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Original Article

Arthroscopic transtendinous repair of articular-sided pasta (partial articular supraspinatus tendon avulsion) injury

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Abstract: Objective: To evaluate clinical efficacy of arthroscopic transtendinous repair of partial articular-sided PASTA (partial articular supraspinatus tendon avulsion) injury. Methods: From February 2011 to July 2014, 12 cases of PASTA, aged 29 to 72 years with an average of 52.9 ± 13.3 years, were treated arthoscopically. To repair PASTA, articular-sided rotator cuff tear was explored, injury site was punctured and labeled with PDS absorbable monofilament suture (Ethicon, Somerville, NJ, USA) suture, subacromial bursa was cleaned up with acromioplasty, and integrity of bursa-side rotator cuff was assessed. Then with arthroscope in glenohumeral joint, footprint of the bursa-side supraspinatus tendon was preserved, rivets were introduced into the joint through supraspinatus tendon, joint-side partial tear was sutured, and anatomical reconstruction of the rotator cuff footprint was established. The patients were followed up post-operatively for 12-36 months, average 22 ± 7.3 months. The clinical outcomes were emulated with ASES (American Shoulder and Elbow Surgeons) Shoulder Score system and UCLA (University of California at Los Angeles) Shoulder rating scale. Results: The post-operative ASES score was 89.7 ± 5.6, higher than the pre-operative one 49.8 ± 9.8 ($t = 12.25$, $P < 0.0001$). While UCLA scale increased from the pre-operative 17.3, ± 3.3 to the post-operative 30.4 ± 3.2 points ($t = 9.87$, $P < 0.0001$), with a satisfaction rate of 11/12 (91.7%). Conclusion: Trans-tendon repair is ideal for PASTA with advantage of maximal preservation of the normal rotator cuff tissue, anatomical reconstruction of the rotator cuff footprint and stable fixation of tendon-bone interface.

Keywords: Arthroscopy, partial the rotator cuff injury, trans-tendon repair

Introduction

PASTA is a common twisting and/or traction injury of the shoulder, usually presenting with pain, functional limitation and/or fatigue on by overhead activities such as lifting outwards, overhead and throwing [1-5]. The tears can occur on both the articular and bursal surfaces and within the intrasubstance of the rotator cuff. Typically the tears are on the articular side compared to the bursal side [6, 7]. The incidence of injury on joint-side portion of the rotator cuff is high. A retrospective analysis of 100 cases of adults by Modi et alrevealed 62/100 (62%) of the shoulder injuries necessitating arthroscopic surgery are on the joint side. Following up of 40 patients with PASTA lesions by arthrography for an average of 412 days, Yamanaka et al [8] stated that the injuries tend to enlarge in 53%, and to progress to full-thickness tear in 28% of the patients, respectively. Ellman [9] described the classification of PASTA: Grade 1 for tears less than 3 mm; grade 2 for tears 3 mm to 6 mm; and grade 3 for those greater than 6 mm. The management of PASTA has been controversial. However, most shoulder surgeons agree with surgical repair for grade 3 injuries, and Waibl et al [10] proposed in detail the repair technique for PASTA, which includes standard technique by completing of the lesion to a full-thickness tear with lateral incision on footprints, and trans-tendon repair preserving lateral undamaged footprints. The latter preserves the normal rotator cuff tissue on lateral, with length-tension of rotator cuff balance closer to a normal anatomy. Here we

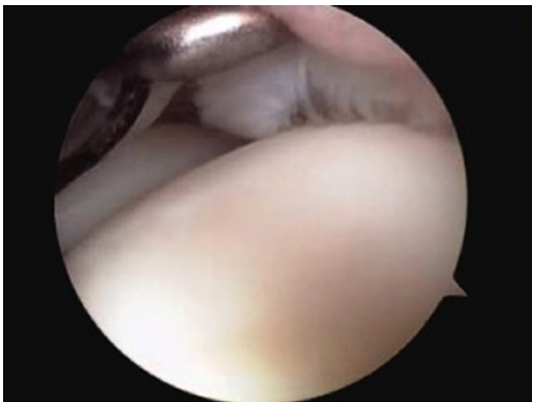

Figure 1. Grade 3 PASTA (>6 mm) on articular-side rotator cuff footprint under arthroscope.

reported treatment of 12 cases of PASTA injuries using modified Lo technique [11], with satisfactory clinical results shown by postoperative follow-up.

