Technical Note

Cable Graft: Simple Superior Capsule Reconstruction Technique for Irreparable Rotator Cuff Tear Using a Teflon Patch

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Abstract: We describe a simple superior capsule reconstruction technique for irreparable rotator cuff tear using a Teflon patch. In this technique, a triple-folded Teflon patch, suture tape, and a strong suture penetrating through the graft are fixed to the glenoid and greater tuberosity using a suture anchor. This allows for reconstruction of the superior capsule while simultaneously playing a role as a spacer. This procedure’s greatest advantage is its simplicity; it is easy to perform, has a short operative time, and avoids the need to collect autologous tissue. More time is saved, as suturing and tying are not required. We believe our study could aid orthopaedic surgeons in clinical decision-making when encountering irreparable rotator cuff repairs.

Introduction (With Video Illustration)

The treatment for irreparable rotator cuff tear without osteoarthritis is controversial. Different surgical modalities such as subacromial decompression, partial rotator cuff repair, tendon transfer, and shoulder replacement with reverse prosthesis are available to treat patients with rotator cuff tear. The concept of superior capsule reconstruction with autologous fascia (fascia lata) has been introduced and shown superior results.1-5 The use of a subacromial balloon spacer recently has been reported6,7 but is not widely practiced by surgeons. We describe a simple superior capsule reconstruction technique for irreparable rotator cuff tear using a Teflon felt patch (Video 1, Table 1).

Preoperative Preparation

Preoperatively, we prepare various patch sizes to minimize the intraoperative time. The patch is prepared from Teflon (2.9 mm thick; C. R. Bard, Inc., Murray Hill, NJ) by tri-folding (approximately 9 mm) and suturing the layers with 5-mm intervals. Five stitches passing through all layers are made per side, except on the side of the crease (Fig 1). Patches are prepared to 35 mm, 40 mm, or 45 mm in length by 30 mm or 35 mm width for surgery.

Surgical Technique

The surgical procedure is shown in Video 1 and Table 1. Pearls and pitfalls are shown in Table 2. The procedure is performed with the patient in a lateral decubitus position with the shoulder at 45° abduction using 4-kg arm traction. Four portals are used (posterior, anterior, posterolateral, and anterolateral). After diagnostic arthroscopy, the long head of the biceps tendon is conserved if noted to be normal; however, if it is torn or absent, debridement of the stump is performed. Dislocated or partially torn tendons are resected. Subacromial decompression (Fig 2A) and debridement for the scapular neck (Fig 2B) are performed followed by stump debridement for the supraspinatus tendon. The subscapularis tendon and infraspinatus muscle, if reparable, are repaired with a double row or single row to the lesser tubercle and greater tubercle, respectively. Patch size is determined based on the distance between the glenoid fossa and greater tuberosity and the anteroposterior diameter of the rotator cuff defect site, both of which are measured intraoperatively in each case (Fig 3A). Two anchors (SwiveLock C 5.5 mm; Arthrex, Naples, FL) are inserted.
at the superior rim of the glenoid (Fig 3B). The posterior anchor is inserted from the posterior portal (Fig 3C) to the 11-o’clock (1 o’clock in left shoulder) position. The anterior anchor is inserted from the anterior portal (Fig 3D) to the 1-o’clock (11 o’clock in left shoulder) position in the right shoulder. One suture used for the anchor is of the strong suture type (FiberWire No. 2; Arthrex Inc.), whereas the other is suture tape (ULTRATAPE; Smith & Nephew, Andover, MA). The anterolateral portal is extended to 2 cm with a 15-mm-diameter cannula (Thoracoport; Medtronic Co., Minneapolis, MN) (Fig 4A). The sutures and tapes are passed through the Teflon patch on the outside of the body (Fig 4B and C). Then, the Teflon patch is gripped with forceps (Fig 4D) and inserted at the anterolateral portal. The Teflon patch is advanced inward until it comes in contact with the glenoid fossa (Fig 4E and F). A 10-mm diameter cannula is inserted into the Thoracoport to prevent excessive drainage leading to an insufficient visual field and to prevent thread tangling (Fig 5A). Sutures and tapes are fixed to the greater tuberosity with a suture-bridge technique. Because tying is not performed at either the glenoid or greater tuberosity sides, the patch is not fixed to bone directly by suturing. This procedure is shown in Figure 6.

