

Transtendon Repair Under Switching-Scope Technique for Articular Partial-Thickness Rotator Cuff Tears



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Abstract: Partial-thickness rotator cuff tears are common diseases causing pain and disability. Among the different surgical methods, the transtendon repair technique is recommended due to its biomechanically superiority. However, this technique has a high learning curve and is time-consuming. In this Technical Note, we introduce a safer and more effective modified transtendon repair technique. Our switching-scope technique sets a switching stick into the glenohumeral joint through the posterior portal and is used as a guide for switching the arthroscope between the subacromial and articular spaces. This technique can reduce surgical time and overcome the disadvantage of vision limitation in articular-sided transtendon repair.

Partial-thickness rotator cuff tears (PTRCTS) are common, causing pain and disability in all age groups, especially in elderly patients.¹ Articular-sided tears have a greater incidence rate than bursal-sided tears in overhead athletes related to internal impingement.² The rate of full-thickness progression in symptomatic PTRCTS has been reported up to 0.22% per month.^{3,4} Arthroscopic surgery has become the gold treatment for the Ellman III PTRCTS. However, there is still controversy regarding the best technique for the treatment of PTRCTS. Several techniques have been introduced, including debridement, transtendon repair, or conversion to a full-thickness tear followed by repair. The transtendon repair is one of the in situ repair

techniques for articular-sided PTRCTS repair. This technique has advantage of leaving the bursal-side layer of rotator cuff intact and anatomical reconstruction of the footprint. However, the transtendon repair is technically more difficult and time-consuming than conversion to a full-thickness tear due to the restricted view.

The rotator cable is a band of collagen fibers around the articular side of lateral rotator cuff that plays an important role in transmitting compressive stress and tensile stress.⁵ Therefore, repair of the rotator cable during the arthroscopic surgery may restore the integrity of rotator cuff and decrease the retear rate.^{6,7} To our knowledge, little research has reported on the technique of cable restoration during transtendon repair.

In this Technical Note, we introduce a surgically efficient and accurate arthroscopic technique for articular-sided PTRCTS repair. This technique is a modified transtendon repair with a switching scope to shorten the surgical time and makes the observation of both articular and bursal sides easier.

Surgical Technique (With Video Illustration)

Preparation

Patients are set up in the lateral decubitus position with the shoulder positioned in 15° forward flexion and 60° abduction. Either general anesthesia or brachial plexus blockage can be used in this surgery. The arm is subjected to about 5 kg of traction. A standard posterior portal is established for visualization. After an intra-

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articular inspection, an anterior portal through the rotator interval is established as a working portal using an outside-in technique. Then, a lateral portal and a posterolateral portal are established. The states of the glenohumeral joint, acromion, rotator cuff, footprint, and rotator cable are evaluated and a debridement of subacromial bursa is performed first (Fig 1).

Tendon Tear Locating and Scope Switching

Setting the scope in posterior portal, the position of articular-side rotator cuff is marked with a polydioxanone (PDS) suture (3.5 mm; Ethicon, Somerville, NJ) through a percutaneous spinal needle as a thread guide. It is important to insert the needle close to acromion and puncture the cuff lesion in a dead-man angle for later suture anchor insertion. The 30° scope is withdrawn from the articular space and switched into the subacromial space through the posterolateral portal while a switching stick (4.3 mm, Smith & Nephew, London, UK) is introduced into the glenohumeral joint through the arthroscopic sheath in the posterior portal. This switching stick is placed there as a guide for switching back of the arthroscope. During the entirety of the transtendon repair procedure, the arthroscope will be switched repeatedly between the subacromial space and the glenohumeral joint through the switching stick to monitor suture anchor insertion and the suture-relaying procedure without blind spots, which is equal to the dual-camera technique.⁸ We call this switching scope technique (Video 1).

