Technical Note

Arthroscopic "Mini-Incision" Transtendon Repair of Shoulder Partial Articular-Sided Supraspinatus Tendon Avulsion

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Abstract: Currently, the treatment of PASTA (partial articular-sided supraspinatus tendon avulsion) lesions includes arthroscopic transtendon and completion repair, but the shortcomings of both surgical techniques are obvious. We present a modified transtendon technique combining the transtendon with the mini-completion repair that is able to minimize the trauma from anchor implantation and add more intra-articular working access using a "mini-incision" on the supraspinatus tendon.

Partial-thickness rotator cuff tears are common, causing shoulder pain and disability. Partial-thickness tendon tears do not have the potential for natural regeneration and can evolve into full-thickness tears.[1] The PASTA lesion, involving 50% or more of the ruptured tendon thickness, is academic guided for surgical reattachment of the tendon.[2] The treatment of a PASTA lesion includes arthroscopic transtendon and completion repair. The contrast between arthroscopic transtendon and completion repair in PASTA lesions demonstrated both pain and functional improvements regardless of the surgical technique.[3]

The transtendon can intactly preserve residual bursal layer fibers and anatomically reattach the ruptured tendon to the articular-side footprint.[4] Conventional surgical procedure and an easy-to-master surgical technique are the advantages of completion repair.[5] However, debate still exists regarding the optimal surgical pattern for PASTA lesions.[6] The transtendon technique possesses deficiencies including tendon trauma from anchor insertion and one intra-articular working access. The residual bursal layer supraspinatus tendon will be thoroughly debrided, which is the essential shortcoming of completion repair, converting a partial-thickness cuff tear into full-thickness tear.[7]

Therefore, we describe the "mini-incision" transtendon pattern, which combines transtendon with mini-completion repair, that is able to minimize the trauma from anchor insertion and add more intra-articular working access using a "mini-incision" on the supraspinatus tendon.

Surgical Technique

Preparation

All patients undergo operation under general anesthesia in the lateral decubitus position; the joint space is gently opened up by upper-limb traction of 4 kg; a 30° scope is applied. The surgical technique is described in Video 1, Table 1 (pearls, pitfalls), and Table 2 (advantages and disadvantages). This research was approved by the ethical department in our hospital, and all patients gave informed consent.

Diagnosis and Evaluation

The posterior portal is executed for glenohumeral joint examination and the standard intra-articular diagnosis is performed. The ruptured articular layer is estimated to ascertain the lesion length (from anterior to posterior of bare footprint) and deepness (from

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Table 1. Surgical Pearls and Pitfalls

Smooth operation considerations
(1) The posterior cannula can allow the scope to be switched with ease from the joint to subacromial space.
(2) The thorough debridement of the rotator interval is beneficial to the suture instrumentation.
(3) Tenotomy or tenodesis of biceps tendon can provide a better intra-articular view.
The "mini-incision" considerations
(1) The establishment of a "mini-incision" must be executed by a sharp bistoury through the second lateral portal, not other portals.
(2) The "mini-incision" should be created gently to prevent turning a partial-thickness into s full-thickness tendon tear.
Anchor implantation considerations
The 12-mm thickness of supraspinatus tendon should be considered; otherwise, the anchor may not be implanted deep enough or too deep.
Suture procedure considerations
Due to the blocking of supraspinatus tendons, the view of suture eyelet is usually blind; retrieving the suture on the knot pusher is the right choice.

cartilage margin to ruptured tendon) using the shaver and hook probe (Fig 1). The repair procedure is performed involving the articular layer tears comprising 30% to 70% of the tendon cross-section. Tears with less than 30% of intact fibers should applicably complete the tendon into full-thickness tear; tears with less than 30% should be treated with debridement and acromioplasty. Either tenotomy or tenodesis is used for biceps tendon tears or SLAP lesions.

Bursectomy is routinely performed. Acromioplasty is performed in curved or hook-type acromion as essential to attain free gliding of the repair procedure. It is mandatory to assess the quality of the bursal-layer tissue. The definite bursal layer lesion or intact tendon with pool tension will in fact be managed as an exclusion criterion in the technique. When the bursal layer is intact with mildly attenuated tendon tension, arthroscopic "mini-incision" transtendon repair will be performed. The patient's demands and age are other aspects to be taken into consideration.

