

# Observation on the Efficacy of One-Knot-Two-Wire Suture Bridge Method Technique in Treating Small and Medium-Sized Rotator Cuff Tears

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## Abstract

**Objective:** To explore the clinical efficacy of shoulder arthroscopic one-knot-two-wire suture bridge technique in the treatment of small and medium-sized rotator cuff tears. **Methods:** The clinical data of 22 patients with small and medium-sized rotator cuff injuries treated with the one-knot-two-wire suture bridge technique from February 2022 to June 2023 in the Department of Orthopaedics of Jingzhou Hospital Affiliated to Yangtze University were retrospectively analysed, among which 14 cases were male and 8 cases were female; the age ranged from 35 to 68 years old, with an average of  $(50.86 \pm 10.80)$  years old. All cases underwent an MRI examination of the shoulder joint to understand the type and degree of injury. The duration of the disease ranged from 120 to 166 d, with a mean of  $(141.23 \pm 13.46)$  d. The evaluation of the operation time, intraoperative bleeding, visual analogue scale (VAS) of pain, Constant-Murley score and Sugaya grading of shoulder MRI were performed at the last follow-up. **Results:** All 22 patients were followed up for 12 - 18 months, with a mean of  $(14.68 \pm 1.89)$  d. The operation time was 38 - 58 min, mean  $(48.18 \pm 5.92)$  min; intraoperative bleeding was 5 - 15 mL, mean  $(10.00 \pm 3.45)$  mL. All patients achieved normal healing without re-tear, vascular and nerve injury, incision infection, anchor nail loosening and dislodgement and other complications. At the last follow-up, both shoulders were normal in shape and symmetrical on both sides. The VAS score was 0 - 1.2 points, with an average of  $0.61 \pm 0.42$  points, and the Constant-Murley score was 70 - 98 points, with an average of  $86.09 \pm 8.56$  points. The Sugaya classification of MRI examination was 17 cases of grade I, 4 cases of grade II, and 1 case of grade III. **Conclusion:** One-knot-two-wire suture bridge technique is used for the treatment of small and medium-sized rotator cuff tears with short operative time, low bleeding, and good clinical outcome.

## Keywords

One-Knot-Two-Wire Bridge Method, Rotator Cuff Tear, Shoulder Arthroscopy, Suture Bridge

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## 1. Introduction

Rotator cuff injuries are the most prevalent upper extremity disorder in orthopaedics, with the main clinical manifestations being shoulder pain and limited motion, and the most common causes include degenerative conditions and shoulder trauma [1] [2]. According to the distance between the severed end of the rotator cuff tear and the attachment point of the humeral head, there are four types of rotator cuff tears: 1) small tears (<1 cm); 2) medium tears (1 - 3 cm); 3) large tears (3 - 5 cm); and 4) large tears (>5 cm). Treatment of rotator cuff tears includes conservative treatment and surgery. Among the surgical treatments, the arthroscopic anchor stapling technique is the preferred surgical treatment for rotator cuff tears because of its advantages of less trauma and a shorter recovery period [3]. It is the preferred surgical treatment for rotator cuff tear. The commonly used techniques include single-row, double-row and suture bridge techniques, among which the suture bridge technique is widely used because of its good repair effect and low re-tear rate after surgery [4]. The suture bridge technique is widely used in the clinic. The one-knot-two-thread bridge technique is a modified suture bridge technique for repairing small and medium-sized rotator cuff tears, which has the advantages of simpler suturing, cost savings, secure fixation, and good postoperative recovery [5]. It has the advantages of simpler suturing, less costly fixation and better postoperative recovery. Currently, there are fewer studies on the efficacy of the one-knot-two-thread bridge technique in rotator cuff tear closure surgery.

The aim of this research is to retrospectively analyze the clinical data of 22 patients with small and medium-sized rotator cuff tears treated with the one-knot two-wire bridge technique between February 2022 and June 2023, to evaluate its postoperative efficacy and clinical outcomes.