Transtendon Window Creation and Suture Anchor Insertion

The guiding PDS suture is found in the bursal side of rotator cuff, and a 3- to 5-mm incision is made with a scalpel at PDS suture insertion point to establish a small

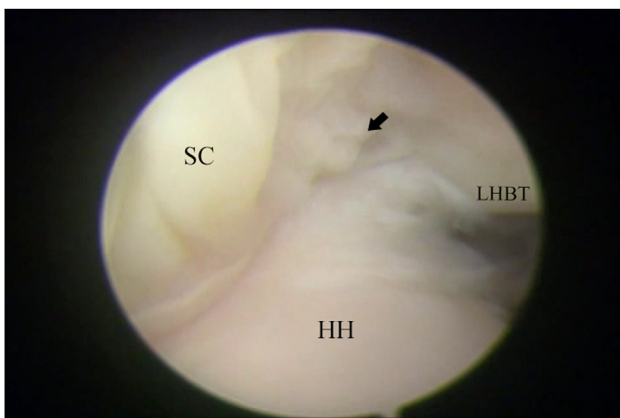


Fig 1. With the patient in lateral decubitus position, arthroscopic imaging from the posterior viewing portal shows a partial-thickness articular-sided rotator cuff tear (black arrow) of the left supraspinatus tendon. (HH humeral head, LHBT long head of biceps tendon, SC superior capsule.)

transtendon window (Fig 2). A motorized shaver is introduced through this small window and complete debridement of the unhealthy rotator cuff tissue and soft tissue over the footprint is performed. One or two 4.5-mm anchors (HEALIX ADVANCE BR; DePuy, Warsaw, IN) are inserted into the medial edge of the footprint through the transtendon window after that (Fig 3). To provide clear view for anchor insertion, the scope is switched to the posterior portal and an arthroscopic probe is inserted in the transtendon window as a retractor from the lateral portal. Therefore, no further transtendon anchor insertion device is needed.

Suture-Relay Procedure

The suture-relay procedure is performed with a spinal needle preloaded with a PDS suture loop, which is monitored with switching scope technique. The spinal needle punctures only the bursal side rotator cuff tendon percutaneously with the scope monitored the subacromial space from posterolateral or lateral portal (Fig 4). Then, the scope is switched to posterior portal to monitor the glenohumeral joint (Fig 5) and the spinal needle penetrates the full thickness of the tendon approximately 5 mm medial to the torn margin of the superior capsule (Fig 6). In some cases, the superior capsule is retracted more medially, which is difficult to penetrate by the spinal needle. Surgeon can grasp the medial edge of the superior capsule through the transtendon window with a tissue grasper or a suture retriever from lateral or superolateral anchor insertion portal.

Once the spinal needle penetrates the superior capsule, one limb of suture anchor is retrieved with a suture retriever and relayed by PDS suture loop. The other 3 limbs of suture anchor are relayed in the same way. With the good view provided with our switching scope technique, all limbs of suture anchor are adjusted to ensure either the bursal side or the articular side of cuff tissue getting a tension balance and good purchase of the rotator cable tissue (Fig 7).

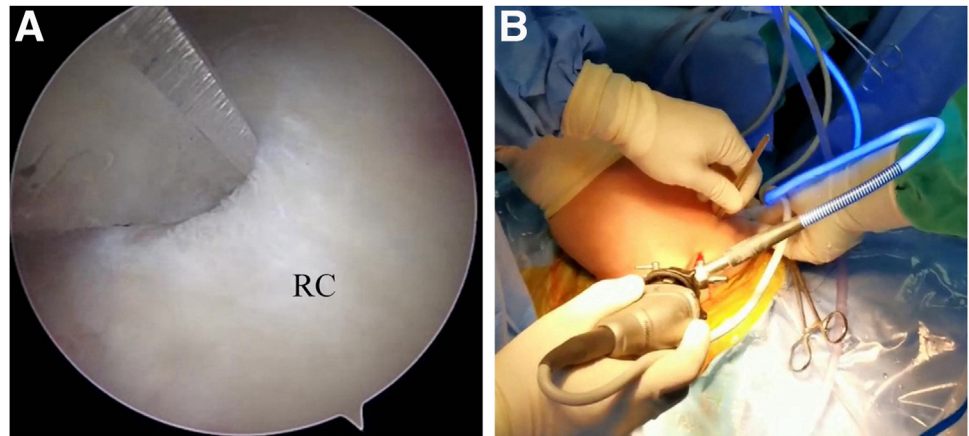
Suture Fixation

After all limbs of medial row anchor are relayed, the scope is switched to the posterolateral portal and the rotator cuff tendon is immobilized with suture-bridge technique by 1 to 2 lateral pushed-in suture anchors (FOOTPRINT Ultra, 4.5 mm; Smith & Nephew). An overall evaluation of the rotator cuff is conducted after repair before the surgeon finishes the surgery (Figs 8 and 9).