Surgical Portals

The "mini-insicion" transtendon technique is designed with 2 glenohumeral joint portals that offer a standard posterior portal, an anterior portal placed in rotator interval, and 2 subacromial portals that offer a standard lateral portal and a second lateral portal for creating the "mini-incision" on supraspinatus tendon (Fig 2). A cannula, which is seated in the posterior portal, can help the scope to be switched with ease from the joint to subacromial space.

"Mini-Incision" Creation

Precise position of suture anchor into the footprint of greater tuberosity is crucial to surgical success. An 18-gauge spinal needle is used as a localizer to situate the accurate aspect from bursal to articular layer tear. A specific incision based on the guiding needle, which is named the second lateral portal, is created on shoulder derma as exclusive anchor insertion access into the subacromial space. A specific incision based on the guiding needle, which is defined the "mini-incision" in the present study (Fig 3), is created on bursal layer of supraspinatus tendon as specific access for anchor insertion from the subacromial space into glenohumeral joint. The "mini-incision" is created along longitudinal orientation of supraspinatus tendon fiber, with the length of 5mm.

Suture Anchor Insertion

A burr is passed through the "mini-incision" and decorticated intra-articular bare footprint to accomplish the bleeding cancellous bone. A double-loaded suture anchor (Corkscrew Anchor; Arthrex, Naples, FL) with No. 2 nonabsorbable polyester strands (blue and white) is introduced percutaneously from the second lateral portal, passed through the "mini-incision," and inserted into the decorticated bone (Fig 4). The number of suture anchors applied for repair procedure depends on the length of decorticated footprint. When the length of decorticated footprint involves less than 1.5 cm, one suture anchor will be enough; otherwise, 2 suture anchors will be suitable.

Suture-Relay Procedure

Then, a spinal needle with a no. 2 polydioxanone (PDS) suture is used to pierce percutaneously into the medial aspect of bursal layer that corresponds to the articular rotator cable. Moreover, the mean of patients require adducting the arm to ameliorate the applicable angle for anchor insertion. The PDS suture will be delivered into the joint through spinal needle. One limb of nonabsorbable suture strand will be delivered from subacromial space into the joint through the "mini-incision" with knot pusher (Fig 5). The aforementioned 2 sutures, including PDS and nonabsorbable suture strand in the joint, are both retrieved from anterior portal and are securely tied together. By pulling another limb of PDS suture strand, the nonabsorbable suture is brought back percutaneously from the joint into subacromial space 10 mm distant from the anchor entry point. The same procedures are repeated and the

Table 2. Advantages and Disadvantages

Advantages
(1) The supraspinatus tendon receives minimal trauma.
(2) The "mini-incision" can be adopted as the second intra-articular working access.
Disadvantages
(1) The supraspinatus tendon will be incised with 5-mm trauma.
(2) Partial-thickness tendon tear may be transformed into full-thickness.

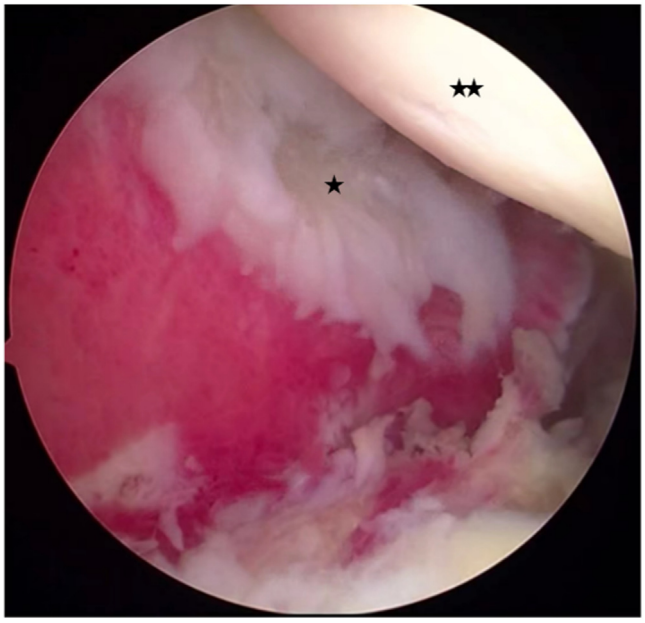

Fig 1. Partial articular-sided supraspinatus tendon avulsion (double stars) is identified in the joint (star indicates humeral head).

