



# Trans-tendon Suture Bridge Rotator Cuff Repair With Biceps Tendon Augmentation for Return High-Grade Partial Articular Supraspinatus Tendon Avulsion (PASTA) Lesions

Jong-Hun Ji, M.D., Darshil Parikh, M.D.(Ortho)., Young-Hoon Han, M.D., and Hwang-Yong You, M.D.

**Abstract:** Revision repair of return partial articular supraspinatus tendon avulsion (PASTA) lesion is difficult for poor tendon quality without tear completion and repair. Trans-tendon suture bridge repair with biceps tendon augmentation can preserve the intact bursal side cuff attachment and has shown satisfactory clinical outcomes. Moreover, trans-tendon suture bridge rotator cuff repair technique, along with biceps tendon augmentation, reinforces high-grade PASTA lesions by moving the tenotomized biceps tendon into the torn articular side cuff defect with added advantage of blood supply through the tenotomized biceps tendon graft. Retear after trans-tendon repair of high-grade PASTA lesions was rare, and its poor tendon quality cause the revision repair to be too difficult. Without tear completion and rotator cuff repair, this arthroscopic trans-tendon suture bridge rotator cuff repair with biceps tendon augmentation is a reliable procedure that could be expected to produce improved short-term functional and radiologic outcomes, along with improved tendon quality of repaired tendon.

## Introduction

High-grade partial articular supraspinatus tendon avulsion (PASTA) lesions are always difficult to treat, and various treatment modalities have shown good and satisfactory clinical outcomes.<sup>1,2</sup> Both arthroscopic trans-tendon repairs and conversion to full-thickness tear (take-down) and then repairing rotator cuff appear to be effective operative techniques, with the rate of good to excellent results ranging from

86% to 94.1%.<sup>2-4</sup> However, residual shoulder discomfort is often reported after trans-tendon repair of PASTA lesions.<sup>5,6</sup> Retears after repair of the high-grade PASTA lesions remains one of the most challenging pathologies for shoulder surgeons to treat, especially in active young patients. It is difficult to repair return PASTA lesions after previous trans-tendon repair, because of poor (thin and fragile) quality of previously repaired tendon along with adhesive scar tissue was formed due to previous surgery (Fig 1). Several treatment options such as arthroscopic debridement, trans-tendon repair, tear completion and repair, or patch augmentation is available for the revision surgery of the re-tear of repaired PASTA lesions.

This biceps tendon augmentation technique reinforces high-grade PASTA lesions by moving the tenotomized biceps tendon into the torn articular side rotator cuff defect with the added advantage of blood supply through the tenotomized biceps tendon graft.<sup>1</sup> This technique might be effective for pain relief and restoration of poor-quality tendon of return high-grade PASTA lesions. Furthermore, this biceps tendon augmentation minimizes tension mismatch between the articular and bursal layer of the cuff, thereby reducing pain and re-tear, and improves rotator cuff

From the Department of Orthopedic Surgery, College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea.

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Address correspondence to Jong-Hun Ji, M.D, Ph.D., Department of Orthopedic Surgery, Daejeon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 64 Daeheung-Ro, Jung-gu, Daejeon 34943, Republic of Korea. E-mail: [jjjh87@gmail.com](mailto:jjjh87@gmail.com)

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**Fig 1.** Preoperative MRI finding (A and B) oblique and coronal MRI view of return high-grade partial articular supraspinatus tendon avulsion (PASTA) lesions.

healing with good-quality tendon in the revision surgery after retears of repaired high-grade PASTA lesions. This technique provides autologous collagen scaffold and blood supply through the tenotomized biceps tendon (Table 1).

This procedure is performed under arthroscopy and includes 5 steps: 1) passing the threads from the inserted suture anchor through the entire return articular side tears in the glenohumeral joint; 2) passing the threads from the inserted suture anchor through the biceps tendon using Bird Beak Suture Passer; 3) passing the threads from the inserted suture anchor through return articular side tears again; 4) moving the tenotomized biceps tendon into the return articular side rotator cuff defect; and 5) repairing trans-tendon suture

bridge with biceps tendon augmentation in the sub-acromial space.