## 2. Information and Methodology

### 2.1. General Information

Inclusion criteria: 1) confirmed diagnosis of rotator cuff injury by imaging; 2) Co-field classification of small or medium-sized tear; 3) symptoms such as pain and limitation of activity and ineffective conservative treatment for more than 3 months; 4) postoperative follow-up and evaluation for at least 1 year. Exclusion criteria: 1) large or massive rotator cuff tear; 2) combination of other shoulder joint diseases; 3) history of previous shoulder surgery; 4) inability to follow up as required.

According to the inclusion and exclusion criteria, a total of 22 patients were included in the study, including 14 males and 8 females; their ages ranged from 35 to 68 years, with a mean of  $(50.86 \pm 10.80)$  years. All cases underwent shoulder MRI to understand the type and extent of injury. The time from onset to surgery ranged from 120 to 166 d, with an average of  $(141.23 \pm 13.46)$  d. The mean time from onset to surgery was 166 d, with an average of  $(141.23 \pm 13.46)$  d.

## 2.2. Surgical Approach

The patient is operated under general anaesthesia in the healthy lateral position. The affected shoulder was placed on top, the body was tilted backward by  $30^\circ$ , and both sides were fixed with pelvic fixation braces. The affected upper limb was placed in the position of  $30^\circ$  abduction and  $20^\circ$  forward flexion, with continuous traction of 3 - 5 kg. For patients with adhesions in the shoulder joint detected during preoperative examination, manipulation was given to loosen them until the degree of mobility was satisfactory. The surgical area was routinely disinfected with a sterile towel, and the acromion, rostral process, and various access points were marked with a sterile marker for surgical reference. The posterior-lateral approach to the acromion was established first, which was localized by means of a yellow needle, followed by the anterior approach. Through these two approaches, the structures in the glenohumeral joint cavity were explored, focusing on the injury status of the supraspinatus tendon, the long head tendon of the biceps muscle, and the subscapularis muscle, and the rotator cuff space was loosened with the use of the radiofrequency electric knife. Next, the subacromial space was accessed through the posterior-lateral approach to the acromion, and the lateral approach was established again with the help of yellow needle positioning. The subacromial membrane is cleaned with a paring knife to fully expose the bursa side of the rotator cuff, and the widest part of the rotator cuff tear is measured accurately with a probe hook. In patients with impingement of the acromion, acromioplasty is performed simultaneously. After cleaning the surface of the rotator cuff, the torn rotator cuff is aligned with a lifting forceps to restore the original anatomical structure as much as possible. The cartilaginous margin of the torn rotator cuff is then polished with a paring knife to freshen the bone surface. One 4.5 mm HEALIX ADVANCE BR Suture Anchor Nail (2 threads, 4 caudal ends) was placed in the cartilage margin by drilling holes using an opening awl. The inner row of anchor wires, spaced at 5 - 8 mm intervals, are passed all the way through the supraspinatus tendon, and the medial pair of these wires are knotted (the wires are knotted at the base at a width of approximately 8 mm, and on both sides at a distance of approximately  $<5$  mm from the anterior-posterior edge of the tear). At the greater tuberosity of the humerus, a hole is made with a hole-opening cone, and the 2 caudal ends of the knotted internal anchor sutures and the 2 unknotted sutures are threaded into 1 external composite suture bone anchor, the sutures are tightened, and the external composite suture bone anchors are driven into the greater tuberosity of the humerus for fixation to form a suture bridge (one knot,

two suture bridges).

