

The Chinese Knot Stitch Technique Using a Footprint Ultrasuture Anchor for Rotator Cuff Repair



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Abstract: Management of the rotator cuff presents specific challenges to orthopaedic surgeons. Several locking suture methods have been reported but often fail for a number of reasons. We describe a different technique that is easy to perform and inspired by the Chinese knot, an arthroscopic double-locking suture using a footprint ultrasuture anchor. This technique is similar to the suture-bridge structure on the bursal side of the tendon in that it increases tissue grip and stabilizes initial tendon-to-bone fixation. This technique is especially suitable for the patients who have bursal-side partial-thickness or degenerative small- and medium-sized rotator cuff tears.

Many factors affect rotator cuff healing; surgical technique is one of great importance.¹ The rotator cuff suture method, which includes single-row, double-row suture, and the suture bridge techniques, enhances fixation. Recently, it has included a variety of locking sutures, such as the double-locked stitch,² the simple cow hitch stitch,³ the “parachute” technique,⁴ the double-row rip-stop technique,⁵ the shoelace technique,⁶ and the double-layer lasso loop technique.⁷ For rotator cuff tears with degeneration or poor tendon quality, some studies have shown that the application of various locking ring sutures can decrease failure rate and prevent the rotator cuff from being re-torn during suture.⁸ However, different suture methods have different biomechanics.⁹ To perform a reliable locking suture, surgeons often need more experience and longer operation times. Conversely, surgeons want a

simple locking suture technique with as few arthroscopic steps as possible.

The Chinese knot is an ancient knitting art and a symbol of Chinese traditional culture. Each knot is knitted from the beginning to the end with a silk thread, and each basic knot is named according to its shape and meaning. Chinese knots are mostly used to decorate rooms, given as gifts between relatives and friends, and retained as personal accessories. Many kinds of locking loop techniques are used in the knitting process. The knots not only symbolize safety and wealth for the coming year for the host but also reflect the host’s personality and aesthetic preferences. We were inspired to use one of the double-locking loop techniques in the rotator cuff suture, which we call the “Chinese knot stitch.” This double-locking loop technique can withstand great traction forces.¹⁰ It is an easy arthroscopic technique that provides greater strength to reattached tendons through a footprint ultrasuture anchor. It offers a reliable option in the patients who have bursal-side partial-thickness or degenerative small- and medium-size rotator cuff tears.

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Surgical Technique

The Chinese knot stitch can be learned quickly by a trained arthroscopic surgeon. It can be performed without any special instruments and uses a footprint ultrasuture anchor to reattach the tendon.

Patient Positioning

The surgery is performed with the patient under brachial plexus anesthesia and general anesthesia. The