### Ethical Approval

The study was performed according to the medical ethical guidelines of our institution, and written, informed consent was obtained for all patients (IRB No : DC23ZASI0040).

### Surgical Technique

The surgical technique is shown in Video 1. The goal of the procedure is restoration of return articular side rotator cuff tears by harvesting the biceps tendon, which is transferred as an autologous collagen tissue inside the return articular side rotator cuff and is

**Table 1.** Advantages and Disadvantages

Advantages	Disadvantages
1. Local blood supply from biceps insertion increases chance of healing.	1. Need advanced arthroscopic technique and long surgical time
2. Autologous collagen supply without allograft	2. Cannot perform this biceps tendon augmentation in case of thin or poor-quality biceps tendon
3. Augmenting with the biceps tendon covers the entire footprint of torn articular side tears.	
4. Prevent tendon buckling	
5. Useful alternative to trans-tendon repair or conversion to full thickness	
6. Preservation of intact bursal layer	
7. Minimize tension-mismatch between the articular and bursal layers of the rotator cuff tendon.	

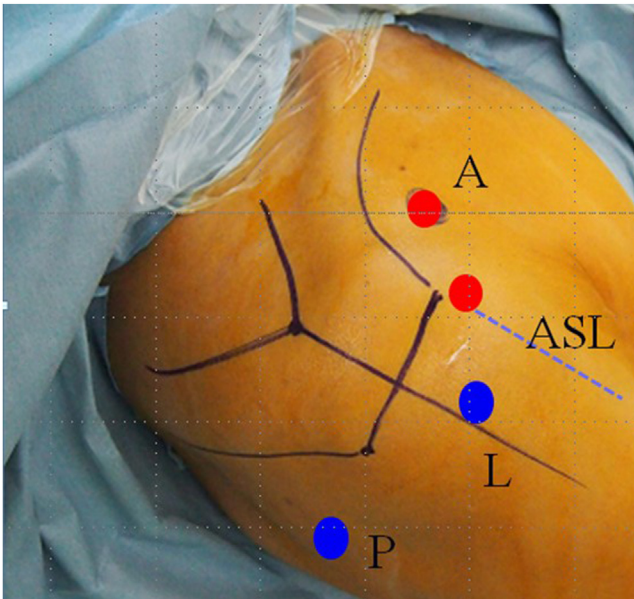
**Table 2.** Procedural Pearls and Pitfalls

Pearls
A standard arthroscopic portal can be used.
Preservation of length and tension relationship of the biceps tendon during trans-tendon suture bridge repair with the biceps tendon augmentation
Rigid fixation of the tenotomized biceps tendon to return high-grade PASTA lesion
Primarily, take additional cuff bites with 1 or 2 No. 2 Ethibond for better cuff coverage from anterior to posterior.
Always check the abutment of tenotomized biceps against the footprint before finishing the procedure in the glenohumeral joint.
Pitfalls
Difficult to identify multiple threads during the procedure
Severely torn or frayed biceps tendon not adequate for the biceps tendon augmentation

repaired with this trans-tendon repair technique, along with biceps tendon augmentation (Table 2).

### Positioning and Portal Establishment and Primary Debridement

Surgery is usually performed with general anesthesia combined with an interscalene block. Also, patient-controlled analgesia (PCA) has been used to optimize postoperative pain relief. A standard operating room table is set up, and the patient is positioned in a lateral decubitus position. The involved arm is placed in a pneumatic arm holder (Spyder; Smith & Nephew, Naples, FL) to facilitate different arm positions during fixation.



**Fig 2.** Three or four portals for the procedure are made, including anterior (A), antero-superolateral (ASL), lateral (L), and posterior (P) portal.

### Bony Landmarks and Portals Management

It was absolutely essential to mark the bony landmark for portal making. The outline for clavicle, acromion, coracoid, and AC joint was drawn. We usually use 3 or 4 portals for the procedure (Fig 2). The posterior portal is the primary viewing portal. The anterior working portal is used to examine the glenohumeral joint. This anterior portal is often replaced by anterosuperolateral (ASL) portal. The ASL portal is used to insert anchor and dock sutures. This portal is created specifically above the biceps tendon and anterolateral margin of the clavicle for the purpose of inserting a suture anchor. Compared to the conventional anterior portal, this ASL portal is useful for adequate anchor insertion without rotator cuff damage. The fourth portal is the lateral working portal. We use it to insert lateral row anchor and manage the instruments.