### 2.3. Post-Operative Treatment

Patients were treated with routine postoperative oedema and analgesia, and the arm was kept in an abduction fixation brace for 4 - 6 weeks. Beginning on the second postoperative day, passive mobility and scapular stability exercises are performed after the relaxation of the shoulder muscles with the assistance of a rehabilitator or family member. At 4 - 12 weeks postoperatively, if pain is tolerated, patients are encouraged to start self-assisted joint mobility (ROM) exercises, such as forward flexion, active weight lifting, and external rotation of the shoulder. 12 weeks later, actively assisted ROM exercises are started, where the patient is assisted to further increase the range of motion of the joint with the help of external force on top of the active exercises, to increase the strength of the shoulder muscles and the control of movement. At 6 months after surgery, the patient was allowed to return to the pre-morbid level of activity. All patients completed the postoperative rehabilitation programme as required.

### 2.4. Evaluation Indicators

Perioperative data, including intraoperative bleeding and operation time, were recorded. The visual analogue scale (VAS) and Constant-Murley shoulder function score were used to evaluate the clinical effect, and the MRI of the shoulder joint was reviewed at the final follow-up to observe the structural integrity of the rotator cuff and the healing process.

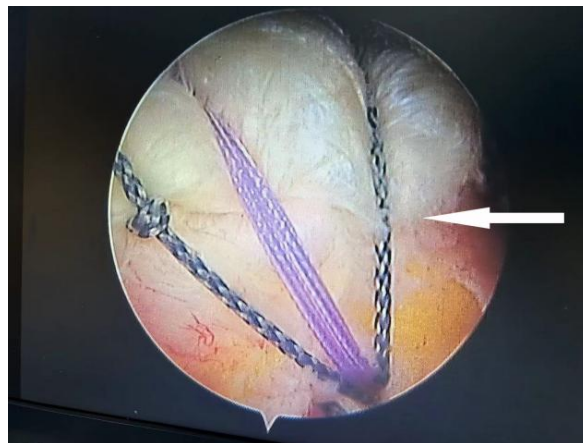
## 3. Results

The operation time ranged from 38 to 58 min, with a mean of  $(48.18 \pm 5.92)$  min; intraoperative bleeding ranged from 5 to 15 mL, with a mean of  $(10.00 \pm 3.45)$  mL. 22 patients were all followed up for 12 to 18 months, with a mean of  $(14.68 \pm 1.89)$  months. All patients achieved normal healing without re-tear. There were no complications such as vascular nerve injury, incisional infection, and anchor nail loosening and dislodging. At the last follow-up, all patients had normal shoulder morphology and symmetry on both sides, with VAS score ranging from 0 to 1.2, with an average of  $(0.61 \pm 0.42)$ , and Constant-Murley score ranging from 70 to 98, with an average of  $(86.09 \pm 8.56)$ . Sugaya at the last follow-up MRI examination [6]. Grading Grade I 17 cases, Grade II 4 cases, Grade III 1 case.

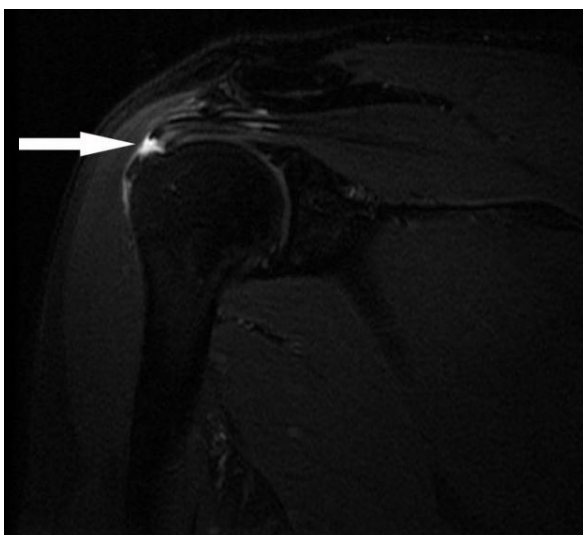
A typical case is a 43-year-old male patient who was admitted to the hospital with right shoulder joint pain and activity limitation for 4 months. After admission, the patient was diagnosed with a right rotator cuff tear by combining the mechanism of injury, preoperative X-ray film and MRI. Under general anaesthesia, arthroscopic repair of rotator cuff tear by the one-knot-two-line-bridge method was performed, and the postoperative efficacy was evaluated as excellent. The preoperative, intraoperative and postoperative imaging data are shown in **Figures 1 - 4**.



