Technical Note

Fully Arthroscopic Pectoralis Minor Tendon Transfer with Bone Fragment for Irreparable Subscapularis Tears

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Abstract: Several techniques to treat irreparable subscapularis (SSC) tendon tear have been described. We introduce a fully arthroscopic technique for pectoralis minor tendon with bone fragment transfer. This procedure starts with glenohumeral exploration and evaluation of the remaining SSC mobility. Then we detach and release the pectoralis minor (PMi) tendon with bone fragment from the coracoid, protecting the plexus structures. Next, the PMi tendon with bone fragment is fixed on the lesser tuberosity passing under the coracoid. This procedure is technically demanding and could be performed safely with low invasiveness and high reproducibility by understanding the regional anatomy and the well-described technique.

Treatment of irreparable subscapularis (SSC) tendon tears remains a challenging situation in young and active patients. Tendon transfer to deal with irreparable SSC tears have been introduced using pectoralis major (PMj), pectoralis minor (PMi), latissimus dorsi, and teres major in the literature.[1-4] With the development of arthroscopic techniques, arthroscopic assisted or fully arthroscopic procedures have been described.[5-8]

An arthroscopic assisted technique of PMi transfer with bone chip was described by Yamakado.[7] We have experience performing arthroscopic coracoid transfer for anterior shoulder instability and open PMj tendon transfer. Depending on these experiences, we describe a fully arthroscopic PMi tendon transfer with bone fragment for irreparable tears of SSC tendon. The purpose of this article is to describe our fully arthroscopic procedure to address irreparable tears of SSC tendon using PMi tendon with bone fragment.

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Surgical Technique

The patient is placed in the beach chair position under general anesthesia with an interscalene regional block. The portals used in this procedure are shown in Figure 1: (A) standard posterior portal; (B) lateral portal; (C) anterolateral portal just 2 cm anterior and lateral to the anterior-lateral corner of acromion and used for preparation for coracoid and visualization of SSC; (D) anterior portal used for anchor placement; (E) inferior-lateral portal located in the axillary fold and 2 to finger-widths distal to the coracoid tip and used for visualization during PMi release and harvesting of bone fragment; (F) inferior and medial portal located 3 finger-widths medial to the inferior-lateral portal through the pectoralis major muscle and used for PMi release; (G) proximal portal above the coracoid process and used for harvesting bony fragment of PMi. The operative technique is shown in Video 1. Pearls and pitfalls of the procedure are listed in Table 1.

Step 1. Arthroscopic Evaluation and Treatment of Concomitant Shoulder Pathologies

Pathologies of the labrum, cartilage, long head of the biceps, and rotator cuff tear were evaluated through general arthroscopic examination. The retracted tendons of the torn rotator cuff are debrided and mobilized. After confirmation of the irreparability of the SSC

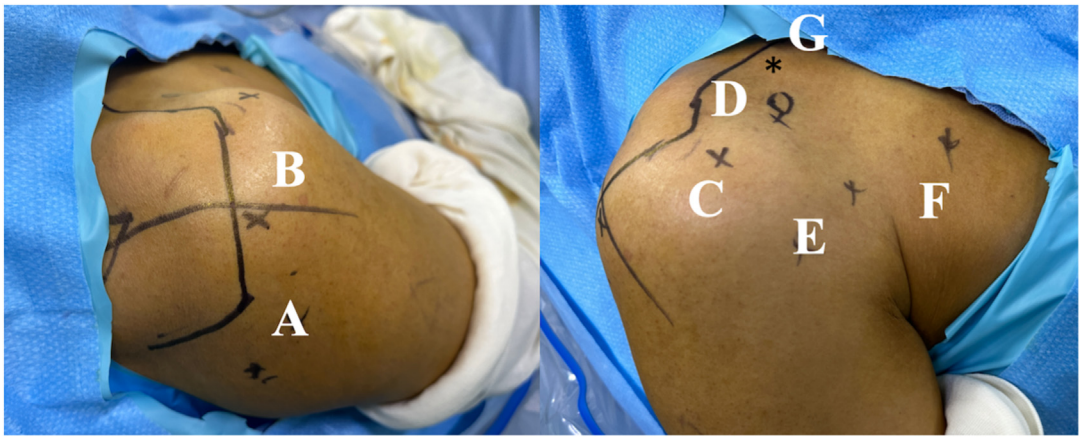

Fig 1. Arthroscopic portals. (A) Standard posterior portal. (B) Lateral portal. (C) Anterolateral portal, just 2 cm anterior and lateral to the anterior-lateral corner of acromion. (D) Anterior portal, used for anchor placement. (E) Inferior-lateral portal, located in the axillary fold and 2 or 3 finger-widths distal to the coracoid tip. (F) Inferior and medial portal, located 3 finger-widths medial to the inferior-lateral portal through the pectoralis major muscle. (G) proximal portal, above the coracoid process.

tendon, the PMi tendon transfer was indicated, and the lateral border of conjoin tendon was exposed down to the upper border of the PMj tendon (Fig 2A).