**Postoperative Rehabilitation**

Immediately after surgery, the shoulder is immobilized using a shoulder abduction brace (Global Sling; Table 1. Cable Graft Technique for Irreparable Rotator Cuff Tear (12 Steps)

| Surgical Step | Description |
|---------------|-------------|
| 1.            | We perform diagnostic intra-articular arthroscopy from the posterior portal and assess the biceps. If the biceps is normal, it is conserved; if it is dislocated or partially torn, it is resected; if it is torn or absent, debridement for stump is completed. |
| 2.            | Subacromial arthroscopy from posterolateral portal; acromioplasty, debridement for supraspinatus tendon and superior area of the scapular neck. |
| 3.            | Insertion of 2 suture anchors with a high-strength suture and a suture tape at the scapular neck is completed. Posterior anchor is inserted from the posterior portal and anterior one from the anterior portal. |
| 4.            | We repair the infraspinatus and subscapularis tendon, if repairable with single or double row, to the greater or lesser tuberosity. |
| 5.            | We measure the size of a defect of rotator cuff and select a Teflon patch of appropriate size. |
| 6.            | We extend the anterolateral portal to 2 cm and insert the 15-mm-diameter cannula. |
| 7.            | We retrieve the sutures and tapes at the cannula. |
| 8.            | We pass through the Teflon patch of sutures and tapes between the layers at the outside of the body. |
| 9.            | We insert the patch through the cannula, tensioning the sutures and tapes, and advancing the patch to the glenoid. |
| 10.           | We insert the 10-mm cannula into the 15-mm cannula (cannula in cannula). |
| 11.           | We retrieve the sutures and tapes from the anterior anchor, fixing to the greater tuberosity with suture-bridge technique. |
| 12.           | We repeat step 11 for sutures from the posterior anchor. |

Fig 1. Picture and schematic of the Teflon patch penetrated by the first sutures. (A) The Teflon is tri-folded and 5 stitches passing through all layers are made per side, except on the side of the crease. (B) Sutures penetrate between the stitches, which have been prepared on the patch, and the upper layer (layer nearer the acromion). Finally, 4 sutures penetrate between the 5 stitches.
Cosmos, Japan). On postoperative day 1, patients begin passive flexion movement in a supine position by physiotherapists. On postoperative day 7, they begin passive external rotation movement. Active elevation exercise training is performed 3 weeks after surgery, and the abduction pillow is removed. One month after surgery, the brace is completely removed, allowing shoulder movement and activities of daily living. Activities involving light work are allowed 2 months after the operation.

Table 2. Pearls and Pitfalls

| Surgical Step | Pearls | Pitfalls |
|---------------|--------|----------|
| 2. Acromioplasty and debridement | We fully remove the subacromial osteophytes, to prevent the graft from abrasion and tearing, and remove the soft tissue near the scapula neck to ensure a visual field for graft insertion. | If the visual field is insufficient, confirmation of thread slack and graft insertion position will be insufficient, which can lead to incorrect position and insufficient fixation. |
| 3. Anchor insertion at the scapular neck | Since the bones of the scapula neck are often hard, we increase the diameter of the bone hole created by the anchorawl if necessary. | Insufficient bone hole preparation may cause difficulty in anchor insertion or breakage of the anchor. |
| 4. Repair of infraspinatus and subscapularis | We believe it is important to make the rotator cuff defect as small as possible by repairing the subscapularis and infraspinatus muscles. We fully remove the adhesions around the rotator cuff and repair that as much as possible. | There is a limit to the size of the patch that can be inserted, so if the defect is too large, the covering may be insufficient. |
| 5. Measurement of the defect of rotator cuff and determination the graft size | We determine the size of the graft by the measured distance from the anchor inserted into the scapular neck to the outer edge of the greater tuberosity. If it seems to be difficult to secure the visual field, we determine the fixation site at this time and prepare the bone hole. | If the size of the graft is too large, it will cause the graft to turn over, and if it is too small, the covering of the humeral head will be insufficient. |
| 9. Patch insertion | Because the graft size is often just the inner diameter of cannula, we insert the graft, which is tightly rolled. After insertion, the graft is need to be reshaped carefully. | Patches retain their shape and are not easily reshaped. |
| 10. Cannula in cannula | A cannula is used to prevent excessive drainage when using 15-mm diameter cannula and to prevent thread tangling. | If drainage increases and the field of view becomes insufficient, it may lead to poor graft fixation and malposition. |
| 11. Suture fixation to the greater tuberosity | If the bone of the greater tuberosity is weak, we increase the anchor diameter. Referring to the bone hole created in step 5, we check the graft tension and fix the anchor. | Insufficient field of view leads to incorrect anchor positions. |