Rehabilitation

All our patients received the same postoperative rehabilitation protocol. The patients are immobilized with an abduction brace for 4 weeks. Passive shoulder exercise including pendulum motion and flexion and

Fig 2. Arthroscopic imaging from the posterolateral viewing portal shows a 3- to 5-mm incision is made at polydioxanone suture insertion point with a scalpel through anterolateral portal. (A) Arthroscopic view. (B) Outside view. (RC, rotator cuff.)



external rotation begins on the second day after surgery. The active motion is subsequently initiated from 6 weeks to 12 weeks. Rotator cuff endurance-strengthening exercises begin at 12 weeks. Heavy manual work and overhead activities are allowed after 6 months.

Discussion

In this Technical Note, we introduce a modified suture bridge, transtendon repair under a switching scope technique for the treatment of articular-side PASTA (partial articular supraspinatus tendon avulsion) lesion (Table 1). The conception of partial rotator cuff tears was first proposed by Codman in 1934.⁹ From the 1990s until now, a great advance has taken place in the surgical techniques for the treatment of PTRCTS.¹⁰⁻¹² The surgical approach has evolved from open to arthroscopic surgery. In addition, the surgical technique has evolved from simple debridement to repair after completion and transtendon repair.

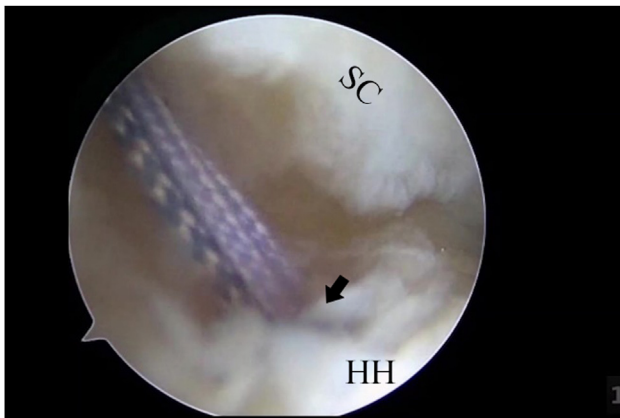


Fig 3. Arthroscopic imaging from the lateral viewing portal shows a 4.5-mm anchor (black arrow) is inserted at the medial edge of the footprint through the transtendon window. (HH humeral head, SC superior capsular.)

For now, the results of repair after completion and transtendon repair technique still remain controversial, although good clinical outcomes of repair after completion have been shown in several studies.¹³⁻¹⁵ Take-down the full thickness of rotator cuff injured the healthy bursal-side tendon tissue and destroyed the tendon integrity. Furthermore, the repair of rotator cuff with this technique led to a nonanatomic restoration of the tendon footprint, which may create a length-tension mismatch.¹⁶ The transtendon repair technique exhibited better biomechanical footprint contact pressure and high ultimate failure load compared with repair after completion.¹⁷ Favorable outcomes of transtendon repair technique had been reported in several studies.^{18,19} Although the existing research has shown a similar clinical result between repair after completion and transtendon repair technique,^{13,20} studies in cadavers have shown that transtendon repair is biomechanically superior to repair after completion.²¹ Recently, studies in cadavers have shown the supraspinatus tendon inserted on only a small portion of the greater tuberosity.^{22,23} Many Ellman III PTRCTS actually consisted of a contact rotator capsule, complete torn supraspinatus, and even partial infraspinatus tendon. Thus, the transtendon repair technique can reconstruct the supraspinatus and preserve the health of the infraspinatus as much as possible.