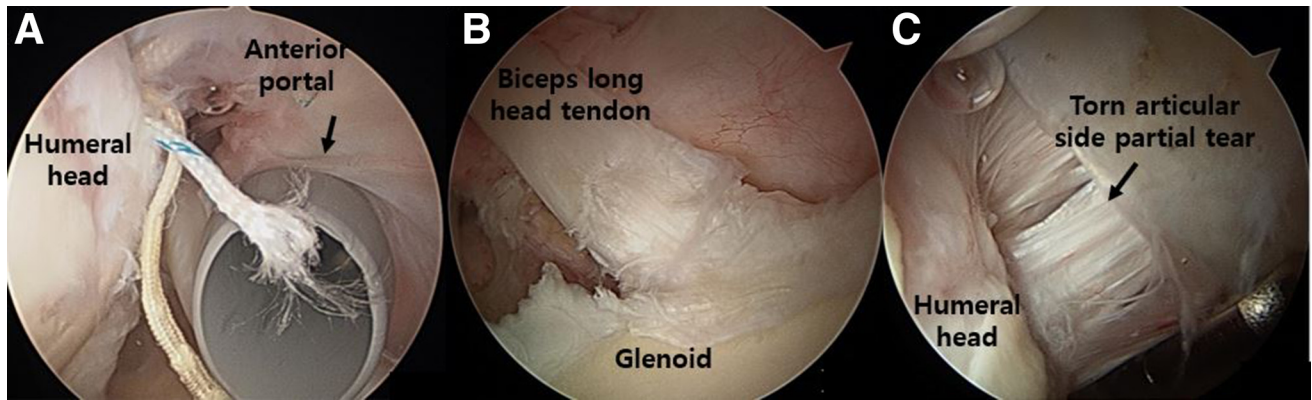
Diagnostic arthroscopy of the glenohumeral joint is always the first step to confirm the retear, debriding the partially return cuff fibers and removing previous suture threads. Torn supraspinatus tendon with broken threads is found (Fig 3, A-C). We mobilize the torn articular side partial thickness rotator cuff tears to expose the footprint area. Using the grasper, the surgeon removes the torn threads of the suture anchors. We prepare the footprint for anchor insertion, just lateral to the articular cartilage of humeral head through the ASL portal using the shaver (Fig 3).

### Step 1. Passing the Threads From the Inserted Suture Anchor Through the Entire Return Articular Side Tears in the Glenohumeral Joint

We insert the double loaded suture anchor (4.5-mm Twin Fix absorbable anchor; Smith & Nephew) in the midportion of the greater tuberosity footprint from ASL portal. All the threads from suture anchor are retrieved through the anterior portal. An 18-gauge spinal needle is inserted at the tear margin of the rotator cuff percutaneously and a non-absorbable suture is used to shuttle the suture limbs from posterior to anterior. All of the threads from the suture anchor are retrieved through the anterior portal again (Fig 4, A-C).

### Step 2. Passing the Threads From the Inserted Suture Anchor Through the Biceps Tendon Using Bird Beak Suture Passer

Each suture strand from cuff is pushed toward biceps to prepare for passing through biceps. Before passing the threads through the biceps, ensure that the biceps tendon is not excessively thin or of poor quality (with too much fraying). Bird Beak Suture Passer (Smith & Nephew) is used to pass through the biceps from distal to proximal, moving toward its glenoid origin. Then, we sequentially pass the suture strands through the biceps (Fig. 5). We use anterosuperolateral (ASL) portal as our



**Fig 3.** Initial arthroscopy findings show high-grade, partial-thickness articular side tears. Previous suture anchor is inserted, and trans-tendon repair was performed. (A) Torn supraspinatus tendon with broken threads is found. (B) The torn biceps tendon is found. (C) Return high-grade partial articular side supraspinatus avulsion (PASTA) lesion is found (arrow).

working portal. After passing the threads primarily through the cuff and secondarily through the biceps, we pull back all of the threads of the biceps onto the cannula of the ASL portal. Next, we prepare for the passage of the threads through the cuff once again.