Materials and methods

Patients

A total of 12 patients, 5 males and 7 females, aged 29 to 72 years (average 52.9 ± 13.3 years) were admitted to our hospital with diagnosis with PASTA, including 9 on right shoulder and 3 on left shoulder. Six of the 12 cases had a history of trauma in shoulder, 3 with shoulder hitting ground and 3 with hand holding ground. All patients presented with ipsilateral shoulder pain and restricted shoulder mobility. They all underwent preoperative conservative management including function exercise, physical therapy, and non-steroids treatment for 1 to 17 months (median duration of 6 months). On physical examination, tenderness on lateral acromia present in 11 cases, Neer impingement sign positive in 9 cases, Hawkins impingement sign positive in 9 cases, 60°~120° painful arc sign positive in 7 cases, and Jobe test positive in 9 cases. Rotator cuff tear were demonstrated in all patients by MRI.

Surgical repair

Under general anesthesia, the patient lying on side was positioned with mild limb flexion & abduction traction, and skin surface markers and bony shoulder all landmarks labeled. After establishing the rear channels, glenohumeral joint was arthroscopicically examined, followed by establishment of front channel, evaluation of severity of shoulder joint and cleanup of ending point of the supraspinatus muscle with a planer and radiofrequency. Repair was only done on grade 3 PASTA lesion (**Figure 1**).

Prior to the surgical repair, space was decompressed, and the arthroscope was inserted through the incision into the subacromial bursa to debridement the synovial tissue outside through the front and rear channels until clear bursa-side rotator cuff footprint being completely seen, then shoulder arthroplasty was performed. When thin, degenerative lateral ending point of the residual rotator cuff or concomitant bursa side injuries present, cleanup was converted into full-thickness tear for surgical repair. If ending point of the lateral rotator cuff point still intact without damage to the bursa side, trans-tendon repair would be carried out. With PASTA lesion being monitored by visualization under arthroscope, lock, the bare medial footprint was treated with burr grinding. To mark location and direction of rivet entrance, a gauge 18 spinal needle was introduced into the glenohumeral joint through supraspinatus tendon and close to the lateral side of the acromion. After piercing the skin and tendon with a small scalpel along the needle, the needle was removed and rivets, 1 of 5.0 mm or 2 of 3.5 mm depending on extent of the anterior-posterior dimension of the injury, being introduced into the joint along cartilage of the greater tuberosity of the humeral head and forming a 45° angle with the bony surface of the greater tuberosity (**Figure 2**). When two rivets used, they were placed in anterior and posterior directions on leading and trailing edge of the injury.

Suture threads were passed through healthy tissue on medial side of supraspinatus tendon by using bird-beak suture passer, with in between distance ≥10 mm to form sufficient tissue bridge for fixation of rotator cuff footprint. Alternatively, spinal needle could used to help passing of sutures, i.e., the rearward strand on the rivet was first passed through via the front entrance, and then a PDS suture thread was introduced by passing the needle medially and rearily to the healthy tissue medial to the damaged end of the supraspinatus tendon. By using the PDS suture as a guide, the remaining rivet sutures were passed through the supraspinatus tendon and then medial