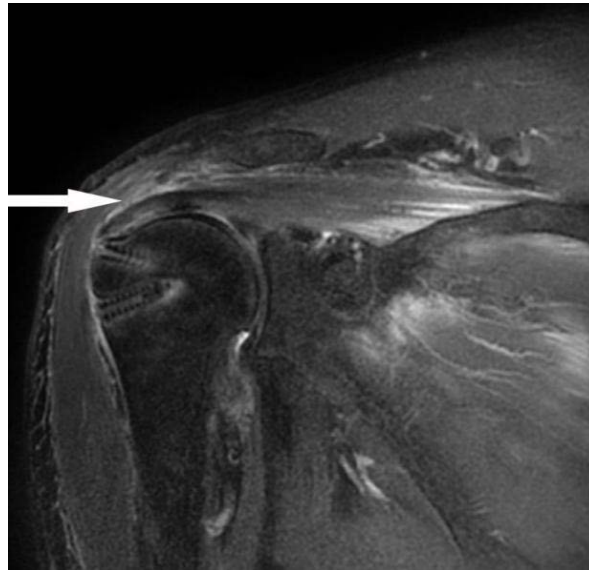
**Figure 1.** Intraoperative shoulder arthroscopy demonstrates a rotator cuff tear and detachment of the supraspinatus tendon from the attachment point (arrowed).



**Figure 2.** Intraoperative shoulder arthroscopy demonstrates good tendon-bone alignment after treatment with the one-knot-two-wire suture bridge technique (shown by arrows).



**Figure 3.** Preoperative MRI showing interruption of supraspinatus tendon continuity in the rotator cuff (shown by arrow).



**Figure 4.** MRI at 12 months postoperatively showing normal thickness of the rotator cuff with homogeneous low signal (arrowed).

#### 4. Discussion

Rotator cuff injuries disrupt the balance between the four muscles that make up the rotator cuff, causing pain and limited movement [7]. The goal of treatment is to relieve pain, restore motion function and prevent the tear from worsening. Treatment options include conservative and surgical treatments. Conservative treatment strategies are available for some patients and include physiotherapy, non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid injections and platelet-rich plasma (PRP) [8]. However, for acute injuries or when conservative treatments are not effective. However, surgical treatment is preferred for acute injuries or when conservative treatment is ineffective. Arthroscopic rotator cuff repair (ARCR) has become the gold standard in the surgical management of rotator cuff injuries due to the advantages of arthroscopic techniques such as less trauma, quicker recovery and fewer complications [9]. Arthroscopic rotator cuff repair (ARCR) has become the gold standard in the management of rotator cuff injury. Surgical methods mainly include single-row suture techniques, double-row suture techniques, suture bridge techniques, and so on. Regardless of the surgical approach, the principles of surgery are to provide strong initial biomechanical support, restore the anatomical footprint of the rotator cuff, and promote tendon-bone healing [10]. The principle of the procedure is to provide strong initial biomechanical support, restore the anatomical footprint of the rotator cuff and promote tendon-bone healing.

The earliest clinical application was the single-row suture technique, which, although easy to manipulate, with fewer anchors implanted and at a lower cost, reduces the area covered by the anatomical footprint and decreases the strength of the fixation [11]. This technique is easy to operate and less expensive, but it reduces the anatomical footprint coverage area and decreases the fixation strength.

