Technical Note

An Efficient “M”-shaped Suturing Technique for L-shaped Rotator Cuff Tear

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Abstract: Rotator cuff tear can be divided into 4 main patterns on the basis of the geometric characteristics: crescent, longitudinal (U- or L-shaped), massive contracted, and arthropathy tears. For L-shaped rotator cuff tear, the surgical procedure often refers to the identification of the apex of the “L” and the side-to-side suturing of the longitudinal split. This technique note introduced an “M”-shaped suturing with 2 suture anchors, 3 sutures, and 4 knotting procedures, especially efficient for L-shaped rotator cuff tear.

The precise identification of the tear pattern is an important initial step for the following surgical strategy to restore of the rotator cuff footprint. In 1944, McLaughlin first described the geometric classification of rotator cuff tears into 3 patterns: transverse ruptures, vertical splits, and retracted tears. However, this classification never got widely adopted. In 1984, DeOrio and Cofield reported a classification of rotator cuff tear by the length of the greatest diameter of the tear to categorize the tear into 4 groups: small, medium, large, or massive. Later, Harryman et al. and Gerber et al. reported their classification system respectively, on the basis of the number of torn tendons. However, these classification systems failed to differentiate specific tear patterns on geometric and to inform decision-making on repair techniques. On the basis of these classifications, Davidson and Burkhart developed a new geometric classification toward rotator cuff tear and linked this system to the treatment and prognosis. In this classification, there are 4 types: crescent, longitudinal (U- or L-shaped), massive contracted, and arthropathy tears.

For the L-shaped tear, the surgical procedure often refers to the identification of the apex of the “L” and the side-to-side suturing of the longitudinal split. Because the repair of this L-shaped tear was supposed to be easier than those massive contracted tears, surgical techniques for this type of tear have been seldom introduced. Still, it will make sense for us to set up an efficient, standardized procedure for L-shaped tears to simplify the surgical procedure and achieve consistently excellent clinical outcomes. In this technique note, we introduced an efficient “M”-shaped suturing technique for L-shaped rotator cuff tears, with 2 suture anchors, 3 sutures, and 4 knotting procedures.

Surgical Technique

Preoperative Evaluation

Rotator cuff tear pattern is identified by preoperative magnetic resonance imaging and confirmed during arthroscopic surgery, on the basis of Davidson and Burkhart’s classification. An L-shaped tear is noted when the medial-to-lateral length of the tear is greater than its anterior-to-posterior width. These longitudinal tears are typically mobile in an anterior/posterior direction and can usually be repaired by a side-to-side/margin convergence technique (Fig 1A and C).

Patient Position and Arthroscopy Portals

The patient is placed in the beach chair position after general anesthesia combined with interscalene block. The operative arm is placed in 30° abduction and 20° forward flexion. Diagnostic arthroscopy is performed...
with a 30° arthroscope through a standard posterior viewing portal and anterior working portal. A thorough evaluation of the glenohumeral joint is performed, including the glenoid and humeral chondral surfaces, glenoid labrum, rotator cuff, and biceps tendon. Then the arthroscope is moved to the subacromial space through the posterior portal, and a lateral portal is created for the main working portal. A posterolateral portal is made on the posterior edge of the torn tendon as the main viewing portal. Acromioplasty is performed if necessary. Debridement of the degenerative tendon tissue is performed to facilitate after identification of the tear patterns. An additional small incision is made on the lateral border of the acromion to insert suture anchors.

Preparation

Once the L-shaped tear is identified, the apex of the “L” will be easy to determine. Then the torn tendon is grabbed to the apex with a suture retriever used to test the coverage and the tension of the tendon after repair (Fig 1 B and D). If the tension is too high, proper releasing of the tendon should be performed. The footprint area is slightly decorticated before the anchors are implanted to facilitate postoperative bone-tendon healing (See Video 1).

Anchor Implantation

The first anchor (Healicoil PK; Smith & Nephew, Andover, MA) is placed at the medial margin of the footprint (on the cartilage junction), along the longitudinal tear (anchor “a”). The second anchor (Healicoil PK) is then placed 0.5 cm laterally to the apex of the “L” to obtain a full coverage of the footprint (anchor “b”). (Fig 2A and B) (See Video 1).

Suturing

The first suture is located at the one-third part of the torn tendon transversely, close to the tendon-muscle border. Two threads, one from each anchor, are passed through the tendon simultaneously. The second suture is located at the two-thirds part of the torn tendon transversely, close to the tendon-muscle border. The other thread from each anchor (2 other threads) is passed through the tendon simultaneously. During these 2 suturing procedures, the torn tendon should be grabbed to the footprint where we desire to guarantee the right position of the sutures on the tendon. The third suture is located at the other side of the longitudinal tear, about 1 to 2 cm to the tear edge and parallel to the middle point of the longitudinal tear, to get the best side-to-side convergence of the torn tendon. The
other ends of the 2 threads of the first anchors are passed through the tendon simultaneously (Fig 2 C-E) (See Video 1).

**Knotting**

After 3 sutures, 4 knotting procedures are done in sequence. The first knotting is on the thread of anchor “a” in the first and third sutures. This knotting will bring the torn tendon back to the footprint and also is the first knotting for the side-to-side convergence. The second knotting is on the thread of anchor “b” in the first suture. The third knotting is on the thread of anchor “b” in the second suture. The second and third knotting procedures compress the torn tendon firmly onto the

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**Fig 2.** Anchor implantation and suturing in right shoulder. The patient is placed in the beach chair position, and the right arm is placed in 30° abduction and 20° forward flexion. (A) Arthroscopic view from lateral portal of anchor “a” implantation via posterolateral portal. (B) Arthroscopic view from lateral portal of anchor “b” implantation via posterolateral portal. (C) Arthroscopic view from lateral portal of the first and second suture via anterior portal. (D) Arthroscopic view from lateral portal of the third suture via standard posterior portal. (E) Illustration of the anchor implantation and sutures of right shoulder. (1, first suture; 2, second suture; 3, third suture; a, anchor “a”; b, anchor “b”; arrowhead, apex of L-shaped tear.)