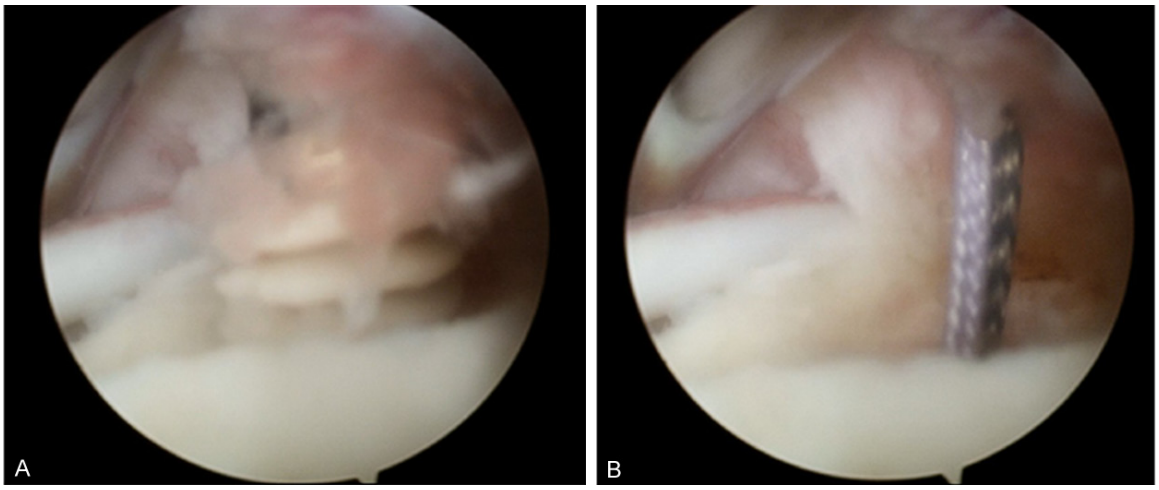

Figure 2. Placement of one 4.5 mm Depuy Mitek suture anchor. A. Viewing from posterior portal, transtendon placement of the anchor. B. Viewing from posterior portal, the anchor was placed just near the edge of articular cartilage.

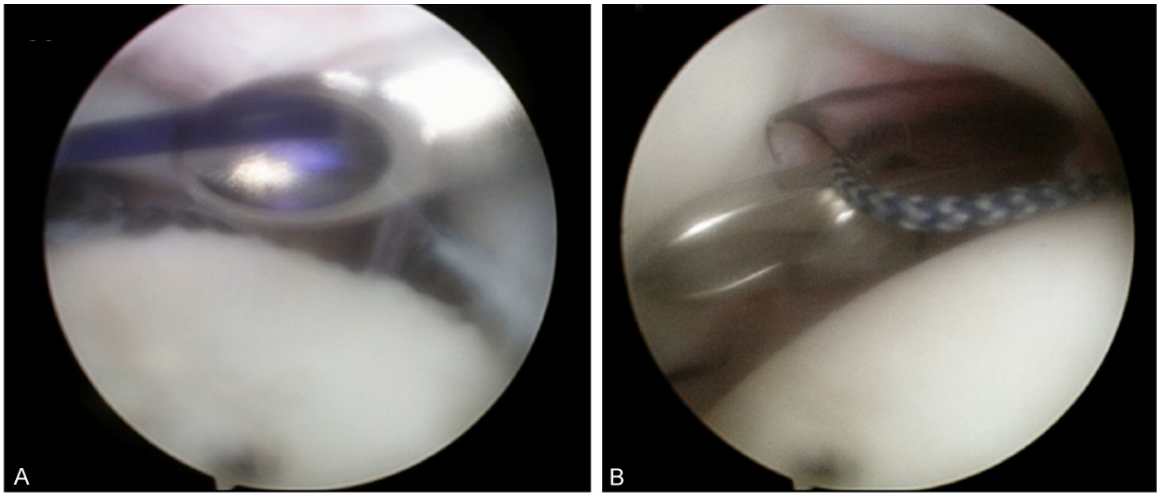

Figure 3. Passing of suture strand with aid of spine needle and PDS suture. The inter-strand distance is 1 cm. A. PDS suture was introduced through the spinal needle. B. Suture from the anchor was grasped out of the joint for retrograde passing.

