Arthroscopic Superior Capsular Reconstruction Combined with Pectoralis Minor Transfer for Irreparable Antero-superior Rotator Cuff tear: A Case Report

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Arthroscopic Superior Capsular Reconstruction Combined with Pectoralis Minor Transfer for Irreparable Antero-superior Rotator Cuff tear: A Case Report

**Running title:** ASCR with pectoralis minor transfer

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Introduction

Superior capsular reconstruction (SCR) is performed as one of treatment options for irreparable rotator cuff tears with shoulder pseudoparalysis to improve shoulder pain and function, but SCR provided inferior improvement of shoulder motion and muscle strength and decreased postoperative acromiohumeral distance when concomitant with an irreparable subscapularis tear. Therefore, it is difficult to treat irreparable rotator cuff tears including a subscapularis tear with SCR alone.

Pectoralis major transfer has been commonly performed to treat irreparable subscapularis tears. However, pectoralis major has a different anatomical force vector than subscapularis. Recently, pectoralis minor transfer was reported, because pectoralis minor has a similar force vector to subscapularis. This suggests that pectoralis minor transfer in addition to SCR would be a possible treatment option for irreparable antero-superior rotator cuff tear by restoring glenohumeral joint biomechanics.

A case of irreparable antero-superior rotator cuff tear treated with arthroscopic SCR (ASCR) combined with pectoralis minor transfer is described. The patient was informed that data concerning the case would be submitted for publication and provided consent.

Keywords: Superior capsular reconstruction, pectoralis minor transfer, irreparable rotator cuff tear, irreparable subscapularis tear

Case report

A 72-year-old woman had shoulder pain after falling on her hand and came to our hospital. An anteroposterior radiograph of her shoulder showed a shoulder dislocation, and
closed reduction of her shoulder was performed immediately. Her shoulder was then
immobilized with an abduction pillow for 3 weeks. After removal of the abduction pillow, the
shoulder pain and restricted range of motion (ROM) continued without improvement. She was
received physical therapy and administrated a pain killer for three months after removal of the
abduction pillow because of continuing pain and dysfunction. Although, her shoulder pain and
function was not recovered. Physical findings after physical therapy for three months showed a
clearly restricted active ROM with flexion of 60 degrees, abduction of 60 degrees, external
rotation of 30 degrees, and internal rotation to the level of the buttock. The Constant score was 6
of 100 points, and the Disabilities of the Arm, Shoulder and Hand (DASH) score was 76 points.
Radiographs and computed tomography findings showed no degenerative changes in the
glenohumeral joint and mild superior translation of the humeral head (Figure 1). Magnetic
resonance imaging showed a rotator cuff tear including subscapularis, supraspinatus, and
infraspinatus (Figure 2A-C). According to the Goutallier classification, upper subscapularis,
supraspinatus, and infraspinatus were stage 3, 3, and 1, respectively (Figure 2D). Based on these
findings, an irreparable antero-superior rotator cuff tear was diagnosed.
The treatment options were discussed considering the condition of the rotator cuff tear.
The supraspinatus and subscapularis tears were considered irreparable based on severe fatty
infiltration, and active elevation was less than 90 degrees. Reverse shoulder arthroplasty (RSA)
was one of the treatment options, but the glenohumeral joint did not show severe osteoarthritic
change. Soft-tissue reconstruction is a suitable for our case having the irreparable rotator cuff
tear without osteoarthritic change, although our patient had the irreparable subscapularis tear.
Previous reports showed that the intactness or reparation of subscapularis was important for good
clinical outcomes of SCR.\textsuperscript{21,35} These suggest that the reconstruction of the subscapularis tendon
ASCR with pectoralis minor transfer could improve shoulder function even with SCR for an irreparable antero-superior rotator cuff tear. In the reconstruction of an irreparable subscapularis tear, we thought that pectoralis minor transfer was better than pectoralis major tendon transfer because the pectoralis minor has a similar muscle vector to subscapularis. It was therefore finally decided to perform ASCR combined with pectoralis minor transfer.