**Fig 3.** Knotting procedures in right shoulder. (A) Final arthroscopic view of the “M”-shaped suturing technique in right shoulder. (B) Illustration of the knotting procedures in right shoulder. (I, first knotting; II, second knotting; III, third knotting; IV, last knotting; arrowhead, apex of L-shaped tear, dotted line, margin convergence of the torn tendon. To better illustrate, the 2 threads of the same anchor were drawn in the same color.)
footprint. Furthermore, the thread of the third knotting will cross over the thread of the first knotting, like a Mason-Allen suture technique, to reduce the shear force of the sutures. The last knotting is on the thread of anchor "a" of the second and third suture to reinforce the side-to-side convergence. Finally, these 3 sutures and 4 knotting procedures will show an M-shaped geometric portrait to achieve an excellent margin convergence and footprint coverage of the L-shaped tear. The tension of the torn tendon distributes uniformly (Fig 3) (See Video 1).

Discussion

Rotator cuff tear is one of the most common lesions in the shoulder joint and has been extensively studied. Among all tear patterns, the massive, irreparable rotator cuff tear is most concerning for surgeons and basic researchers, because this kind of tear is most difficult to treat, and its prognosis is uncertain. Compared to a massive tear, the L-shaped tear is relatively easy to handle. Thus surgical techniques for L-shaped tears have seldom been introduced. A standard surgical procedure for L-shaped tears is lacking, especially for first learners. Moreover, if the repair doesn't get good footprint coverage and margin convergence with low tension, it can still lead to an inferior prognosis and even retear.8-11

| Table 1. Pearls and pitfalls of the technique |
|-----------------------------------------------|
| **Pearls**                                    |
| Place the second anchor (anchor “b”) 0.5 cm laterally to the apex of the “L”, to obtain full coverage of the footprint. |
| Use the suture retriever to grab the torn tendon to the apex of the “L” to test the coverage of the footprint and the tension of the torn tendon. |
| Proper releasing need to be performed if the tension of the torn tendon is too high. |
| Grab the torn tendon to the right place before every suturing to guarantee precise location of every suture. |
| Knotting procedures should be performed in a certain sequence as mentioned in this technique note to obtain the best coverage of the footprint and uniform tension of the tendon. |
| **Pitfalls**                                   |
| If the second anchor is placed right at the apex of the “L,” the anchor will take a small part of the footprint, leading to the failure of full coverage. |
| If the tension of the tendon is too high, it may affect the tendon-to-bone healing post operation, and even lead to retear. |
| It will be difficult to find the right location for the sutures if the torn tendon is not grabbed to the right place before suturing. And this will lead to an inferior footprint coverage and uneven tension of the tendon. |
| Knotting in a wrong sequence may cause uneven tension of the tendon. The Mason-Allen sutures will not be available in this technique. |

| Table 2. Advantages and Limitations of the Technique |
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| **Advantages**                                       |
| This is efficient and could be a standard technique for L-shaped tears. |
| No special anchors or instruments are needed. All of the skills in this technique are regular. So it is friendly to the users, especially for first learners. |
| It has consistent good footprint coverage and margin convergence with low tension. |
| It contains a Matson-Allen suture to reduce the shear force of the threads. |
| Only 3 sutures on the tendon can avoid excessive the damage caused by the extra sutures. |
| **Limitation**                                       |
| This technique is only suitable for L-shaped tear (maybe also for U-shaped tear). It will not be so valid to the massive retracted tear. |

In this technique note, we introduced “M”-shaped suturing with 2 suture anchors, 3 sutures, and 4 knotting procedures, especially efficient for an L-shaped tear. It can eventually obtain good footprint coverage and margin convergence with low tension repair. And it’s quite simple to perform, with no need for special instruments or skills. We hope this technique can provide a standard solution for L-shaped tears, especially for first learners of shoulder surgery. Several points need to be noted in this technique, including the identification of the tear pattern, the position of the anchors and sutures, and the sequence of the knotting procedures (Table 1). The main advantage of this technique is its high efficiency. It only needs 2 suture anchors, 3 sutures, and 4 knotting procedures. All of

Fig 4. Illustration of the “double M”-shaped suturing in right shoulder. (a, anchor “a”; b, anchor “b”; c, anchor “c.”)
the instruments, anchors, and skills required in this technique are regular ones. And it can achieve good footprint coverage and margin convergence with low tension (Table 2).

Furthermore, if the tension of the torn tendon is still too high after thorough releasing, an additional lateral row anchor (anchor “c”) could be used with the unilateral 2 suture ends of anchor “a” after this “M”-shaped suturing procedure to create a “suture-bridge” stitch for reducing the tension and improving the coverage of the footprint in advance. This modified technique could be named as a “double M”-shaped suturing according to its geometric portrait (Fig 4). This “M”-shaped suturing technique is also suitable for U-shaped tears as long as the right position for anchor “b” is determined. However, we don’t think it works for massive retracted tears. For a massive retracted tear, a more complex procedure needs to be performed, such as biceps tendon augmentation12,13 and superior capsular reconstruction.

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