4 limbs of the nonabsorbable suture strands are all passed into the subacromial space with a triangular shape.

Suture Fixation

The scope is then placed in the subacromial space. Via the lateral portal, the sutures are securely tensioned and tied with a Mason-Allen pattern on bursal side tendon (Fig 6). We obtain a triangular suture configuration that presses the tendon down to the footprint. The distended tendon can be mildly tightened. The scope is replaced within the joint and the reattached tendon is examined eventually (Fig 7).

Fig 2. The schematic diagram of the second lateral portal.

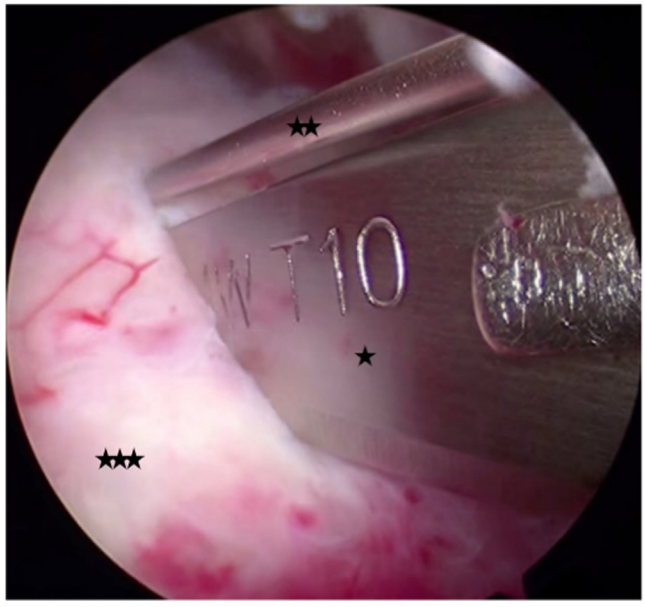

Fig 3. The "mini-incision" was created on the bursal side of the supraspinatus tendon (double stars) (star indicates sharp bistoury and triple star indicates the supraspinatus tendon).

Discussion

Completion repair for PASTA lesion is an optional surgical pattern that offers better surgical visualization and repair procedure with a familiar technique.[2] Cheow et al.[8] reported significant improvements in pain and functional scores after completion repair in a

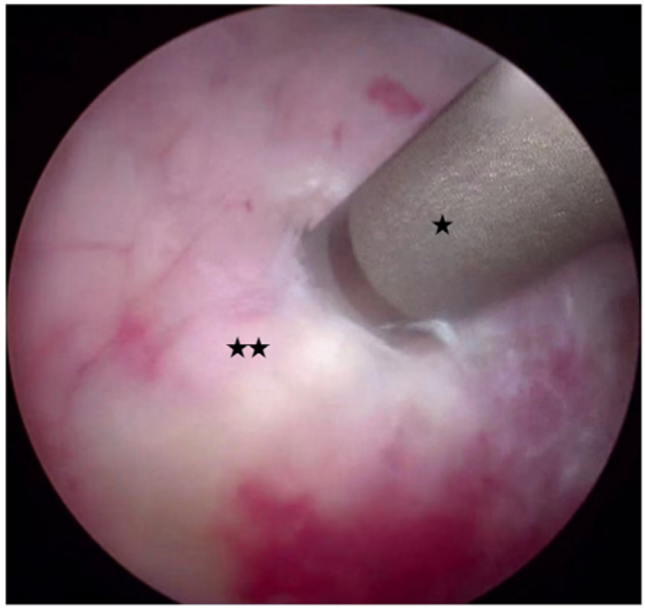

Fig 4. The suture anchor (star) is passed through the "mini-incision" and embedded into the decorticated footprint (double star indicates the supraspinatus).