Shoulder arthroscopy was performed with the patient in the beach chair position under general anesthesia. A 30-degree arthroscope was used for visualization. Standard diagnostic arthroscopy was used to evaluate intra-articular structures and the rotator cuff. Supraspinatus and infraspinatus were torn extensively, with anteroposterior diameter of 20 mm and mediolateral diameter of 25 mm (Figure 3A). Furthermore, the subscapularis was also torn completely and could not be repaired directly (Figure 3B), and the long head of biceps tendon was dislocated to the medial side of the bicipital groove (Figure 3C). Tenodesis of the long head of biceps tendon at the bicipital groove (HEALICOIL RG 4.75 with ULTRABRAID; Smith and Nephew plc., London, UK) was performed (Figure 4A). Fascia lata (size 90 x 25 mm²) was harvested from the lateral aspect of the contralateral thigh distal to the greater trochanter. A graft (length 40 mm, width 20 mm, and thickness 8 mm) was fashioned by folding the fascia lata twice. Arthroscopic infraspinatus repair with single-row technique was performed using one suture anchor (CorkScrew FT 4.5 mm; Arthrex Inc., Naples, FL, USA) (Figure 4B). Then, ASCR was performed. Two suture anchors (ICONIX 2.3 mm; Stryker Co., Kalamazoo, MI, USA) were inserted into the superior glenoid. Two suture anchors (HEALICOIL RG 4.75 with ULTRATAPE; Smith and Nephew plc.) were inserted into the medial side of the greater tuberosity. After threads were passed through the graft, the graft was inserted into the greater tuberosity along the articular margin. The medial side of the graft was fixed by mattress suture,
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and then the lateral side of the graft was fixed using a suture bridging technique with two anchors (Swivelock C, Closed Eyelet 4.75 mm; Arthrex Inc.) inserted into the lateral aspect of the greater tuberosity (Figure 4C). Finally, two side-to-side sutures with No.2 FiberWire were added between the graft and the infraspinatus tendon. Then, a 5-cm skin incision was made over the coracoid process, and the coracoid process was exposed from the deltopectoral interval.

Pectoralis minor was detached from the medial base of the coracoid, and two No. 2 polyester suture (Ethibond; Ethicon, Somerville, NJ, USA) were passed around the edge of pectoralis minor. After harvesting pectoralis minor, this tendon was passed beneath the conjoint tendon to the lesser tuberosity and fixed with suture-bridge technique using 2 medial anchors (HEALICOIL RG 4.75 with ULTRATAPE; Smith and Nephew plc.) and two lateral anchors (Swivelock C, Closed Eyelet 4.75 mm; Arthrex Inc.)(Figure 4D). An abduction pillow sling was applied for six weeks postoperatively. Passive range of motion exercise was started 4 weeks postoperatively. Active ROM exercise was started 6 weeks postoperatively.

At the latest follow-up, 16 months after surgery, she had no pain in her right shoulder. Active ROM improved, with flexion of 170 degrees, abduction of 170 degrees, external rotation of 60 degrees, and internal rotation to T12. The Constant score improved to 94 points, and the DASH score improved to 8 points. Radiographs showed no progression of degenerative change in the glenohumeral joint. MRI showed healing of the graft on the greater tuberosity and pectoralis minor tendon on the lesser tuberosity (Figure 5).

Discussion

Numerous options for surgical treatment of irreparable massive rotator cuff tears have been described, including débridement with subacromial decompression, partial rotator cuff
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repair, tendon transfer, biceps tendon interposition, RSA, and SCR. RSA was designed to improve the outcome of shoulder replacement in the setting of rotator cuff insufficiency. Although cuff tear arthropathy was the main condition managed with RSA initially, indications for this procedure expanded to other disorders including irreparable rotator cuff tear without arthropathy. On the other hand, ASCR is performed as one of treatment options for irreparable rotator cuff tears for soft tissue reconstruction. Mihata et al reported that SCR theoretically restored superior stability of the glenohumeral joint by balancing the coronal force.

RSA remains controversial for the treatment of irreparable rotator cuff tears without glenohumeral osteoarthritis. Mulieri et al showed that RSA can reduce pain and improve function for irreparable rotator cuff tears without osteoarthritis. On the other hand, Boileau et al suggested that RSA provided significant improvement of anterior active elevation for patients who had preoperative elevation <90 degrees, but anterior active elevation decreased from 146 degrees to 122 degrees in patients who had preoperative elevation >90 degrees. In addition, RSA has some limitations and complications, such as dislocation, scapular notching, and postoperative fractures of the scapular spine or acromion. Therefore, soft tissue reconstruction such as SCR might be effective for the treatment of irreparable rotator cuff tears without glenohumeral osteoarthritis.