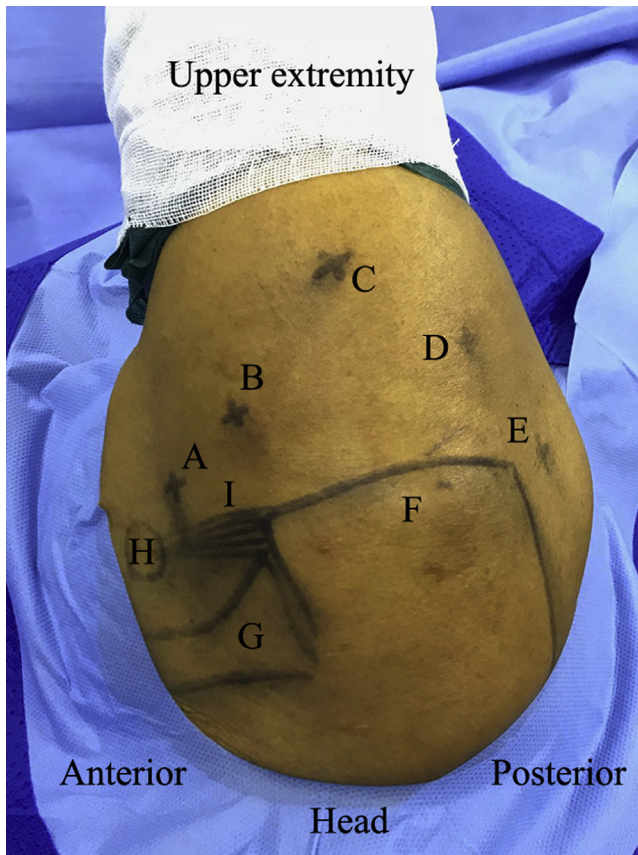


Fig 1. Representative rotator cuff surgical position in a 59-year-old woman with a right rotator cuff tear. She was placed in the lateral decubitus view using a pelvic fixator on a standard operating table. The operative arm was placed in a foam traction sleeve, and 3 kg of traction was applied with a simple traction frame. The torso was tilted back 30°, the operative arm abduction was 70°, and the flexion was 20°. Then, the shoulder joint bone was marked. Portal placement of the right shoulder demonstrating (A) standard anterior portal, (B) accessory anterolateral portal, (C) standard lateral portal, (D) accessory posterolateral portal, (E) standard posterior portal, and anatomical landmarks (F) acromion, (G) distal clavicle, (H) coronoid process, and (I) coracoacromial ligament.

patient is placed in the lateral decubitus view using a pelvic fixator on a standard operating table. All bony protrusions are well padded with sponge cushions to prevent pressure sores, and the nonoperative arm is placed at a 90° flexion, the knees are bent, and the head is in neutral alignment. The range of motion and the capsular conglutination are evaluated by examination while the patient is under anesthesia. The operative arm is then placed in a foam traction sleeve, and 3 kg of traction is applied with a simple traction frame. The torso is tilted back 30°, the operative arm abduction is 70°, and the flexion is 20°. Then, the shoulder joint bone is marked.

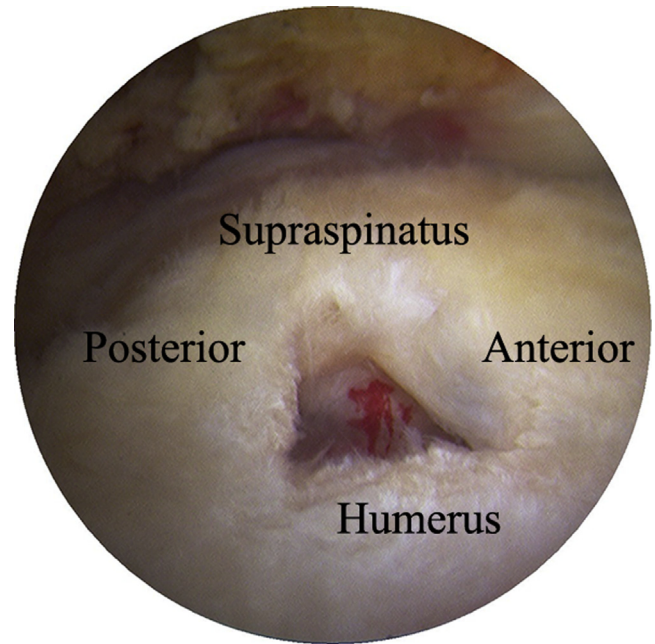


Fig 2. Representative arthroscopic view of the right shoulder in the lateral decubitus position in a 59-year-old woman with rotator cuff tear. Arthroscopic image from the standard lateral portal shows that the supraspinatus is a partial tear from the greater tuberosity of the humerus.

Arthroscopic Portal Placement

First, the posterior portal incision is made 2 cm inferior and 1 cm medial to the posterolateral corner of the acromion. A preliminary arthroscopic examination is performed through this portal using a 30° arthroscope. Following the heart needle localization, the anterior portal is made lateral of the coracoid process and 4 cm inferior to the anterior acromial corner. The lateral portal is placed 2 cm lateral to the distal acromion in the axis of supraspinatus. Other accessory lateral portals should be established if necessary (Fig 1).