Step 2. Arthroscopic Visualization and Release of the PMi

The arthroscope was placed in portal E, and electrocautery (Arthrocare; Smith & Nephew, London, UK) was placed in portal F, which allowed a better view of the coracoid and easy release of the PMi. The coracoacromial ligament should be preserved. The coracoid process was exposed from its tip to the insertion of the coracoclavicular ligaments at the base of the coracoid, and the footprint of the PMi tendon on the medial side of the coracoid was visualized. Electrocautery was used to carefully expose the upper border and lower border of PMi tendon and muscle (Fig 2B). The connection between the PMi and conjoint tendon should be totally released. Medial release of the PMi was performed to the branches of lateral thoracic nerve between the PMi and PMj muscle (Fig 2C).

Step 3. Arthroscopic Harvesting of the PMi Tendon With Bone Fragment

Portal G was created for release of the PMi tendon with bone fragment using a needle, usually 2 cm at the medial superior part of the tip of coracoid, making sure that the needle was oriented to the medial and perpendicular to the coracoid (Fig 2D). The electric saw was used to perform osteotomy on the cortex 3 to 4 mm lateral to the medial margin on the coracoid process where the PMi was inserted (Fig 2E). The medial insertion of the conjoint tendon sometimes could be released to complete the osteotomy. After the PMi tendon was released with a small bone fragment, 2 polydioxanone suture II (PDSII) sutures were passed around the tendon-bone junction as traction sutures to pass the PMi under the coracoid (Fig 2F). The posterior of the PMi was released, and care should be taken to avoid to injury the plexus (Fig 2G).

Step 4. Arthroscopic Fixation of the PMi Tendon With Bone Fragment

The lesser tuberosity was debrided to make a bleeding bone bed to optimize healing potential. Typically, 2 suture anchor sites were drilled, and the suture anchors (4.5 mm Healix; Depuy Synthes, Johnson & Johnson, New Brunswick, NJ, USA) were inserted at the medial border of bone bed on a lesser tuberosity through portal D. By pulling the traction sutures, the PMi with bone fragment could be passed under the coracoid and reach the lesser tuberosity. Horizontal mattress sutures through the inferior and superior aspects of the bone-tendon junction (Fig 2H) were performed, and 2 areas just lateral to bone bed were used to create a superior and inferior footprint for lateral row fixation (4.5 mm Footprint; Smith & Nephew) (Fig 2I). Figure 2J shows the PMi tendon behind the conjoint tendon after fixation.

Postoperative Rehabilitation

Patients were immobilized with an abduction pillow for 6 weeks. Passive shoulder range-of-motion exercise was started on the third day after surgery. Strict limitations were placed on passive external rotation (<45°) and abduction (<90°), and no active internal rotation was permitted for at least 6 weeks. Strengthening exercises were started at 12 weeks after surgery.

Discussion

The PMj tendon transfer is the most frequently used for irreparable tears of the SSC tendon among several operative techniques.[9,10] Wirth and Rockwood[3] first

Table 1. Pearls and Pitfalls of Fully Arthroscopic PMi Transfer With Bone Fragment

Pearls
Expose coracoid tip and preserve the coracoacromial ligament, open the space behind and under the coracoid
Separate the connection between the PMi and conjoint tendon. Fully expose the upper and lower border of the PMi tendon and muscle
Carefully perform the osteotomy of the coracoid with 3 to 4 mm bone fragment using the chisel or saw instruments
Medial release of the PMi to the branches of lateral thoracic nerve between the PMi and PMj muscles
Posterior release of the PMi tendon and muscle
Pitfalls
Bleeding of soft tissue under the coracoid
Damage musculocutaneous nerve and plexus structures
Possible coracoid fracture if harvesting big bone fragments
Neurovascular injury behind the coracoid process
Injury of branches of the lateral thoracic nerve
Inadequate release may cause overtension when the PMi tendon is transferred under the coracoid
Damage to the plexus behind the PMi

used the PMi tendon as a graft to treat irreparable SSC tears.