SCR for cases with irreparable rotator cuff tears including subscapularis tear showed poor clinical outcomes. Mihata et al showed that postoperative shoulder ROM, abduction muscle strength, and acromiohumeral distance of patients having irreparable subscapularis tears did not improve significantly. Takayama et al reported that the reparability or intactness of the subscapularis is an important factor that affected clinical outcomes after SCR, especially in
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pseudoparalysis patients. A biomechanical advantage of SCR is reconstruction of the force couple by improving the muscle force of the infraspinatus and teres minor if the subscapularis is intact or reparable. However, irreparable subscapularis tears caused imbalance of the shoulder force couple, leading to inferior clinical outcomes. Therefore, the reconstruction of the subscapularis tendon combined with SCR may improve clinical outcomes due to the reconstruction of the shoulder force couple.

Some muscle tendinous transfers have been introduced as substitutes for subscapularis function. Pectoralis major transfer has been commonly performed for irreparable subscapularis tears. Pectoralis major transfer usually improves shoulder pain, however recovery of shoulder strength, active motion, and stabilization of anterosuperior migrated humeral heads recovered insufficiently. Pectoralis major originates anterior to the chest wall, and subscapularis runs behind the chest wall. Therefore, the force vector of the transferred pectoralis major does not coincide with that of the subscapularis completely. A transfer underneath the conjoined tendon better mimics glenohumeral kinematics that closer to those in the intact shoulder than a transfer above conjoined tendon. Although, other previous studies showed that the transfer above conjoined tendon provided good clinical results. Therefore, we surmise that the transfer underneath the conjoined tendon may be not necessarily better than that above the conjoined tendon and that loss of power transduction at the conjoined tendon pulley is inevitable.

Recently, pectoralis minor transfer has been reported to reconstruct the subscapularis tendon. Paladini et al reported the promising outcomes of pectoralis minor transfer for patients with irreparable subscapularis tears. They concluded that it was anatomically feasible to use the pectoralis minor as a graft to treat irreparable subscapularis tears, this technique was safe in
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terms of brachial plexus and musculocutaneous nerve injury, and the force vector exerted by this
procedure provided good shoulder function and pain relief. Yamakado et al reported
arthroscopic-assisted pectoralis minor transfer, and this technique can lead to significant
improvements in shoulder pain and function. This suggests that pectoralis minor transfer can be
combined with ASCR to compensate for the shortcomings, since clinical outcomes of ASCR for
irreparable antero-superior rotator cuff tears are good.

In the present case, the antero-superior rotator cuff tear required surgical treatment to
restore the shoulder force couple. ASCR combined with pectoralis minor transfer improved
shoulder pain and function, suggesting that the combination of SCR and pectoralis minor transfer
can balance the shoulder force couple. Furthermore, pectoralis minor can be harvested with a 5-
cm skin incision over the coracoid process and can be easily performed in addition to ASCR. We
were unable to find any surgical reports for a similar case with a search of the literature. This is
one of the first reported cases of ASCR combined with pectoralis minor transfer for irreparable
supraspinatus, infraspinatus, and subscapularis tears.

In conclusion, the current patient presented with an irreparable rotator cuff tear
including a subscapularis tear. She was treated with ASCR combined with pectoralis minor
tendon transfer and showed improved shoulder pain and upper limb function. This method was
useful to provide the balanced shoulder force couple for the treatment of an irreparable antero-
superior rotator cuff tear.

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immobile rotator cuff tears leads to satisfactory quality of living: results at 3-year follow-
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**Figure legends**

**Figure 1.** Preoperative radiographs and computed tomography findings. **A.** Anteroposterior radiograph. **B.** Scapula Y radiograph. **C.** Axial view of computed tomography. **D.** Coronal view of computed tomography. **E.** Sagittal of computed tomography.

**Figure 2.** Preoperative magnetic resonance imaging findings. **A.** Oblique coronal view. **B.** Oblique sagittal view. **C.** Axial view. **D.** Oblique sagittal view of the medial muscle of the rotator cuffs.

**Figure 3.** Arthroscopic findings. **A.** Supraspinatus and infraspinatus tears. **B.** Subscapularis tear (arrowhead). Asterisk; conjoint tendon. **C.** Dislocation of the long head of biceps tendon (arrowhead). Asterisk; bicipital groove.

**Figure 4.** Arthroscopic findings and a photograph after the operation. **A.** Arthroscopic finding after long head of biceps tenodesis. **B.** Arthroscopic finding after repair of the infraspinatus tendon. **C.** Arthroscopic finding after ASCR of the supraspinatus tendon. **D.** Photograph after pectoralis minor tendon transfer.

**Figure 5.** Magnetic resonance imaging findings 1 year after the operation. **A.** Oblique coronal view **B.** Oblique sagittal view **C.** Axial view
Figure 1
A
B
C
D
E
Figure 4

A

B

C

D
Figure 5