The transtendon repair technique also has its defects. Despite the clinical and biomechanics superiority, the learning curve and time-consuming nature of transtendon repair is greater than repair after completion technique. Meanwhile, the most concerning problem is postoperative pain and stiffness following transtendon repair technique. Some studies deemed that the transtendon repair technique was one of the risk factors of shoulder stiffness after operation.^{16,24} Castagna et al.²⁵ found patients with small footprint exposure or large degree of tendon retraction and severe degenerative

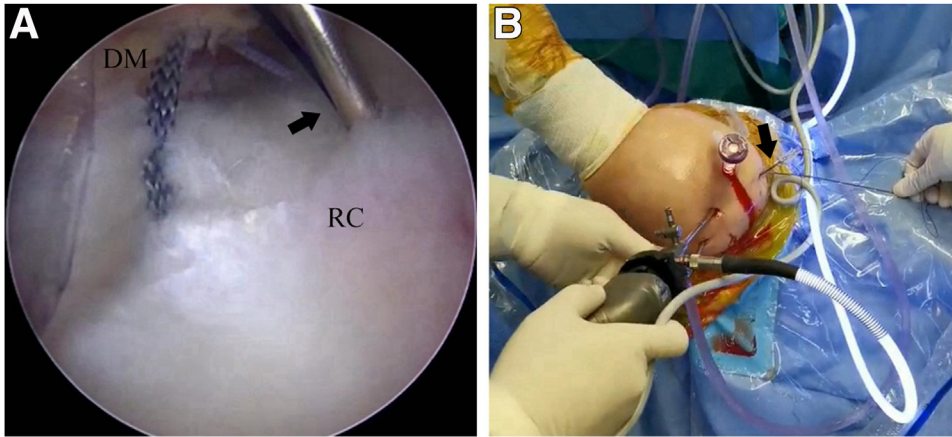
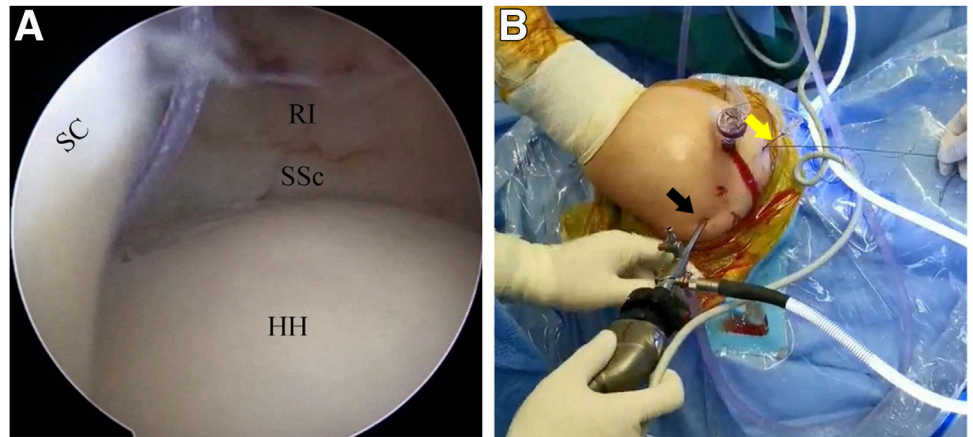


Fig 4. Arthroscopic imaging from the posterolateral viewing portal shows the switching scope technique. The spinal needle (black arrow) punctured only the bursal side cuff tissue percutaneously with the scope monitored. (A) Arthroscopic view. (B) Outside view. (DM, deltoid muscle; RC, rotator cuff.)

Fig 5. The scope (black arrow in B) is switched to posterior portal and the spinal needle remained in bursal side cuff tissue (yellow arrow in B). (A) Arthroscopic view from the posterior viewing portal. (B) Outside view. (HH, humeral head; RI, rotator interval; SC, superior capsular.)



tears, especially elderly people, were more like to have postoperative shoulder discomfort. The authors believed the bursal layer of the rotator cuff may be bunched up after transtendon repair, which led to the postoperative shoulder discomfort.

Several studies have proposed different modified techniques to overcome the internal defect of the transtendon repair technique. Dilisio et al.²⁶ described a double-row, transosseous-equivalent arthroscopic repair for treatment of partial-thickness, articular-side