### Step 3. Passing the Threads From the Inserted Suture Anchor Through Return Articular Side Tears Again

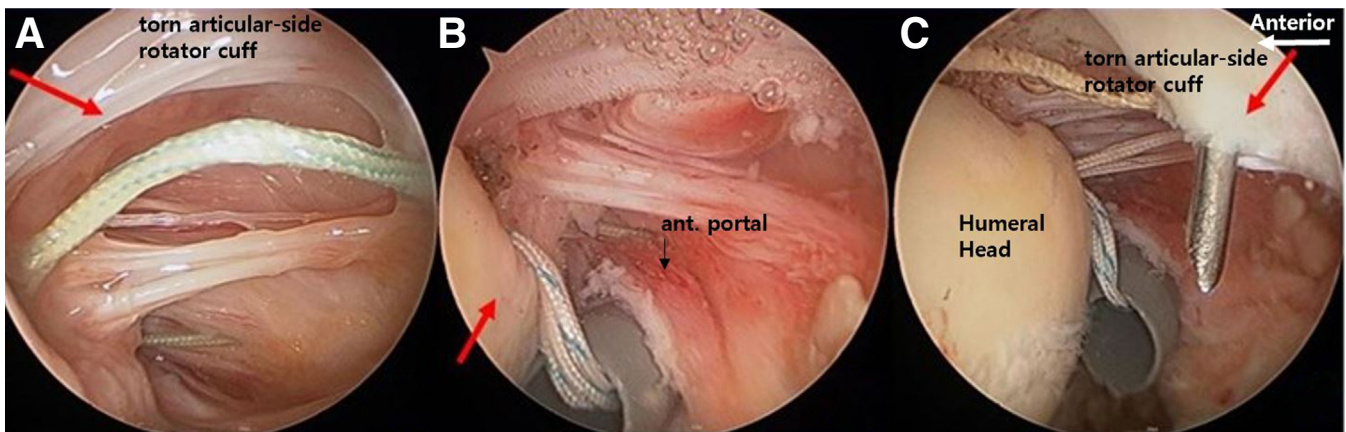
Now, using an 18-gauge spinal needle we penetrate at the tear margin of the rotator cuff again, percutaneously (Fig 6A) and a non-absorbable suture is used to shuttle the suture limbs from posterior to anterior. Two important considerations should be kept in mind. First, ensure there is sufficient spacing between each strand. Second, the posterior-most strand is passed up to distal extent of tear to ensure complete coverage of the entire footprint.

Currently, we have four strands that are passed from both the biceps tendon and rotator cuff (Fig 6B).

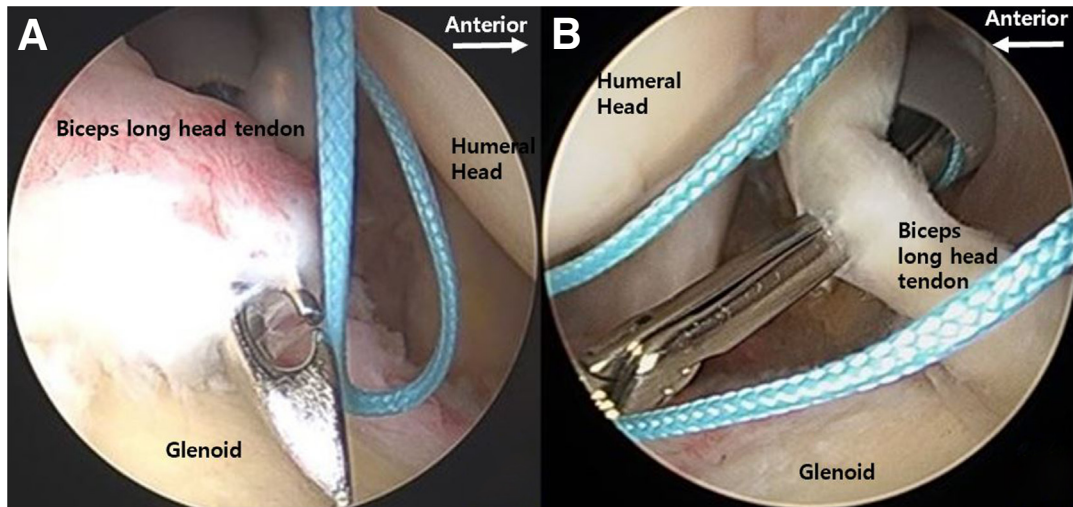
### Step 4. Moving the Tenotomized Biceps Tendon Into the Return Articular Side Rotator Cuff Defect

