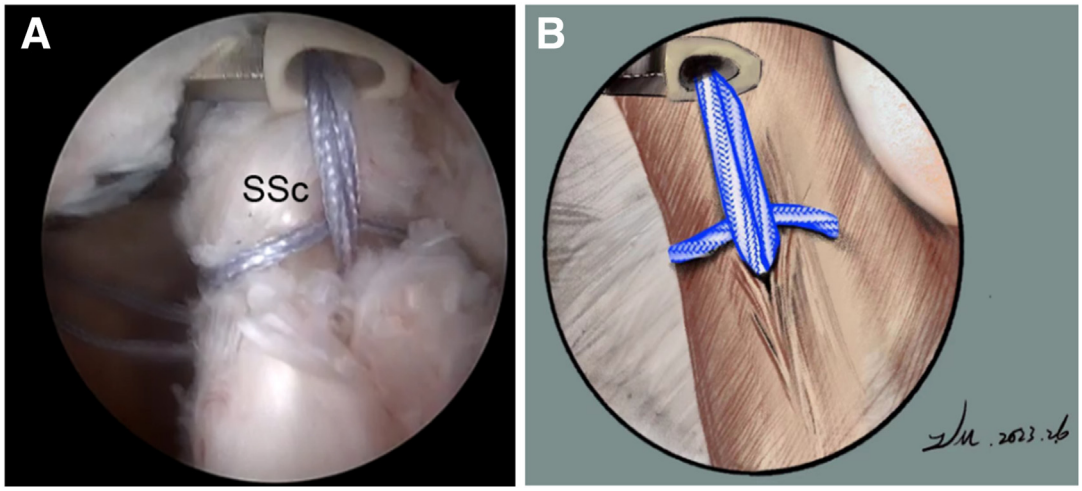

Fig 7. Arthroscopic image in lateral decubitus position. The left shoulder was viewed under arthroscopic from a posterior portal, and the images were 30° arthroscopy. (A) A SwiveLock 4.75 anchor was used to fix the tail of the line at the footprint area and fit the tendon injury area at the insertion point. (B) An illustration summarizes the corresponding step. SSc, subscapularis.

Table 1. Tips and Tricks

The cannula is placed through rotator interval in anterior portal to facilitate operation.
The first stitch is threaded on the inferomedial side of the tear.
After the tear is threaded to form a loop, a second PDS is passed through the inside of the loop.
The tail of suture is pulled to laterally and is fixed at the lesser tubercle.

Table 2. Advantages and Disadvantages

Advantages
Single-portal and spine-needle guidance can reduce the risk of intraoperative vascular and nerve injury
Reduced wire knot reaction
Ideal for suturing longitudinal tears
Simple operation and short learning time
Simple suture tools and a single anchor can reduce surgical costs
Disadvantages
The anchor may become loose or even pull out
Not suitable for large subscapularis tears

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