

Single row rotator cuff repair with modified technique

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Abstract

Rotator cuff tear is a common medical condition. We introduce various suture methods that can be used for arthroscopic rotator cuff repair, review the single row rotator cuff repair method with modified technique, and introduce the Ulsan-University (UU) stitch. We compare the UU stitch with the modified Mason-Allen (MA) suture method. The UU stitch configuration is a simple alternative to the modified MA suture configuration for rotator cuff repair.

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Key words: Shoulder; Rotator Cuff Repair; Mason-Allen Stitch; Ulsan-University Stitch

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INTRODUCTION

Rotator cuff tear is a common medical condition fre-

quently diagnosed, in an increasingly active elderly population, due to the advancement of diagnostic technology such as magnetic resonance imaging^[1,2]. Non-surgical treatment is generally used as the primary treatment of partial thickness rotator cuff tear and can improve symptoms. However, in the case of a full-thickness rotator cuff tear, surgical treatment can help improve the shoulder joint functions when non-surgical methods have failed^[3,4]. Development of various surgical methods^[5-8] such as open suture and mini-open suture^[9,10] as well as arthroscopic suture^[11] have been reported. A secure and stable suturing method is necessary for the repair of a broad rotator cuff tear^[10]. By attaching the tendon to the greater tubercle of humerus the rotator cuff tissue is repaired and shoulder joint function improved. This method of surgical rotator cuff repair shifts from open suture to mini-open suture and arthroscopic suture^[5,6]. There are several known advantages of arthroscopic suture^[11,12]. However, this method has the limitation that it requires a long time for the surgeon to acquire enough skill and the tendon-suture connection is relatively weak. Therefore, arthroscopic suture can lead to more frequent re-tear than open suture. Use of arthroscopic rotator cuff repair has increased recently along with the development of more advanced surgical equipment and techniques as well as optical technology^[13,14] and there are reports of good results. In this review, we introduce various suture methods that can be used for arthroscopic rotator cuff repair.

DETAIL REVIEW

Early re-tear of the arthroscopic suture may be caused by knot failure or suture anchor failure, but the most frequent cause is suture pull-out through the rotator cuff^[4,15]. The initial weak connection and the distraction of the suture cause gap formation between tendon and bone tissue eventually resulting in imperfect tendon-bone healing. When re-tear of the sutured rotator cuff occurs, it inevitably leads to pain and functional weakening through time^[13]. In the case of broad rotator cuff tears, in particular, a high rate of re-tear after the arthroscopic suture can be proven by objective evaluation^[13,16]. The weakest area

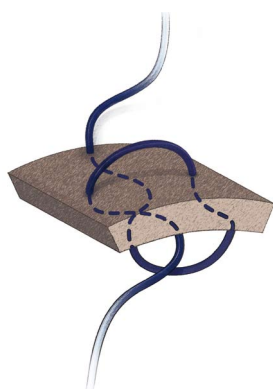


Figure 1 Modified Mason-Allen suture.

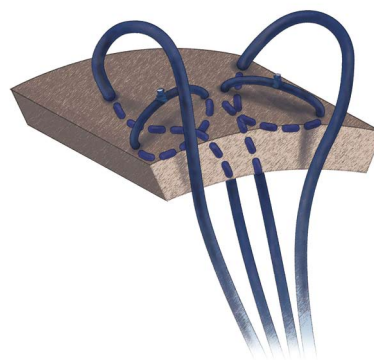


Figure 2 Massive Cuff stitch.

after rotator cuff repair is the contact surface between the rotator cuff tendon and the sutures. Since re-tear occurs in this area, the development of a suture method is needed to stitch up the tendon tissues with lasting strength.

Modified Mason-Allen suture

Compared with other suture methods for rotator cuff repair currently in use, the modified Mason-Allen (MA) (Figure 1) suture is considered a standard suture method that can securely stitch the tendon tissue^[15,17-19]. The modified MA suture has been known to be biomechanically sturdier than simple suture and mattress suture as proven by *in vitro* studies^[15]. Compared with Bunnel, Krackow and mattress suture methods, the modified MA suture was found to have a similar tendency to develop rotator cuff tissue necrosis as the simple suture^[17,18]. However, the limitation of the modified MA suture is that it is difficult to perform using arthroscopy^[17].

Massive cuff stitch

The previously reported Massive Cuff (MC)^[11] (Figure 2) stitch can significantly increase the strength of single-row rotator cuff sutures and shows biomechanical strength comparable to that of the modified MA suture. This suture method uses two sutures, one forming a horizontal mattress connection loop, the other forming a simple vertical connection loop^[17]. The simple vertical connection loop is routed through the inside of the horizontal mattress connection loop. This cross looping is similar to that of the modified MA suture. That is, the horizontal mattress connection loop acts as a check rein so that the re-tear of the sutured tendon does not cause the simple vertical connection loop to slide out through the tear gap. The advantage of the MC suture is that it can be performed easily using arthroscopy. This was reported by Scheibel and Habermeyer as another modified MA suture technique^[18,20]. However, the MC suture has three knots in each stitch with one knot created in the horizontal mattress connection loop and two knots created in the two simple vertical connection loops. We believe that knot impingement is possibly higher when there are more knots in the sutured rotator cuff tissue. We propose a modified Mattress-Locking suture that can stitch without knots^[11].