Confirm all 4 strands pass through the rotator cuff sequentially at the same distance. The insertion area of the biceps tendon was subsequently cut using an ArthroWand (ArthroCare, Austin, TX) (Fig 7), and tenotomized biceps tendon is incorporated into the torn cuff tendon defect at the end of the procedure. At this point, an additional cuff suture using a No. 2 Ethibond can be passed with the suture shuttle technique to achieve better coverage of the rotator cuff through the biceps tendon (Fig 8).

Finally, we check the abutment of the biceps tendon against the articular surface by pulling the threads. It



**Fig 4.** Continuous arthroscopic findings in the same patient who has undergone trans-tendon suture bridge rotator cuff repair with biceps tendon augmentation in retears after trans-tendon repair of PTRCT. (A) Initial arthroscopic findings of retear (arrow) of the repaired PASTA lesion 4 years ago in our institution. (B) Anchor (arrow) is inserted for trans-tendon repair. (C) All the 4 strands of suture anchor are passed through the torn edge (arrow) of the partial articular rotator cuff tear by using spinal needle (arrow) for shuttle relay.



**Fig 5.** Each strand of suture anchor was penetrated through the diseased biceps tendon with the use of a Bird Beak Suture Passer after passage through biceps tendon.

should ensure that the biceps tendon covers the entire footprint of the articular side rotator cuff.

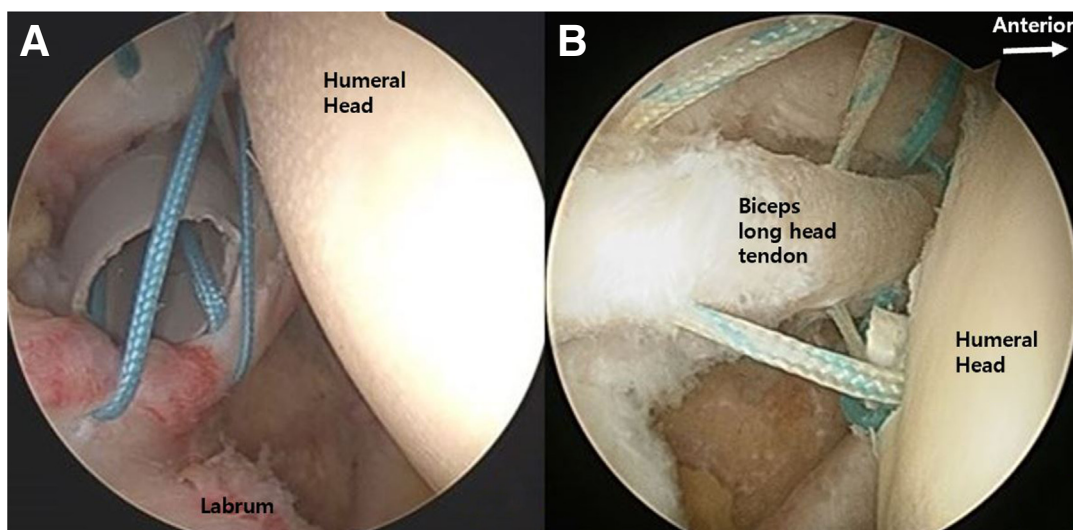
#### Step 5. Trans-Tendon Suture Bridge Repair With Biceps Tendon Augmentation in the Subacromial Space

We enter the subacromial space through the posterior portal. We confirm all 4 strands (6, in case of Ethibond threads) are properly positioned in subacromial space. We retract all of the threads and proceed to secure all 4 strands by tying sliding knots, thereby completing the medial row repair. We retract all the threads and proceed to secure all 4 strands by