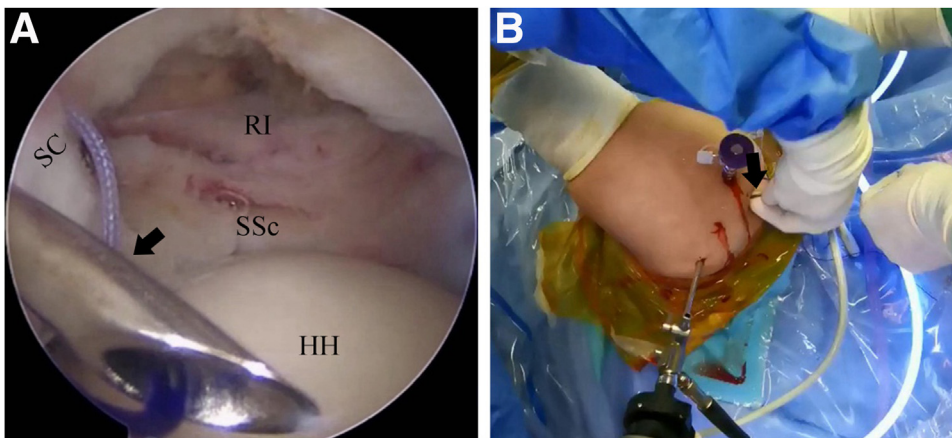


Fig 6. Arthroscopic imaging from the posterior viewing portal shows the spinal needle (black arrow) penetrates the full thickness of the tendon approximately 5 mm medial to the torn margin of the superior capsule to purchase enough rotator cable tissue. (A) Arthroscopic view. (B) Outside view. (HH, humeral head; RI, rotator interval; SC, superior capsular; SSc, subscapularis.)

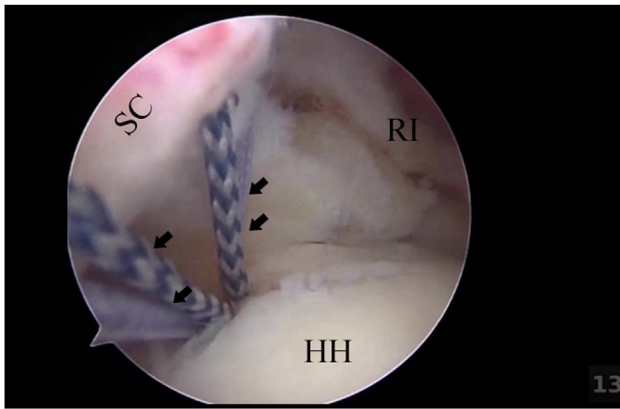


Fig 7. Arthroscopic imaging from the posterior viewing portal shows all limbs (black arrow) of suture anchors are relayed in the same fashion. (HH, humeral head; RI, rotator interval; SC, superior capsular.)

rotator cuff tears. Hirahara and Andersen²⁷ described a modified PASTA bridge technique for the repair of articular-side PASTA lesions. Spencer et al.²⁸ proposed an all-inside repair without tying down the intact bursal layer of cuff. Tuttle et al.⁸ reported a dual-camera technique to eliminate the blind spots PASTA lesion and gained a suitable tension of torn cuff. Yet, our technique also has been shown to be time-costing and with a learning curve. The tension of the articular-side PASTA lesion can be restored appropriately under our switching-scope technique.

Our switching-scope technique has several advantages compared with the traditional arthroscopic transtendon repair technique. Primarily, the technique has the ability to restore the retracted articular-layer rotator cuff anatomically to the footprint under direct visualization. This is the key to obtain a balanced tension of 2 layers of rotator cuff, avoiding the post-operative pain and stiffness. The reason of discomfort

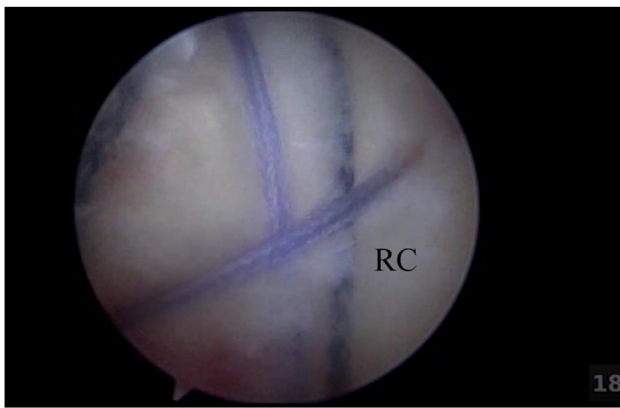


Fig 8. Arthroscopic imaging from the posterolateral viewing portal shows subacromial view of the repair after suture-bridge. (RC, rotator cuff.)