Modified Mattress-Locking suture

The modified Mattress-Locking suture is a simplified method of arthroscopic suture for rotator cuff repair in which the simple vertical loop is connected to the horizontal mattress loop for easy arthroscopic manipulation. The follow-up observation over two years after the application of this method to the repair of mid-size full-thickness rotator tear revealed good results and we believe this modified Mattress-Locking suture can be used in rotator cuff repair with reduced failure rate^[11]. The Ulsan-University (UU) suture is a further modification of this modified Mattress-Locking suture for more convenient use and it is similar to the tension-band suture.

Ulsan-University suture

Among those who did not show a positive response to conservative treatment, thus requiring surgery, there was a growing number of older patients at advanced stages of atrophic rotator cuff, fatty change and other conditions that may increase the risk of re-tear during surgery. To address this problem, various surgical techniques and suture methods were developed and introduced in order to improve post-operative rehabilitation and lower the frequency of re-tear. We employed the ∞-shaped UU suture, a method of locking the high-tension suture, to reduce the re-tear risk and improve suture strength.

Suture technique: UU suture is performed as follows: A banana-shaped suture needle (Banana Suture Lasso, Arthrex, Naples, FL) is inserted through the anterior entrance and is passed through the anterior section of the rotator cuff tear while lifting it with a retriever inserted through the anterior superior entrance. The banana-shaped needle is then passed through the posterior section of the rotator cuff tear while it is lifted with a retriever (Figure 3). A Polydioxanone suture is then inserted and is caught under the posterior spine of the scapula using a grasper positioned at the anterior superior entrance, having first removed the banana-shaped needle. A shuttle relay is created on the joint exterior and the suture is passed through the rotator cuff by hooking it through the shuttle-relay and pulling it between the rotator cuffs (Figure 4). One end of the suture is then pulled out through the anterior superior entrance. Likewise, a banana-shaped suture needle is inserted through the pos-

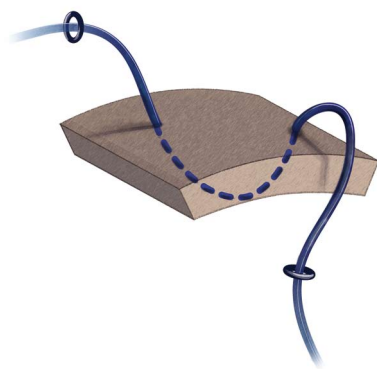


Figure 3 Ulsan-University stitch - Initial transverse suture loop.

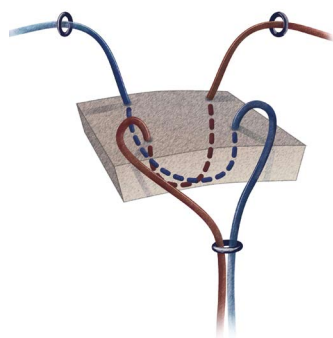


Figure 4 Ulsan-University stitch making two crossed transverse loops connected at the outside of the cannula.

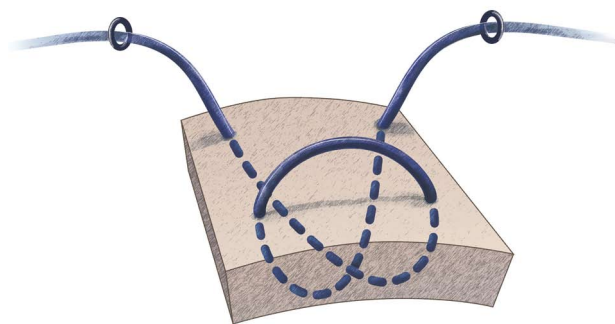


Figure 5 U-shaped medial horizontal loop. Circular horizontal mattress loop and vertical loop cross over.

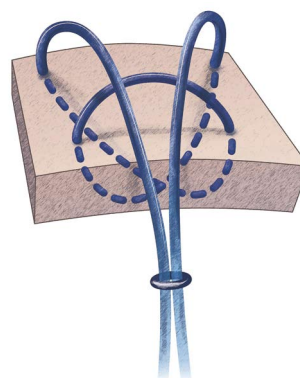


Figure 6 Like tension band suture. U-shaped loop at medial side and interference screw at lateral side.

terior entrance and passed through the rotator cuff and the Polydioxanone suture is pulled out using a grasper positioned at the anterior superior entrance. A U-shaped loop can be created in the interior of the rotator cuff by creating a shuttle relay on the suture which was pulled out to the joint exterior through the anterior superior entrance, hooking the suture previously pulled-out through the shuttle-relay and pulling it tight (Figure 5). Both ends of the suture are pulled out through the anterior superior entrance to complete preparation for the UU suture (Figure 6).