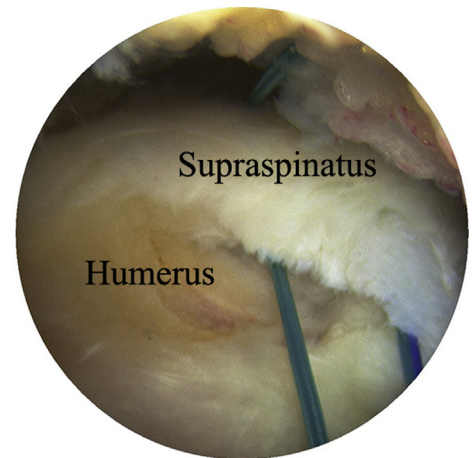
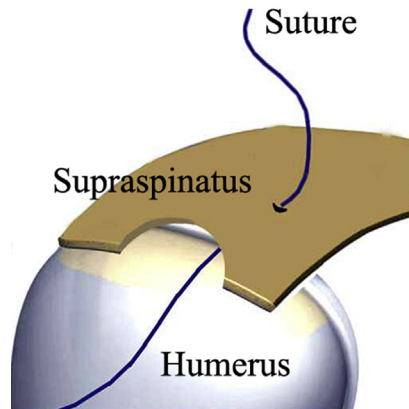
Evaluation of the Glenohumeral Joint

The glenohumeral joint is examined through the posterior portal. Then, a forward portal is established if the long head of the biceps is torn or inflamed. The age of the patient and the findings of the clinical examination will determine whether it should be repaired or cut off. If it is found that the capsule adhesion is serious, it is necessary to release it, and other pathologic changes in the joint need to be repaired at the same time.

Subacromial Decompression and Rotator Cuff Repair Preparation

When viewing from the posterior portal to the subacromial space, one should enter from the lateral portal to remove damaged and inflamed tissue from the thickened bursa with an arthroscopic shaver (Smith &

Fig 3. The first step of Chinese knot stitch technique. The no. 2 ETHIBOND Excel Polyester Suture was first passed through the tendon from the articular side to the subacromial side.



Nephew, Andover, MA) and radiofrequency ablator (Smith & Nephew) for hemostasis. Then, the field of vision is turned to the acromion. If acromial hyperplasia and impingement are observed, mark the lateral acromion. The arthroscopic shaver is used for debridement of the subacromial hyperplasia of the soft tissue and then a grinding drill (Smith & Nephew) to remove any subacromial spur. To complete the procedure, the cancellous bone surface is smoothed, and then a radiofrequency ablator is used to stop the bleeding. Then, the anterior acromion angle is treated from the posterolateral approach in the visual field. The size, shape, and quality of rotator cuff tears are evaluated. The rotator cuff tear is released and the tension-free suture is evaluated. The tendon footprint is prepared using an arthroscopic bone shaver to expose the greater tuberosity on the cortical bone until the bone surface is fresh enough to stimulate the healing response (Fig 2).

Chinese Knot Stitch Technique for Rotator Cuff Repair (With Video Illustration)

Depending on the footprint of the rotator cuff, the posterior or lateral portal can be used for viewing. The anterior, anterolateral, and posterolateral accessory can be used as an operative portal. A step-by-step video of the procedure showing the cannula being placed in the operating portal can be seen. A permanent No. 2 ETHIBOND EXCEL Polyester Suture (Johnson & Johnson, New Brunswick, NJ) is first passed through the torn tissue using a suture shuttling device (DePuy Synthes, Warsaw, IN) in a horizontal mattress fashion starting at the medial edge of the rotator cuff tear from the articular side to the subacromial side (Fig 3).

The other free end of the suture also is passed through the rotator cuff tear, which is approximately 10 mm from the first position. The middle part of the suture makes a loop under the articular side (Fig 4).

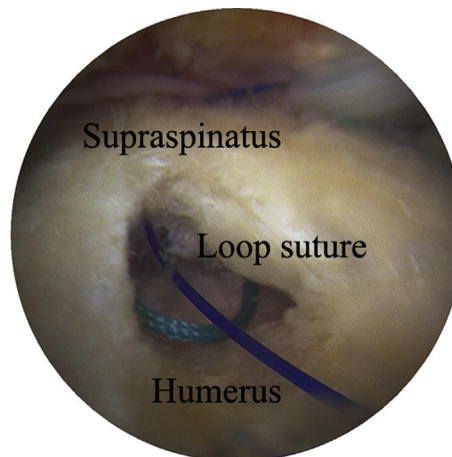
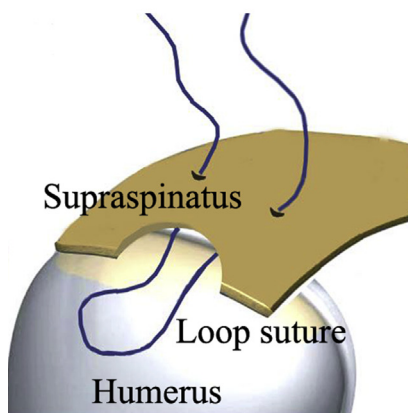


Fig 4. The second step of Chinese knot stitch technique. The other free end of the suture also was passed through the tendon and the middle part of the suture created a loop under the articular side.