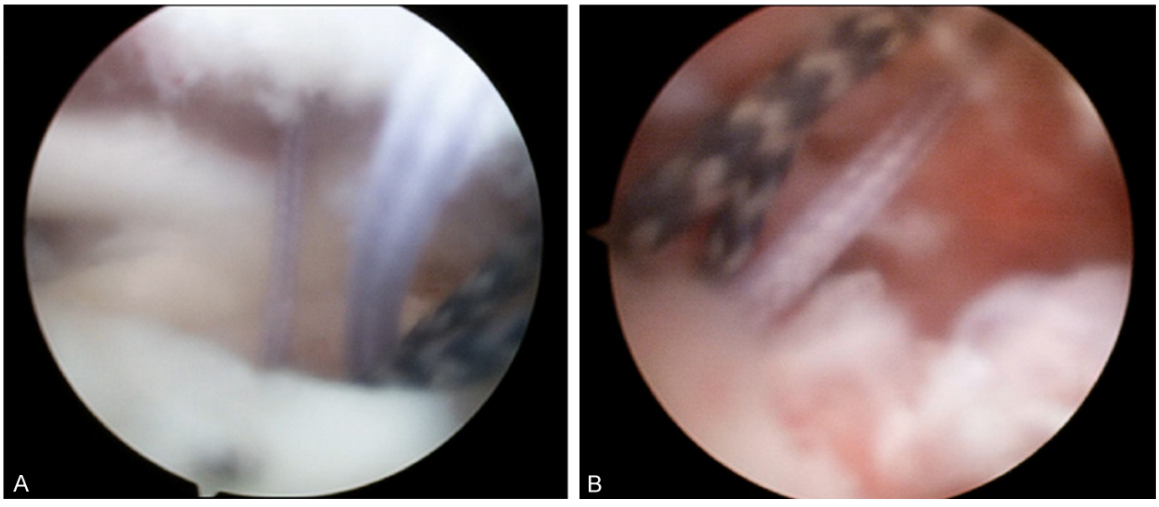

Figure 4. The anchor suture in glenohumeral joint, after passing the supraspinatus. A. Articular side view. B. Subacromial side view.

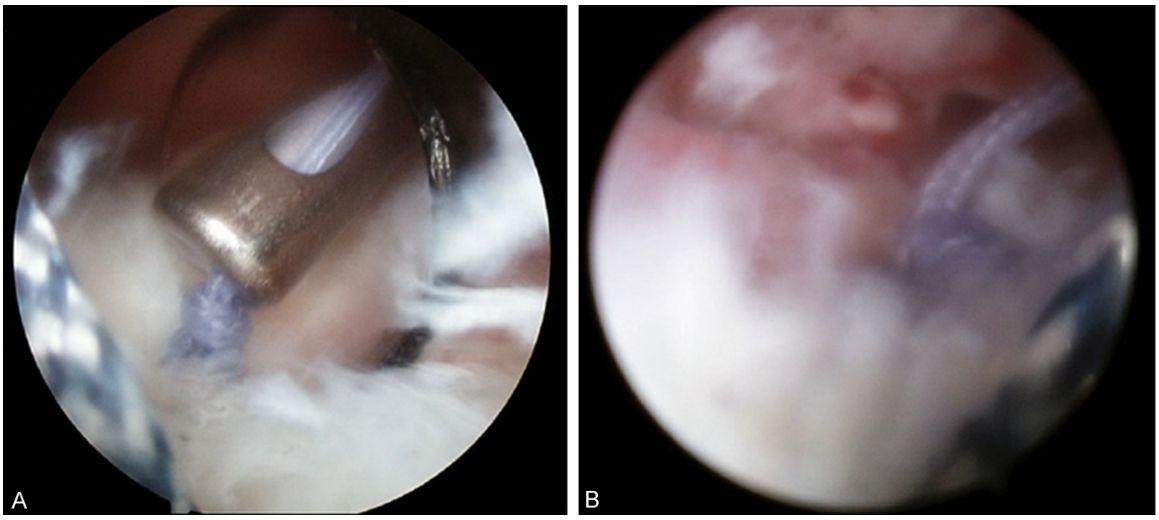

Figure 5. The sutures from medial anchor tied by SMC knot in subacromial space. A. Viewing from posterior portal,the suture was tied with SMC knot. B. Viewing from posterior portal,suture of medial row anchor ready for lateral fixation.