The double-row suture technique, which was modified from the single-row, solved the above problems, increased the anatomical footprint coverage area, and provided stronger biomechanical fixation; however, it caused the occurrence of medial-based retear due to the possibility of excessive repair tension [10]. The subsequently improved invention of the double-row suture bridge technique, which utilises an inner row of knotted suture thread tails connected to an outer row of anchor pegs to form a suture bridge, allows for an even distribution of forces in the suture channel area and strengthens biomechanical support. However, the increase in the number of anchors not only reduces the tendon-bone contact area, but also leaves more knots on the rotator cuff surface, which affects part of the rotator cuff blood supply, especially exacerbates postoperative shoulder pain, and is not conducive to tendon-bone healing [12]. This is particularly important for postoperative shoulder pain and is not conducive to tendon-bone healing. Wang Ting *et al.* [13] similarly concluded that arthroscopic repair of rotator cuff injuries by reducing the number of intraoperative knots could improve the local blood supply to the rotator cuff, promote healing, and reduce the rate of retear. Some scholars have proposed the technique of one knot and two lines method for the treatment of small and medium-sized rotator cuff injuries, which can achieve a good therapeutic effect and at the same time reduce the surgical time and cost [5]. The technique can achieve a good therapeutic effect and at the same time reduce the operation time and cost.

In this study of the one-knot-two-wire suture bridge technique for the treatment of small and medium rotator cuff tears, the author included a total of 22 patients in the orthopaedic department of our hospital for efficacy observation. The results showed that at the final follow-up, the VAS scores were significantly lower and the Constant-Murley scores were significantly higher than the preoperative scores, and these differences were statistically significant. Upon final follow-up MRI imaging, all patients were found to have healed well with no re-tears occurring. This indicates that the arthroscopic one-knot-two-wire bridge method technique can achieve good clinical efficacy.

In this study, a one-knot-two-wire suture bridge technique was used to treat small and medium rotator cuff tears under shoulder arthroscopy. This surgical protocol effectively restored the anatomy of the rotator cuff and the function of the shoulder joint. This is an improvement over the “anti-tear” technique proposed by Burkhart *et al.* [14] (2008), who proposed a combination of an “anti-tear” suture and a double-row suture bridge technique. The advantage of this new and improved technique is that only one internal suture anchor is placed at the cartilage edge, which effectively increases the fixation area of the internal suture anchor and improves the efficiency of suture utilisation. At the same time, 2 medial sutures from the inner row of suture anchors are knotted to achieve firm fixation of the tendon attachment point. The 2 lateral sutures, together with the medial knotting thread tail, are fixed in the greater tuberosity via the push-in composite suture bone anchor pegs to form a one-section, two-stranded suture bridge,

which effectively presses down on the stump of the torn tendon, thus increasing the contact area between the supraspinatus tendon and the footprint area, and achieving an even distribution of pressure in the suture channel area. This approach balances and accommodates the three main surgical principles of providing strong initial biomechanical support, restoring the anatomical footprint of the rotator cuff, and promoting tendon-bone healing. It restores the anatomical footprint effectively, minimizes knotting's impact on rotator cuff blood supply, optimizes the tendon healing microenvironment, and reduces acromial impingement incidence while ensuring secure fixation. The use of the one-knot-two-wire suture bridge technique in the treatment of small and medium-sized rotator cuff tears promotes tendon-bone healing and restores the anatomical integrity of the rotator cuff, combining short-term improvement of patient symptoms with a long-term reduction in the incidence of re-tears.

This study has limitations, lack of clinical randomised controlled trial, small sample size and short follow-up. In the future, this trial needs to be conducted to increase the number of patients, expand the scale, and provide long-term follow-up to obtain objective and real efficacy and provide a basis for clinical decision-making.

In summary, the one-knot-two-wire suture bridge technique shows significant advantages in the treatment of small and medium-sized rotator cuff tears. This technique can effectively relieve the pain symptoms of patients, significantly improve the function of the shoulder joint, and reduce the re-tear rate, with good clinical results. The advantages of this technique are also reflected in the small number of implanted anchors, easy operation, short operation time, and low bleeding, which effectively reduces the complexity of the operation and the trauma of the patient, and is in line with the development trend of modern surgery, which is highly efficient and minimally invasive, and is worthy of further promotion and application in clinical practice.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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