Fig 2. Posterolateral subacromial view of right shoulder. (A) Subacromial osteophytes are fully removed to prevent the graft from abrasion and tearing. The arrow shows the acromion from which osteophytes have been fully removed. (B) Soft tissue near the scapula neck is fully removed to ensure a visual field for graft insertion.
Fig 3. Posterolateral subacromial view of the right shoulder (A-B) and overall view from the cranial side of the right shoulder (C-D) lying in the left lateral decubitus position. (A) The size of the graft is determined by the measured distance from the anchor inserted into the scapular neck to the outer edge of the greater tuberosity. (B) Two anchors are inserted at the 11-o’clock and 1-o’clock positions, fixed with one suture tape and one strong suture each. (C-D) A posterior anchor is inserted at the posterior portal (C) and an anterior anchor is inserted at the anterior portal (D).

Fig 4. Overall view from the cranial side of the right shoulder and Teflon patch (A-D), and the posterolateral subacromial view of the right shoulder (E and F). (A) The portal is extended to 2 cm with a 15-mm diameter cannula. (B) Sutures are penetrated using a suture passer. The suture passer is inserted in the upper layer, that is the layer nearer the acromion. (C) All sutures (4 suture tapes and 4 strong sutures) from the anterolateral portal are penetrated inside the graft. One suture tape and one strong suture are paired and passed through one place. (D) The Teflon patch is grabbed with forceps and prepared for insertion. (E) The graft is twisted and sutures have slack just after insertion of the graft. (F) The graft is advanced until it reaches the glenoid fossa while pulling on the sutures to prevent the slack of the sutures. The position is adjusted so that the graft is stable. The graft is positioned between the rotator cuff and bone.
Discussion

In treating irreparable rotator cuff tears, preventing the upward migration of and stabilizing the rotational center of humeral head are necessary to allow for optimal outcomes in active shoulder elevation postoperatively. This is achieved by replacing the glenoid with a spherical structure in the reverse shoulder prosthesis, and, in superior capsule reconstruction with autologous fascia, fixing the scapula and humeral head at an appropriate tension using an elastic femoral fascia patch. The balloon spacer aims to occupy the subacromial space without gaps.

In our technique, the scapula and humeral head are secured by sutures and a Teflon patch. This allows for functional reconstruction of the superior capsule, as can be seen from the arthroscopy observation wherein the graft suppresses the upward migration of the humeral head when it is pushed up after fixation of the graft. On radiography, upward migration of the humeral head is improved immediately after surgery (Fig 7).

Conversely, since the suture and the Teflon patch have low elasticity, the tension must be minimized to ensure shoulder adduction movement. The superior translation force at the shoulder abduction seems to vary depending on individual differences (e.g., the person’s physique, muscular strength, balance, etc.) and is unknown; therefore, there is a possibility that the tension and suppression of humeral head upward migration is insufficient. However, the Teflon patch has a thickness of about 9 mm and can occupy the subacromial space with virtually no gap. In this case, the graft can be expected to play a role as a spacer. The fundamental concept of our technique is a combination of superior capsule reconstruction and employment of a subacromial spacer. Advantages and limitations are shown in Table 3.

The patch is held by penetrating threads; thus, there is no concern of dislodgment forward or backward movement, and we have adopted a method that does not fix the patch and bone directly by suturing. The greatest advantage of this procedure is the simplification of the surgery. The operative time is reduced, as there is no need to collect autologous tissue because artificial materials are used. In addition, no suturing and tying in the vicinity of the suture anchor insertion site where the visual field is limited is necessary.

Although anchor failure and suture tears may lead to patch instability and poor results, this method avoids overstretching at the suture site because suturing is not performed and thus helps prevent suture tears caused by subacromial impingement, as the suture is not exposed to the subacromial space. Since the
patch material can be confirmed by radiography, it is easy to assess the patch condition by radiography after surgery.

A limitation of this surgery is related to the material used. The Teflon patch is not bioabsorbable or replaceable and cannot be biologically fused to bone or replaced with physiological tissue. Foreign body reactions occur at a constant rate; thus, careful observation is required after surgery. Further research is needed to develop a more biocompatible material.

Another limitation is that biomechanical testing for durability is necessary. Durability in this procedure may depend on anchor and bone fixation, and thread durability. However, even if one fixation site fails, the volume fraction of the patches in the subacromial space is so large that it seems unlikely that significant instability will occur. In that case, we believe that the patch should play a role as a spacer, as mentioned previously. The last limitation is that the risk of infection may be greater than in an autologous tissue.

**References**

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