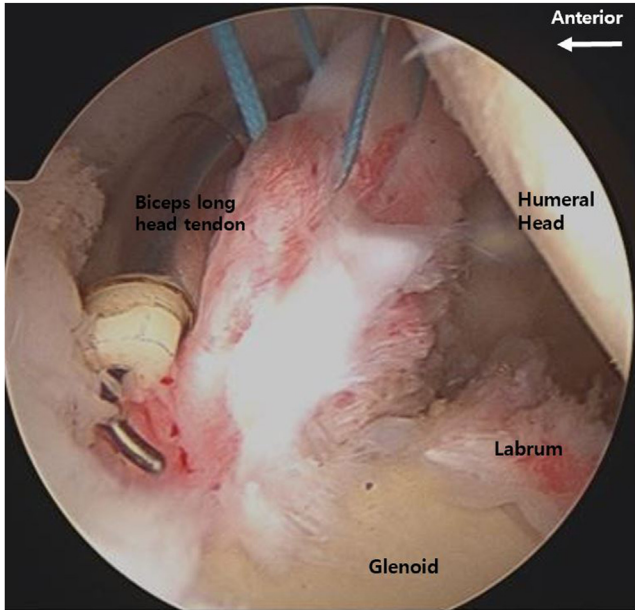
tying sliding knots, thereby completing the medial row repair. (MULTIFIX; Smith & Nephew) (Fig 9). To ensure improved coverage of the cuff, we use 2 lateral row anchors. This lateral row repair (arrow), combined with the trans-tendon suture bridge repair and biceps augmentation technique, helps prevent buckling within the bursal layer of the cuff.

#### Step 6. Confirming the Integrity and Biceps and Attachment of Biceps

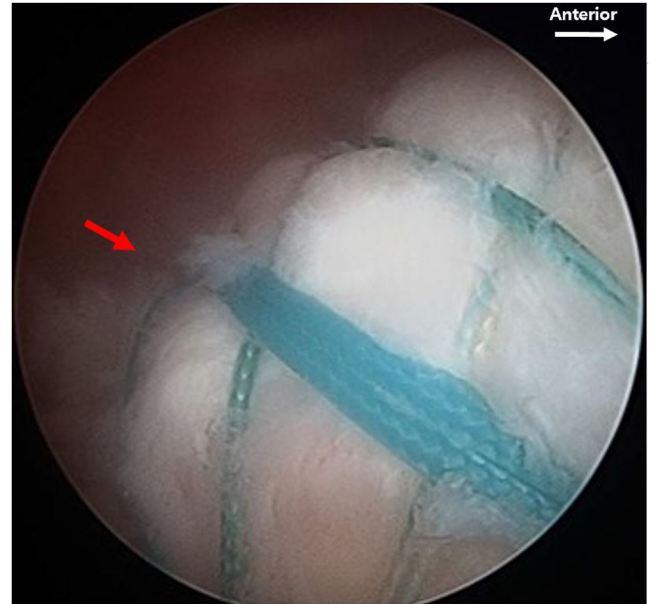
We again move the arthroscope into the glenohumeral joint to confirm the firm integrity of the repaired rotator cuff with the biceps tendon (Fig 10).



**Fig 6.** All four strands of the suture anchor, after passing through the biceps tendon, are then passed through the torn edge of the partial articular rotator cuff tear. This is done by using a spinal needle (arrow) for shuttle relay. (A) Illustration of the strands being parked in the ASL portal. (B) Demonstration of the strands being passed through the torn edge of the rotator cuff once again using the suture shuttle technique.