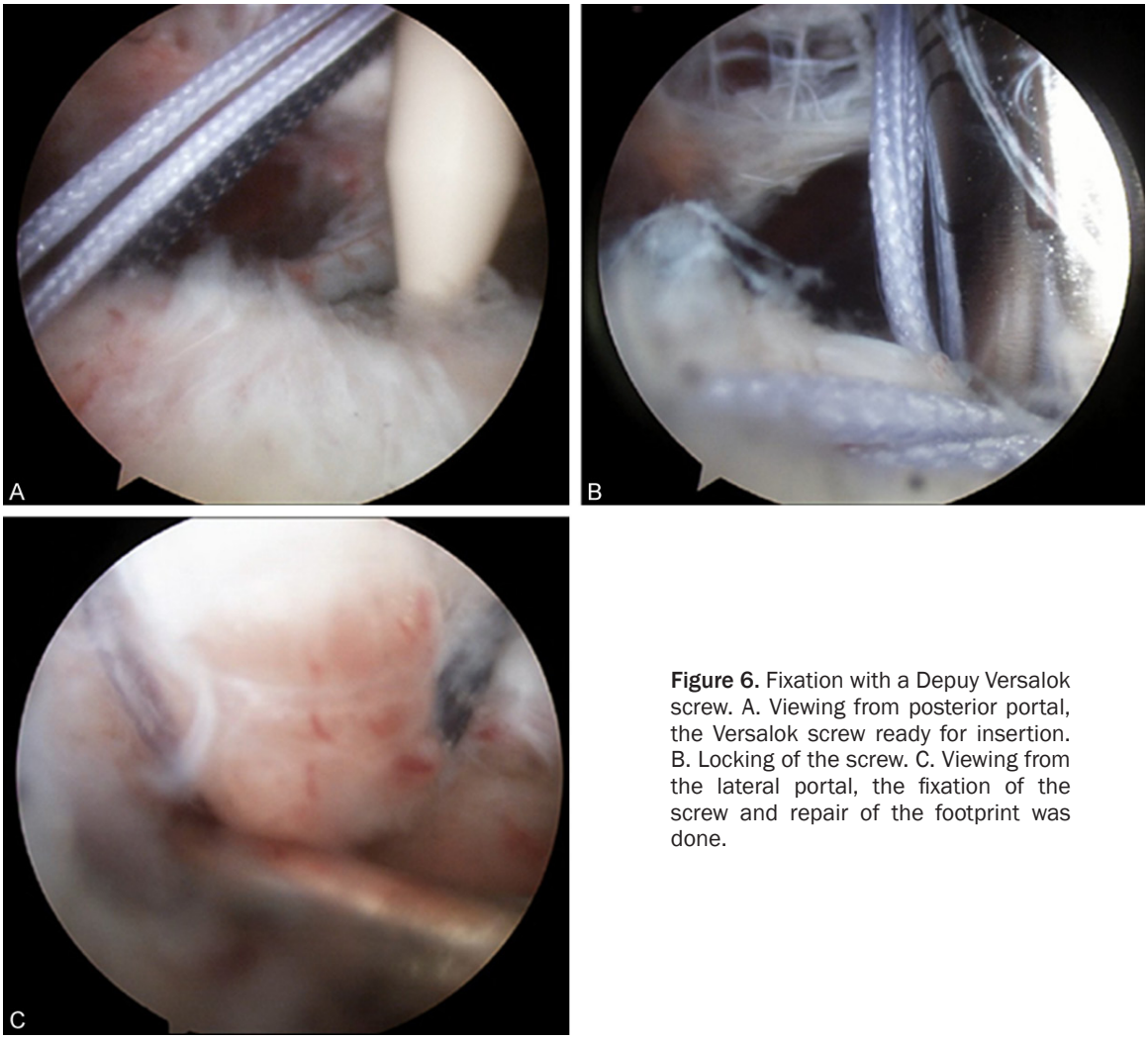

Figure 6. Fixation with a Depuy Versalok screw. A. Viewing from posterior portal, the Versalok screw ready for insertion. B. Locking of the screw. C. Viewing from the lateral portal, the fixation of the screw and repair of the footprint was done.

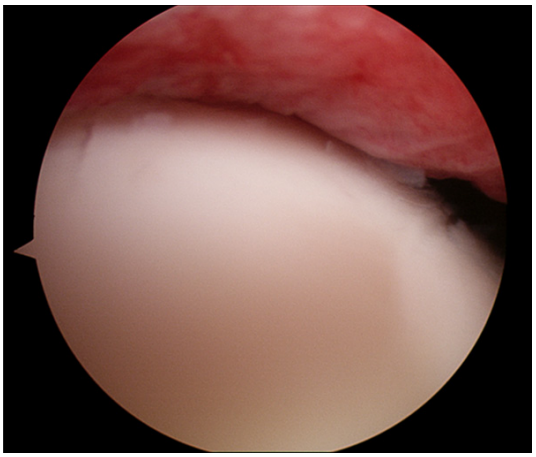

Figure 7. Viewing from posterior portal in glenohumeral joint, reconstructed rotator cuff footprint close to humeral head cartilage.

edge of the supraspinatus muscle (**Figures 3**, **4**). Two strands of suture could be passed at the same time if the front-rear distance of the injury <2 cm (**Figure 1**). When the damaged tendon on the articular-side retracted, a grip plier could be used to reset it in place and held by an assistant to help the surgeon finish suturing. When two rivets were used, the above operation could be repeated. With the arthroscope in the subacromial space, two strands of the same color were tied with SMC knot (**Figure 5**). To ensure better coverage on rotator cuff footprint and more fitting of the sutured rotator cuff, Depuy Versalok screws could be pinned into a suitable location lateral to the footprint (**Figure 6**). Arthroscopic evaluation of reconstruction of the rotator cuff footprint should see the reconstructed rotator cuff footprint close to the humeral head cartilage (**Figure 7**), with proper rivet positioning shown on postoperative X-ray (**Figure 8**).

Postoperative rehabilitation

The operated shoulder was kept for 4 weeks in a mild abduction position by virtue of skull traction bandage after surgery, with early postoperative pendulum motion, Godman movement, passive external rotation exercises, and elbow flexion and extension exercises. However, overhead movement was avoided within 4 weeks postoperatively. After the skull traction bandage being removed at week 4 postoperatively, over-head stretching exercises and medial rotation and stretching exercises was practiced. Isometric exercises started in all the patients 10 weeks thereafter.

Figure 8. Proper positioning of the Depuy Versalok screw, Depuy Mitek screw invisible (Shoulder X ray).

Evaluation and follow-up

The patients were followed up, every 2 weeks within the first 2 months then at 3, 6, 12 months and once a year afterwards postoperatively, for functional improvement of joint movement with Jobe test, Neer sign and anti-resistance movement, and ASES scoring system and the UCLA scoring scale [12, 13].

Statistics

Paired two-tailed Student's t-tests were used to compare preoperative and postoperative outcome scores with SPSS (IBM, Armonk, NY, USA). $P < 0.05$ was considered statistically significant (bilateral).