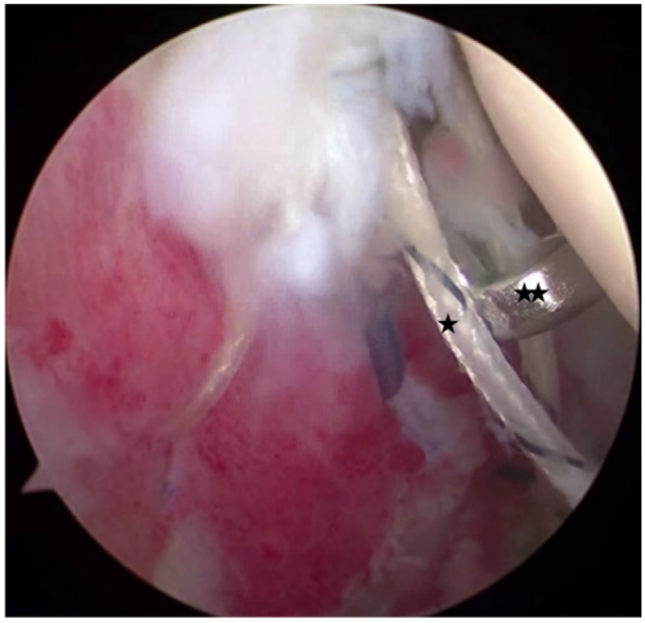

Fig 5. The suture is passed through the "mini-incision" with a knot pusher (double star) were knotted in subacromial space.

significant number of patients with a minimum 24-month follow-up.

Shin[7] believed that transtendon repair technique could provide greater cuff integrity. Peters et al.[9] reported that the transtendon technique could prove high ultimate failure strength and better biomechanical footprint contact pressure. Nathani et al.[10] reported that transtendon repair obtains better biomechanical properties and less gapping. A biomechanical study showed

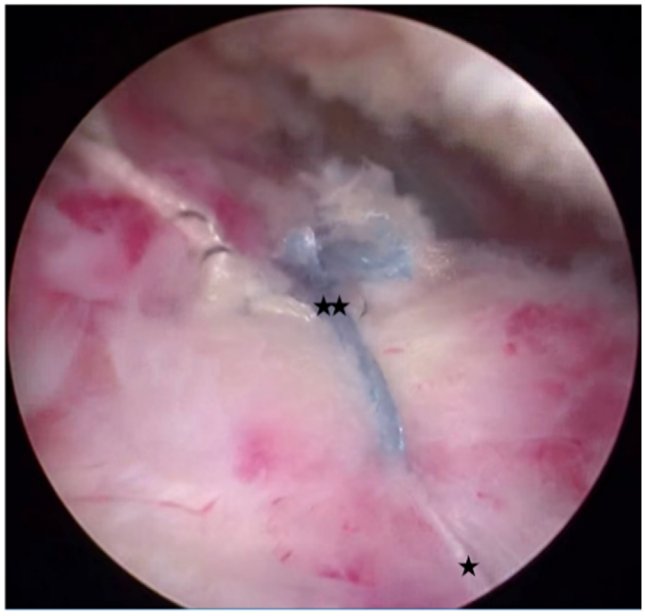

Fig 6. Via the lateral portal, the sutures are securely tensioned and tied with a Mason-Allen pattern (double star) on bursal side tendon (star indicates the "mini-incision" which is tied).