UU suture can be completed by connecting 4.5 mm interference screws (Push-lock screw, Arthrex, Naple, FL) to each end of the suture and screwing them through the cartilage of the articular fovea at the humeral head. When necessary, a stronger suture can be made by additionally creating a reverse mattress suture in the rotator cuff interior and connecting it to the interference screws in a similar way as in the UU suture.

After creating a medial row of sutures as described above, a lateral row could be created by hooking simple sutures through the anterior and posterior rotator cuff tear sections remaining without suture and fixing them with 4.5 mm interference screws.

Biomechanical and clinical results: Newly developed suture techniques must produce good clinical results, ensure the continuous integrity of the sutured muscle, and show similar or better performance than the existing

suture techniques which are widely used and approved by biomechanical tests. Together with joint researchers, we tested the degree of fatigue and the biomechanical strength of the UU suture and performed a data analysis^[20]. Compared with the modified MA suture method, which is generally known to be the strongest suture, our proposed UU suture did not show any significant differences when the strongest, currently available, suture material was used. The UU suture and the modified MA suture are considered to have similar biomechanical strength. The UU suture is a simplified version of the modified MA suture, which cannot be used in arthroscopic rotator cuff tear repair, but further modified to allow convenient use of arthroscopy. In the precedent study using a modified Mattress-Locking suture, we were able to achieve good results by applying it to the repair of mid-size full-thickness rotator cuff tear and we believe this modified Mattress-Locking suture can be used in rotator cuff repair with a reduced failure rate^[11]. The UU suture could successfully be employed to repair relatively easy-to-suture narrow rotator cuff tears as well as mid-size full tears surrounded by wide spreading partial tears, to provide reinforcement of the surrounding thinned tendon and stitch the full tear section. The UU suture can also be used in the repair of large-size and broad rotator cuff full tears with advanced stages of degenerative fatty change - normally difficult to repair - to provide reinforcement to the weakened sections of tendon tissue and suture the full tear section. Recently, we used this

method in partially suturing non-suturable broad tears and could achieve good results. Broad rotator cuff tear is difficult to suture because it has a high degree of fatty change and is accompanied with atrophy and involution of muscles^[21-23]. Even if complete suture is possible, re-tear can easily be caused by minor external force, making post-operative rehabilitation difficult^[24]. Using the UU suture, we performed double-row suture on broad tears and could achieve good results compared with a simple suture. Using an arthroscopic suture on broad tears, we could achieve good results. When double-row suture using the UU suture method was compared with single-row suture using the simple suture method, no difference in clinical symptoms could be observed. However, when compared on the revision cuff repair, double-row suture showed superior results.

We performed arthroscopic repair of full-thickness rotator cuff tears using the UU suture and, from follow-up observations of over one year, achieved good results. Also, compared with the modified MA suture method, which is generally accepted as the strongest suture method, UU suture did not show significant differences when the strongest currently available suture material was used^[21]. Based on these results, we believe that arthroscopic UU suture can reduce pain and improve joint function when used for the repairing of full-thickness rotator cuff tear.

DISCUSSION

The modified MA suture can provide strong stitching of tendon tissue but it is used in open suture and difficult to use in arthroscopic suture. MC suture^[15] provides stronger stitches and has similar level of biomechanical strength as the modified MA suture, but since it consists of three knots, it may have higher risk of developing know impingement.

The modified Mattress-Locking suture method, without using knots, has been proposed^[11]. This suture method uses a simple vertical loop and a horizontal mattress loop connected together. The UU suture was devised by further modifying the modified Mattress-Locking suture similarly to the high-tension suture.

Our biomechanical test revealed that there was no difference in resistance to cyclic loading between the UU suture and the modified MA suture. This indicates that the degree of relaxation of the UU suture is similar to that of the modified MA suture. Ultimate tensile load that causes tear also showed no difference between the two suture methods, which suggests that the same degree of postoperative activities will cause similar level of failure rates. We used the UU suture method for the repair of broad rotator cuff tears with much advanced fatty muscle replacement and for the revision cuff repair of re-tears. We used this method too for the augmentation of double-row sutures or the sutures performed with suture bridge technique and could achieve improvement of rotator cuff suture strength. We believe that the UU

suture can be used for rotator cuff repair with improved biomechanical strength.

In conclusion, The UU suture can provide a simple and excellent suture method that can be used for arthroscopic rotator cuff repair. We believe that this method can be used as an alternative to the modified Mason-Allen suture and that the arthroscopic UU suture is not only easy to perform in patients with full-thickness rotator cuff tear but also results in a similar level of symptomatic and functional improvement to other arthroscopic suture methods.

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