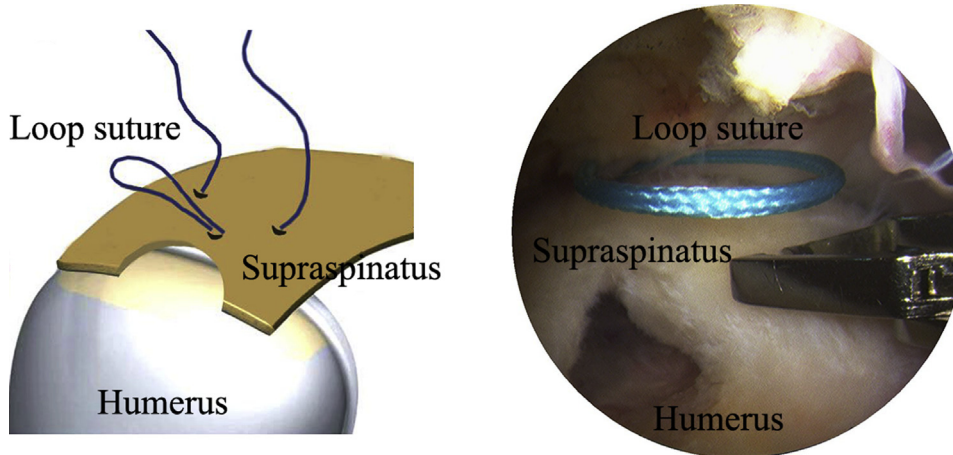


Fig 5. The third step of Chinese knot stitch technique. The loop was passed to the bursal side, and the 3 points form an isosceles triangle.

The loop is passed to the bursal side, which is at a distance of 5 mm from the front of the 2 positions, with the 3 points forming an isosceles triangle (Fig 5). The free end of the suture is pulled through the loop and, subsequently, the 2 locking loops are made by tightening the 2 ends of the suture, creating a Chinese knot (Fig 6).

The 2 sutures are fixed by a footprint ultrasuture anchor, which is implanted into the greater tuberosity lateral row (Fig 7). If the rotator cuff tear is large, another Chinese knot can be added (Video 1).

Postoperative Rehabilitation

Postoperative rehabilitation involves immobilizing the patient's arm in a sling for 6 weeks, allowing passive movement alone. The forearm must be kept against the side of the body in neutral rotation and in mild abduction, thereby reducing the tension on the repaired cuff. Passive motion and closed kinetic chain exercises are initiated within 2 weeks. The 6 weeks after postoperative care includes passive- and active- assisted

motion. Weight bearing or strengthening exercises are allowed after 12 weeks.

Discussion

With the aging population, the incidence of the rotator cuff tears in patients with joint degeneration and osteoporosis is increasing. Nonoperative management can result in the progression of fatty tissue infiltration and the decreased acromiohumeral distance, limiting shoulder function and increasing pain.¹¹ With the development of arthroscopic technology, there are many kinds of the rotator cuff suture methods from which surgeons can choose. Arthroscopic repair of the rotator cuff tears is associated with a significant re-tear rate. The etiology of these re-tears is likely multifactorial, including age, tendon quality, and surgical technique. Surgeons decide on the appropriate technique choice according to the age of the patient, shape and size of the tears, degree of retraction and fatty degeneration, and surgeon's personal preferences. The ideal suture should have the

Fig 6. The fourth step of Chinese knot stitch technique. Passage of the free end sutures through the loop, then the 2 locking loops were created by tightening the 2 ends of suture, making a Chinese knot.