**Fig 7.** Using an ArthroWand, the biceps tendon is cut at the insertion area of the biceps tendon.



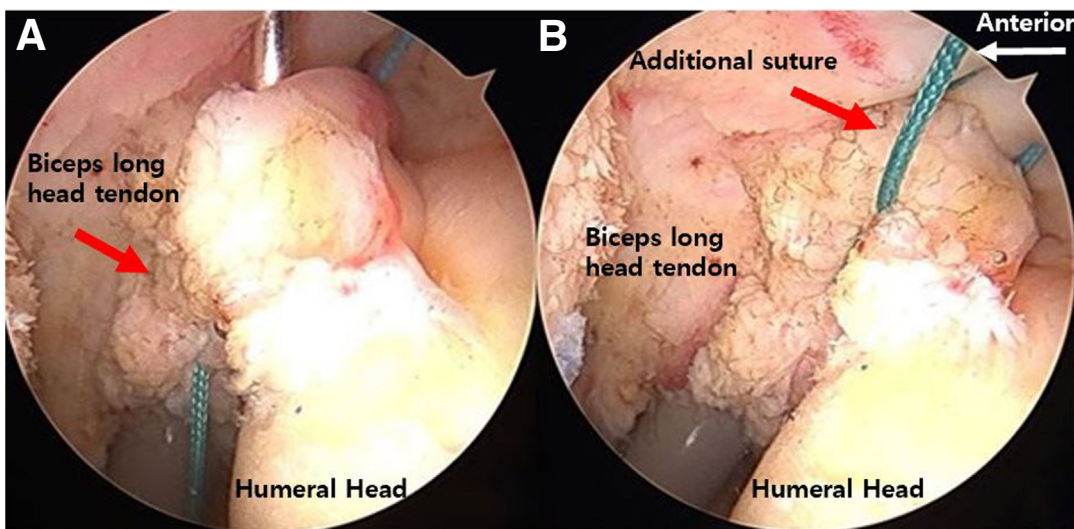
**Fig 9.** Trans-tendon suture bridge repair (arrow) with the biceps tendon augmentation is completed in subacromial space.

**Postoperative Management**

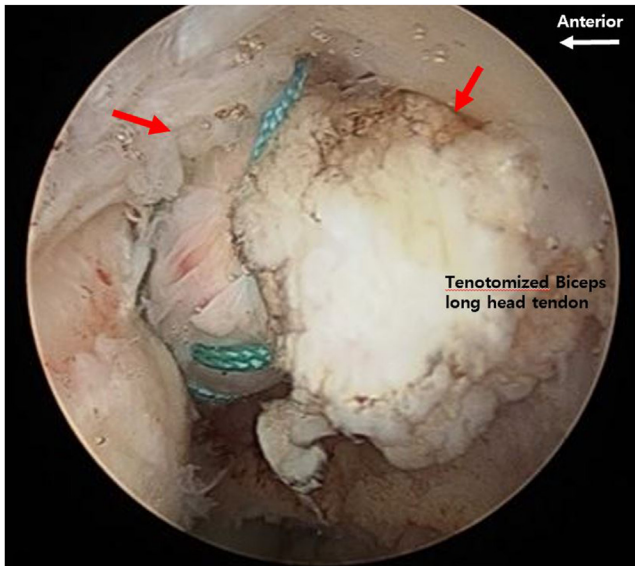
Postoperatively, patients are immobilized in a sling for 6 weeks. Passive range of motion, such as pendulum exercise, is started immediately and continued for 6 weeks after surgery. Active ROM exercises start at 6 weeks postoperatively, and strengthening exercise is permitted at 12 weeks. Postoperative radiographs and MRI images are performed to assess tendon healing or retear (Fig 11).

**Discussion**

In our study of retear after trans-tendon repair of PASTA lesions, revision surgery using autologous biceps tendon (trans-tendon suture bridge repair with biceps tendon augmentation) shows the restoration of footprint and torn tendon thickness. Postoperative follow-up MRI shows sufficient tendon thickness and preserved footprint coverage with biceps tendon augmentation, and no retear was found at short-term



**Fig 8.** The tenotomized biceps tendon was incorporated into the return articular side rotator cuff defect. (A) The abutment of the biceps tendon (arrow) against the articular surface by pulling the threads. (B) Additional rotator cuff repair using a No. 2 Ethibond (arrow) is performed.