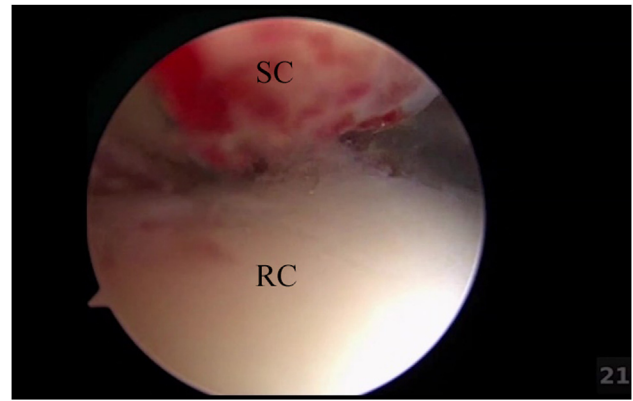


Fig 9. Arthroscopic imaging from the posterior viewing portal shows the glenohumeral joint view of rotator cuff repair. (RC, rotator cuff; SC, superior capsular.)

after transtendon repair is mainly caused by over-tightened bursal layer of rotator cuff due to the poor view. In addition, knotless suture bridge fixation methods are conducted in our technique, which is biomechanically superior to single-row or double-row repairs. This knotless suture bridge fixation technique

Table 1. Pearls and Pitfalls

1. MRI examination is required to evaluate the subscapularis tendon and long head of biceps femoris tendon, as well as the footprint and tear pattern.
2. With the shoulder positioned in 60° of abduction, a good view of articular side PTRCT can be achieved, which is important for the transtendon repair technique.
3. Thorough debridement of degenerate tendon tissue on both the bursal and articular sides can be achieved by switching scope technique without blind spot for intra-articular and extra-articular views, and the shaver is introduced from the lateral portal through the small transtendon window.
4. The transtendon window is created to facilitate thorough debridement of degenerative cuff tissue, transtendon anchor insertion, and manipulation of rotator cable tissue with a tissue grasper or suture retriever during suture relay procedure.
5. The adjacent structures around the footprint need to be taken care of iatrogenic injury while inserting the percutaneous scalpel to make the transtendon window.
6. After debridement, a thorough and careful arthroscopic inspection is performed to confirm the tear pattern of rotator cuff from both the subacromial space and the glenohumeral joint.
7. During the entirety of the transtendon repair procedure, the arthroscope will be switched repeatedly between the subacromial space and the glenohumeral joint through the switching stick to monitor the suture anchor insertion and suture-relaying procedure without blind spots, which is equal to the dual-camera technique.
8. Because the posterior portal and posterolateral portal are used as viewing portals alternatively with this technique, a percutaneous spinal needle preloaded with a suture loop is recommended for the suture-relay procedure. The limbs of the suture should be adjusted to ensure the tension balance of both bursal and articular sides before final fixation of the lateral anchors

MRI, magnetic resonance imaging; PTRCT, partial-thickness rotator cuff tears.

Table 2. Advantages and Disadvantages

Advantages
Better view of both articular and bursal side of rotator cuff
Spinal needle used for accurate and minimal invasive suture-relay procedure
Good balance of tension distribution of sutures
Knotless suture-bridge fixation provides a mechanical advantage
Capture good qualified rotator cable tissue for cuff repair
Disadvantages
Possible iatrogenic injuries during the insertion of the scalpel percutaneously
The posterior portal is occupied by a switching stick, so that it can't be used as working portal during the suture-relay procedure
Requires a certain learning curve

yields less stress on both the bursal and articular layers of rotator cuff, reducing the occurrence of postoperative stiffness. Furthermore, we identify the state of rotator cable at the initial arthroscopic inspection.²⁹ The torn rotator cables are repaired during the surgery and the healthy rotator cables are protected from being injured during the surgery. Finally, this technique needs no special equipment and has a similar procedure to the traditional transtendon technique. The disadvantages of this technique are the risks of injury of adjacent structures during the insertion of percutaneous scalpel and posterior portal occupation with the switching stick during suture-relay procedure (Table 2).

In conclusion, arthroscopic transtendon repair of articular-side PASTA lesion is a favorable surgical technique and demonstrates good clinical results. Our modified suture bridge, switching-scope technique is a safe, effective, and technically practical method for the treatment of articular-sided partial tears of the rotator cuff.

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