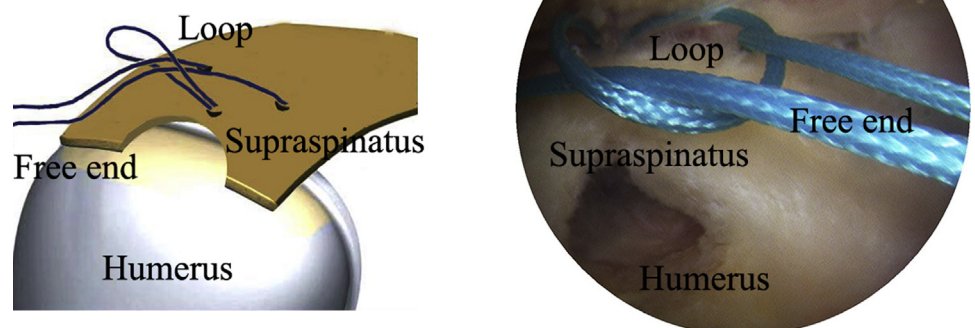
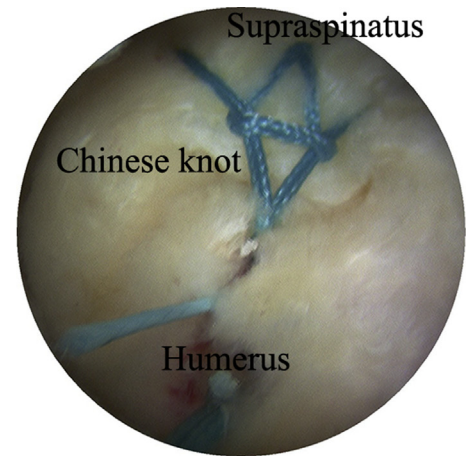
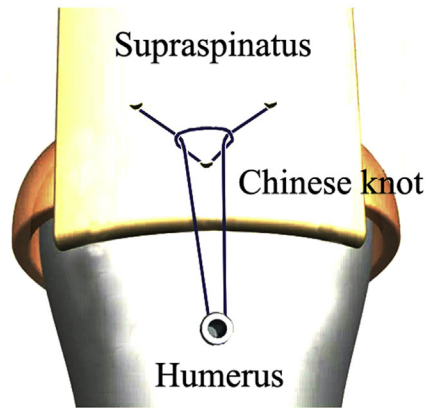


Fig 7. The last step of Chinese knot stitch technique. The 2 end sutures are fixed by a footprint ultrasuture anchor.



advantages of being simple to perform, firm, economical, and requiring less anchor implantation. Studies have confirmed that the locking suture can improve the success rate of the torn rotator cuff repair without an obvious degeneration or poor quality.^{4,7,12} However, the reported techniques of locking stitches increase procedure length and difficulty, which limits their application. The Chinese knot stitch technique can be accomplished using conventional shoulder suture tools. Two locking loops can be constructed with 3 sutures and fixed in place without separate knots. This technique is easy to perform and has a short learning curve. It can be accomplished by shoulder surgeons at all levels of experience and may be more suitable for beginners with poor knotting skills. The pearls and pitfalls of the Chinese knot stitch technique for the rotator cuff repair using a footprint ultrasuture anchor are summarized in [Table 1](#).

The double-locking loop stitches of the Chinese knot are used to lock the rotator cuff fibers in the oblique direction. Because it's knotless, the surface of the rotator cuff is smooth, which reduces stitch stimulating response. More interesting, the Chinese knot stitch will form a suture bridge on the bursal side, which is

in the shape of the Eiffel Tower. Uniform pressure on the rotator cuff and increased tendon–bone contact area may be conducive to rotator cuff healing. Another advantage is that this technique has less anchor usage and is more economical. For a medium-sized rotator cuff tear less than 4 cm, 1 or 2 Chinese knot stitches can be made. To our knowledge, medial row anchors reduce the coverage of footprint and tendon perfusion, so only one footprint ultrasuture anchor is fixated in our technique, which also reduces anchors, operation steps, and operation time. The described technique has some advantages and disadvantages ([Table 2](#)).