**Fig 10.** The biceps tendon augmentation (arrow) was done under torn PASTA lesion.

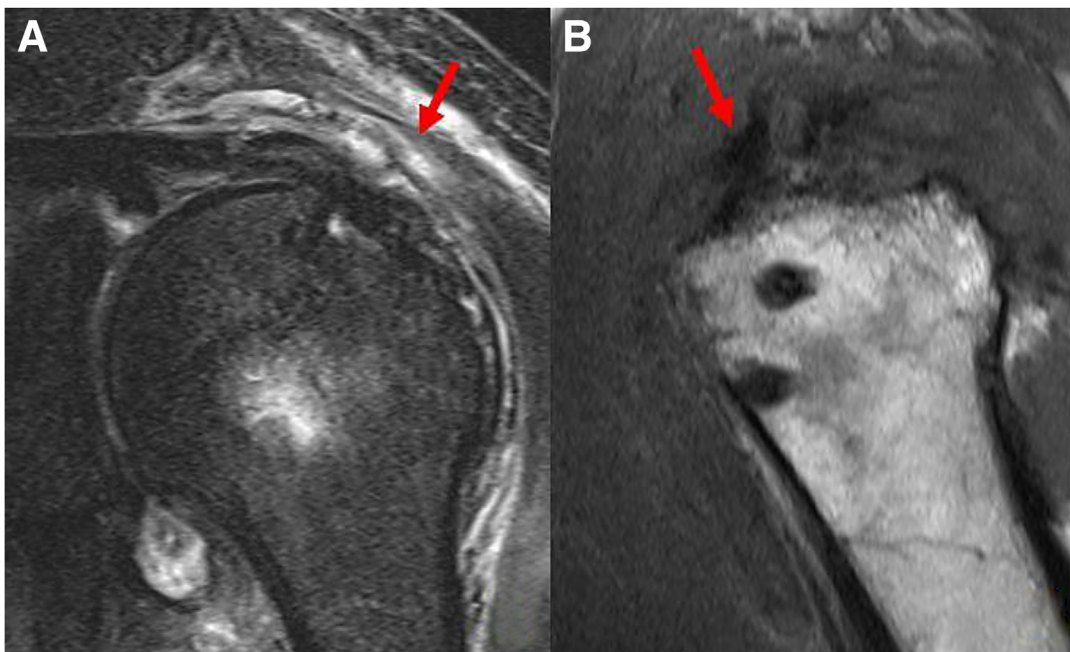
follow-up. In all patients, their clinical and radiological outcomes are improved significantly, as compared to preoperative status.

Retear after trans-tendon repair of high-grade PASTA lesions or suture bridge repair of full-thickness tears was rare but challenging to treat, as the quality of the tendon was too poor, and it becomes necessary to complete the tear and repair it. Furthermore, subtle residual shoulder discomfort was common after the initial repair (trans-tendon repair of high-grade PASTA

lesions or suture bridge repair of full-thickness tears), and pain, weakness, and stiffness were common symptoms of retears.<sup>5-8</sup> The novel transtendon suture bridge repair technique with tenotomized biceps tendon augmentation helped minimize tension mismatch and bursal bulging,<sup>9,10</sup> reducing postoperative shoulder pain and stiffness, especially residual shoulder discomfort. The reason for the reduced shoulder discomfort might be that local blood supply from biceps insertion increases chance of healing and autologous collagen supply without allograft. There are limited studies on revision PASTA lesion treatment, and this study is the first to focus on repair of re-tear after trans-tendon repair.

Two more issues—tendon quality and blood supply—are resolved by biceps tendon augmentation, which balances the tension imbalance between the bursal and articular sides and also provides blood flow through the tendon.<sup>1</sup> Even in repairs of significant cuff tears, biceps tendon has been demonstrated to improve collagen support and lower the risk of structural failure.<sup>11,12</sup>

Our patients have experienced decreased anterior shoulder pain and VAS scores after biceps tendon augmentation. Also, we consider this biceps augmentation has a similar tenodesis effect as that of the suprapectoral biceps tenodesis. Clinical scores and ROM, such as forward elevation, abduction, external rotation, and internal rotation were improved significantly in this patient, as compared to prerevision surgery status.



**Fig 11.** In the postoperative oblique coronal and sagittal MRI, the torn articular surface tear is restored, and the restoration of the rotator cuff defect is achieved by augmentation with the biceps tendon (arrow).

## Conclusion

Retear (partial articular side tear) after trans-tendon repair of high-grade PASTA lesions is rare, and its poor tendon quality cause the revision repair of re-torn PASTA lesions to be difficult. Without tear completion and rotator cuff repair in the return PASTA lesions, arthroscopic trans-tendon suture bridge repair with biceps tendon augmentation is a reliable procedure that can be expected to produce improved short-term functional and radiologic outcomes along with improved tendon quality of the repaired tendon.

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