Results

All the 12 cases of PASTA had grade 3 injuries. They were postoperatively followed up for 12-36 months (average 22 ± 7.3 months). The ASES score of these patients was 89.7 ± 5.6 points, comparing to that of 49.8 ± 9.8 preoperatively ($t = 12.25$, $P < 0.0001$). While UCLA score was significantly increased from preoperative 17.3 ± 3.3 to 30.4 ± 3.2 points ($t = 9.87$, $P < 0.0001$). The satisfaction rate was 11 out of the 12 patients (91.7%).

After surgery, all the patients had relief of joint pain within an average of 4 weeks (3 to 6 weeks), resumed normal joint motion and strength within 2 to 5 months (average 3

months), experienced improvement of joint functions within 6 weeks, and returned to normal daily activities within 1 year. MRI imaging demonstrated that edema signal was present in the repaired areas at 4 weeks but disappeared at 6 weeks after surgery, and X-ray revealed that the rivets were in place on shoulder anteroposterior and supraspinatus outlet position films.

Discussion

PASTA injuries are common pathologic lesions. Treatment for this condition remains controversial. However, surgical repair of the tendon is generally recommended for grade 3 injuries. Our result with 12 PASTA lesions demonstrated that transtendon rotator-cuff repair is a safe and reliable technique that ensures satisfactory clinical benefits.

Surgical options for PASTA include debridement and completion of the tear to full thickness, followed by repair, intertendinous sutures, and transtendon suture techniques [14]. Among these options, transtendon rotator-cuff repair preserves the intact lateral portion of the tendon while repairing the medial aspect of the tendon back to the footprint, with hope of anatomic restoration of the footprint and maintenance of the normal intact lateral cuff [4, 15]. Clinical data have shown that although debridement and sub-acromiol decompression can provide pain relief [3], a large portion of cases result in full-thickness and deterioration of the lesion [16]. When repair was performed, conversion the lesion to full thickness tear and then repair has higher re-tear rate due to formation of scar healing and lack of restoration of fibrocartilage connection in bone-tendong junction [17]. Actually, studies have shown that only surgical repair is associated with satisfactory clinical outcomes [4, 11, 15, 17, 18]. Most recent attempts to preserve bursa-side footprint using trans-tendon repair technique enhance healing and improved clinical outcomes [4, 11, 17].

Lo et al [11] reported a unique technique to repair PASTA. In his method, 2 rivets are used with double pulley technique to form a horizontal suture bridge on medial surface of the supraspinatus tendon. The pros of this technique are: (1) Suture bridge can firmly fix rotator cuff footprint; and (2) Double pulley technique reduces times of threading and thus facilitate surgical procedure. The cons of this technique are obvious as well: (1) In most PASTA cases, bare footprint is just big enough to hold one rivet; (2) The double pulley technique works best with the sixth-finger pusher, nut not the ordinary knot pusher; (3) For retracted tendonous ends, inward placement of the puncture needle results in excessive extension force on the rotator cuff and thus bulging of the bursa-side tissue and increased postoperative pain [18]. Therefore, we modified this technique in our practice: (1) Use one 5.0 mm rivet with 2 strands of suture; (2) The two strands can be passed at the same or different time and are fixed with a slip knot to reduces the risk of overload on greater tuberosity, risk of loose knotting, and patients' cost as well; (3) After implantation of rivets and before rotator cuff repair, retracted tendon is anatomically restored with grip pliers, thus avoiding bulging of bursa-side rotator cuff and imbalance of tendon tension.

Taken together, trans-tendon repair for grade 3 PASTA lesions provides maximal preservation of normal rotator cuff tissue, anatomical reconstruction of the rotator cuff footprint, and stable fixation of tendon-bone interface. Our modified Lo technique achieves more desired therapeutic effects.

This study has a number of limitations. It had a relatively small sample size, and the follow-up period was relatively short, which might bring bias to the study. However, in terms of clinical efficacy, we believe that our technique is clinically meaningful, and our results are significant and set good background for further study.

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Disclosure of conflict of interest

None.

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