In summary, we have applied the Chinese knot stitch to small- and medium-sized rotator cuff tears with degeneration or poor quality. The operation is simple and convenient, and the clinical effect is satisfactory. The Chinese knot stitch is composed of 2 double-locking loops which creates superior tissue-grip strength that can lead to a lower re-tear rate and better clinical outcomes. However, further studies are required to compare the biomechanical and clinical effects of this technique with suture bridge technique or other locking suture methods.

Table 1. Pearls and Pitfalls of the Chinese Knot Stitch Technique

Pearls	Pitfalls
The footprint needs sufficient freshness or microfracture to improve healing	Poor tissue quality may lead to tear through the ETHIBOND EXCEL polyester suture
Rotator cuff should be loosened sufficiently to reduce the tension	Severe osteoporotic bone may lead to anchor cut out with the locking suture
The first needle and the second needle are 10 mm apart from the lateral margin and the third needle is 5 mm apart, so that the tension is balanced	Improper suture management can occur with double locking loops
In the osteoporosis, the footprint ultrasuture anchor can be implanted into the cortical to prevent pull-out	Postoperative rehabilitation is required to improve function and minimize stiffness and re-tear rate
When pulling out the inserting rod of anchor, the anchor can be pressed with an awl to prevent pulling out, especially in osteoporosis	

Table 2. Advantages and Disadvantages of the Chinese Knot Stitch Technique

Advantages	Disadvantages
Superior tissue-gripping strength in degenerated, poor-quality rotator cuff	Time-consuming due to the double locking technique
Simple suture operation	Irreparable, retracted structure is not suitable for this technique
High footprint coverage, similar to suture bridge	Increased difficulty due to 2 locking sutures
Better pressure contact to footprint	
Reduces suture anchors, lower cost	

References

- Mall NA, Tanaka MJ, Choi LS, Paletta GA Jr. Factors affecting rotator cuff healing. *J Bone Joint Surg Am* 2014;96:778-788.
- Miyazaki AN, Zanella LA, La Salvia JC, et al. Arthroscopic double-locked stitch: A new technique for suturing rotator cuff tears. *Arthrosc Tech* 2014;3:e223-e225.
- Hawi N, Krettek C, Hawi A, Meller R. The simple cow hitch stitch technique for arthroscopic rotator cuff repair and stabilization using knotless suture anchors. *Arthrosc Tech* 2015;4:e189-e191.
- Natera L, Consigliere P, Witney-Lagen C, et al. The "Parachute" technique: A simple and effective single-row procedure to achieve an increased contact area between the cuff-tendon and its footprint. *Arthrosc Tech* 2017;6:e1903-e1909.
- Bills CC, Field ED, Field LD. "Double-row rip-stop" technique for arthroscopic rotator cuff repair. *Arthrosc Tech* 2017;6:e2053-e2059.
- Lall AC, Cain EL Jr. Margin convergence in rotator cuff repair: The shoelace technique. *Arthrosc Tech* 2018;7:e823-e827.
- Opsomer GJ, Gupta A, Haeni DL, et al. Arthroscopic double-layer lasso loop technique to repair delaminated rotator cuff tears. *Arthroscopy* 2018;34:2943-2951.
- Baleani M, Ohman C, Guandalini L, et al. Comparative study of different tendon grasping techniques for arthroscopic repair of the rotator cuff. *Clin Biomech (Bristol, Avon)* 2006;21:799-803.
- Liodakis E, Dratzidis A, Kraemer M, et al. The lasso-loop, lasso-mattress and simple-cinch stitch for arthroscopic rotator cuff repair: Are there biomechanical differences? *Arch Orthop Trauma Surg* 2016;136:1581-1585.
- Anz AW, Branch EA, Saliman JD. Biomechanical comparison of arthroscopic repair constructs for meniscal root tears. *Am J Sports Med* 2014;42:2699-2706.
- Kim JY, Park JS, Rhee YG. Can preoperative magnetic resonance imaging predict the reparability of massive rotator cuff tears? *Am J Sports Med* 2017;45:1654-1663.
- Koganti AK, Adamson GJ, Gregersen CS, Pink MM, Shankwiler JA. Biomechanical comparison of traditional and locked suture configurations for arthroscopic repairs of the rotator cuff. *Am J Sports Med* 2006;34:1832-1838.