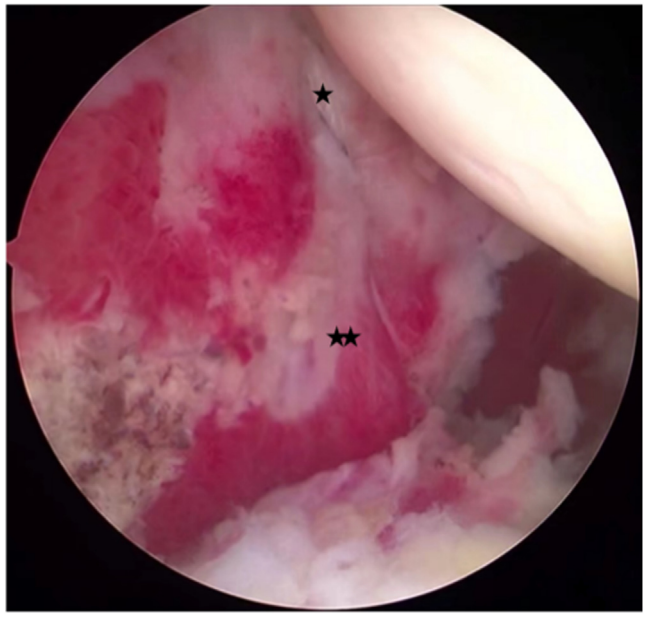

Fig 7. Anatomically restored articular-side tendon is performed in glenohumeral joint (star indicates the suture that reattach the tendon and double star indicates articular side of supraspinatus tendon).

that transtendon repair could increase intra-articular strain with progressive cuff tearing and return to near the intact tendon state.[11]

Even so, completion repair technique sacrifices the intact bursal-sided cuff tendon. Kim et al.[12] believed that possession of residual bursal layer might be prerequisite for anatomic healing due to the secondary poor regeneration capacity of bursal layer. Well-organized tendon with greater resistance to tensile strength can be acquired for bursal layer; even if one-third of the whole thickness is ruptured, residual bursal layer can retain powerfulness.[13]

We consider the deficiencies of transtendon technique are inevitable. First, the tendon trauma from anchor insertion is unavoidable.[14-16] Peters et al.[9] raise concerns over the trauma on residual bursal layer during transtendon anchor insertion. A little perforation is produced by a tap or awl instrument accompanied with anchor insertion through the tendon. The indication of fragmented fibers in the hole suggests that the perforation is probably transected by anchor, leastways in the center of tendon trauma. Unfortunately, the procedure of anchor insertion is blind instrumentation. The surgical visualization is located in the joint, whereas the anchor instrumentation is carried out in the subacromial space. In addition, the anchor must penetrate the tendon and embed in decorticated footprint, which further augments the operation nondeterminacy. Second, the anterior portal is the sole working access in the joint, resulting in the inability of multiorientation instrumentation. Applying some

instrumentation will be very awkward, especially when retrieving the anchor sutures near the footprint.

Arthroscopic "mini-incision" transtendon repair for the treatment of PASTA lesion is a modified surgical technique that combines transtendon with mini-completion repair. First, the "mini-incision" can be adopted to the intra-articular working assess with the same diameter as suture anchor. The anchor can be placed into the joint passing through "mini-incision" smoothly without damaging the bursa layer. Second, the "mini-incision" is predesigned to pinpoint in the decorticated footprint near the articular margin. As long as the suture anchor is placed in the joint through "mini-incision," it can be accurately positioned in the decorticated footprint. The whole instrumentation is executed under direct vision, and the step of repeatedly anchor penetrating the tendon does not exist. Third, the "mini-incision" can be adopted as the second intra-articular working access, which allows for multi-orientational instrumentation in the joint. The anchor sutures can be passed through the "mini-incision" and sent into the joint with the knot pusher, which greatly simplifies the difficult of suture procedure.

Although the "mini-incision" is performed on bursa layer, the tendon trauma is minimized for the following factors: first, a sharp bistoury is adopted to create "mini-incision" on the tendon instead of radiofrequency, which can eradicate the tendon trauma caused by thermal damage. Second, the orientation of creating the "mini-incision" is longitudinally along the tendon fibers, rather than transection the tendon, which is more in line with the anatomical feature. Third, the length of the "mini-incision" is merely 5 mm, which is the same as the diameter of suture anchor, exactly permitting one anchor passing through. An excessively long incision will not only increase the tendon trauma but may also transform a partial-thickness tear into a full-thickness tear. Finally, when the tendon is eventually tied with a Mason-Allen pattern, the "mini-incision" is also tightened and tied.

Arthroscopic "mini-incision" transtendon pattern is a modified transtendon technique that, combined a transtendon with mini-completion repair, is able to minimize the trauma from anchor insertion and add more intra-articular working access using a "mini-incision" on supraspinatus tendon.

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