It was shown that it was anatomically feasible to use the PMi tendon as a graft; the procedure was safe in terms of brachial plexus and musculocutaneous nerve injury; and PMi transfer could improve shoulder function and provide pain relief in patients.[11] The PMi tendon was frequently released during the arthroscopic coracoid transfer procedure during the anterior instability operation; complications related to release were not reported.[12-14] Another advantage is that the line of pull of the PMi was more similar to that of the SSC compared with the PMj.[15]

Different techniques for PMi tendon transfer have been reported, including open surgery and arthroscopy-assisted techniques.[7,16] Yamakado[7] described an arthroscopy-assisted technique that preserved a flake of bone at the tendon insertion on the coracoid to allow bone-to-bone healing. In the present study, we describe our preferred fully arthroscopic technique to transfer the PMi tendon with bone fragment for the treatment of irreparable SSC tears. Arthroscopic techniques have the advantage of allowing for less-invasive surgery compared with open techniques, with a lower risk of damage to the deltoid and less donor site muscle morbidity and infection.

It is well known that tendon transfers for irreparable rotator cuff tears are technically demanding procedures that need advanced arthroscopic skills with expert knowledge of the anatomy. Potential injuries to the important anatomic structures such as the musculocutaneous and axillary nerves or vascular structures exist during all phases of surgery. This procedure is technically demanding and could be performed safely with low invasiveness and high reproducibility by

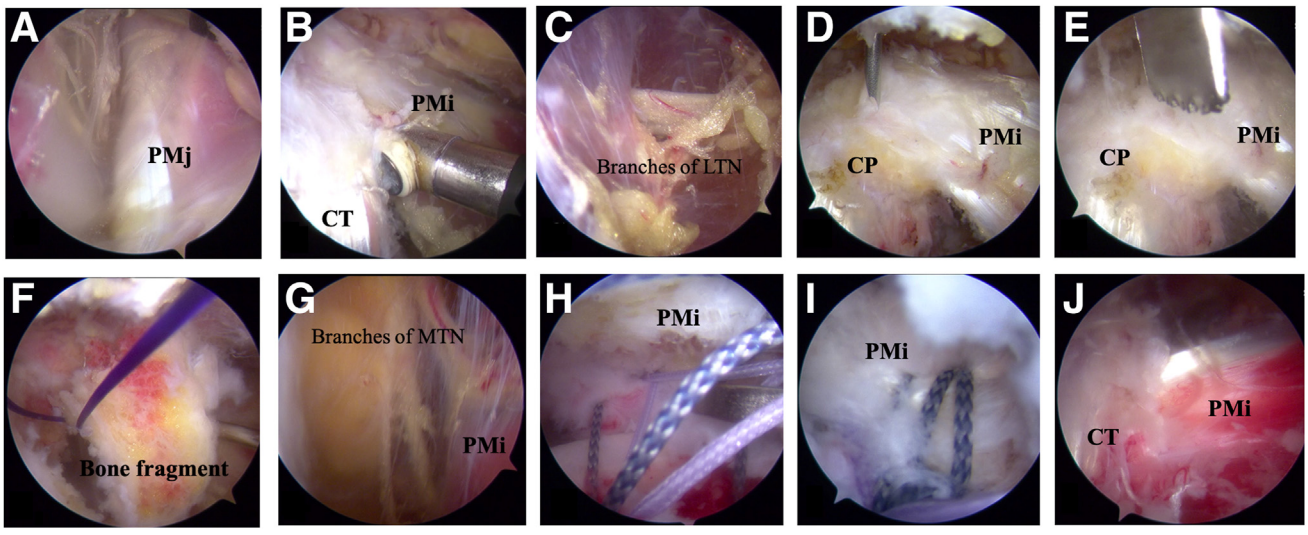

Fig 2. Arthroscopic procedure. (A) The lateral border of conjoin tendon was exposed down to the upper border of the PMj tendon. (B) The upper and lower borders of the PMi tendon and muscle were released. (C) Medial release of the PMi was performed to the branches of the lateral thoracic nerve between the PMi and PMj muscles. (D) The needle was used to created G portal. (E) The electric saw was used to perform osteotomy on the cortex 3 to 4 mm lateral to the medial margin on the coracoid process where the PMi was inserted. (F) PDSII sutures were passed around the tendon-bone junction as traction sutures to pass the PMi under the coracoid. (G) The posterior of the PMi was released, and care should be taken to avoid to injury the plexus and nerve branches of medial thoracic nerve. (H) Horizontal mattress sutures through the inferior and superior aspects of the bone-tendon junction. (I) Lateral row fixation. (J) PMi tendon behind the conjoint tendon after fixation was shown. CT, conjoint tendon; LTN, lateral thoracic nerve; CP, coracoid process; MTN, medial thoracic nerve.

understanding the regional anatomy and the well-described technique.

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