Technical Note

All Knot-less Arthroscopic Superior Capsular Reconstruction

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Abstract: Irreparable rotator cuff tears are a complicated problem, and current treatment options include nonoperative rehabilitation, debridement with or without a biceps tenotomy, tuberoplasty, partial rotator cuff repair, patch augmentation, biodegradable spacers, tendon transfer, and reverse shoulder arthroplasty. Arthroscopic superior capsular reconstruction is a more recent technique that is gaining popularity for use in irreparable rotator cuff tears. However, this surgery can be technically complicated. The purpose of this technique is to increase reproducibility and simplify a complicated procedure by addressing the current challenges of previous techniques.

Injury to the rotator cuff can result in massive and irreparable tears. Current treatment options include nonoperative rehabilitation, debridement with or without a biceps tenotomy, tuberoplasty, partial rotator cuff repair, patch augmentation, biodegradable spacer, tendon transfer, and reverse shoulder arthroplasty.1

A more recent technique, arthroscopic superior capsular reconstruction (ASCR), was first developed by Mihata et al. and showed promising and favorable short-term clinical outcomes.2,3 In addition, there have been multiple studies showing the importance of the superior capsule in maintaining passive stability and preventing translation of the glenohumeral joint.4,5

Despite the success of ASCR, it remains technically challenging, time consuming, and difficult to reproduce. A challenge in this procedure is suture placement and graft management after insertion into the joint space. This particular technique attempts to minimize this problem by doing the majority of the graft and suture preparation on the back table and then completing this procedure with a completely knotless repair while maximizing security and compression of the graft (Table 1, Video 1). The aim of the technique is to simplify, making a difficult procedure more reproducible and efficient.

Technique

Surgical Indications

General indications for ASCR include irreparable supraspinatus and/or infraspinatus tears confirmed by magnetic resonance imaging, conservative management failure, and intolerable shoulder pain. Surgery should be avoided in cases with moderate to severe arthropathy, significant bone defects, and dysfunction of deltoid, pectoralis, or latissimus dorsi.

Patient Positioning and Anesthesia

The procedure is performed with the patient under general anesthesia and positioned in the lateral decubitus position. All bony prominences should be well padded, including a pillow for the peroneal nerve at the knees and an axillary roll. A physical examination should be performed to demonstrate any instability with anterior superior, anterior middle, or anterior inferior zone load and shift as well as posteriorly.

Diagnostic Arthroscopy

Establish a midposterior glenoid portal, followed by an anterior rotator interval portal. Perform a diagnostic arthroscopy of the glenohumeral joint to examine the extent of the damage, and debride any...
labral fraying, arthritic changes, and chondromalacia. It may be necessary to repair some of the rotator cuff including the subscapularis and infraspinatus. Abrade the superior neck of the glenoid and the greater tuberosity. The greater tuberosity should also be microfractured to maximize healing of the graft to bone.

Surgical Technique

Create holes for the 2.9-mm footprint knotless glenoid anchors through percutaneous stab wounds. Place an anterior hole through an anterior clavicle approach into the superior glenoid and another posterior to the acromion. Do not place anchors; instead, leave spinal needles in anchor holes to help later identify anchor placement after graft insertion into the joint space. Punch holes for the medial and lateral row of the transosseous equivalent double-row portion of the superior capsular reconstruction on the medial footprint. Measure the distances between drilled anchor holes using a knotted suture.

Prepare the Allograft LifeNet patch (LifeNet Health, Virginia Beach, VA) on the back table. Stretch and restretch the graft using 4 corner clamps, and then cut to the appropriate length using the measurements (in millimeters) provided by the knotted suture. Create the medial border by measuring the distance from the anterior medial (AM) anchor hole to the posterior medial (PM) anchor hole and adding 5 mm to both sides of the holes (PM + AM + 5 + 5 = medial border). Create the lateral border by measuring the distance from the anterior lateral (AL) anchor hole to the posterior lateral (PL) anchor hole and adding 5 mm to both sides of the holes (PL + AL + 5 + 5 = lateral border). Create the anterior border by measuring the distance from the AM anchor hole to the AL anchor hole and adding 5 mm for the medial border and 12 mm for the lateral border (AM + AL + 12 + 5 = anterior border). Create the posterior border by measuring the distance from the PM anchor hole to the PL anchor hole and adding 5 mm for the medial border and 12 mm for the lateral border (PM + PL + 12 + 5 = posterior border) (Fig 1).

Next, pass No. 2 UltraBraid (Smith & Nephew, Andover, MA) on the medial border of the graft in an inverted fashion at the AM and PM locations. Pass inverted UltraTape sutures (Smith & Nephew) at the AL and PL locations. Pass an additional UltraTape under each inverted UltraTape on the bursal side of the graft at the AL and PL locations. Two limbs of UltraTape...
should exit inferiorly and 2 superiorly from the graft at these locations (Figs 2 and 3). Place a simple stitch midway on the graft both anteriorly and posteriorly with No. 2 UltraBraid to pass side-to-side sutures later to the native cuff adjacent to the graft. Place luggage tag No. 2 UltraBraid sutures in the anterolateral and posterolateral corners. When passing sutures, be sure to leave 5-mm borders from the edge of the graft. This is done to help ensure the sutures do not pull through the sides of the graft (Fig 4).

Fig 3. Suture placement in the graft used for superior capsular reconstruction in the right shoulder. The figure (viewing from superior) shows the inverted No. 2 UltraBraid placed along the medial border (AM and PM) and the inverted UltraTape at the AL and PL locations. UltraTape (LS) is also looped under each inverted UltraTape on the bursal side of the graft at the AL and PL locations. The figure shows a limb from each LS UltraTape being combined with the UltraBraid luggage tag sutures located in the posterolateral corner (PLT). The other limb from each LS UltraTape will be combined with the UltraBraid luggage tag suture located in the anterolateral corner (ALT). The image (viewing from posterior and superior) also shows the No. 2 UltraBraid, which will be used for anterior and posterior side-to-side sutures (SSA and SSP). (AL, anterior lateral; ALT, anterior luggage tag; AM, anterior medial; LS, looped suture; PL, posterior lateral; PLT, posterior luggage tag; PM, posterior medial; SSA, side-to-side anterior; SSP, side-to-side posterior.)

Fig 4. Suture and graft orientation (viewing from superior) for superior capsular reconstruction in the right shoulder. The medial border (M) will be anchored to the superior glenoid. The anterior border (A) will be attached to the native cuff adjacent and anterior to the graft with side-to-side sutures. The posterior border (P) will be attached to the native cuff adjacent and posterior to the graft with side-to-side sutures. The lateral border (L) will be anchored to the humeral head via 2 anchor rows.
MultiFix S Ultra anchors. The result should be 4 MultiFix S anchors in the humeral head, 2 medially and 2 laterally with a completely knotless transosseous equivalent double-row suture capsular reconstruction. Finally, place the side-to-side sutures anteriorly and posteriorly for added tension and stability (Figs 6 and 7).6

Inspect the joint for anatomic reconstruction of the superior capsule from the articular side. Drain the shoulder and close the portals with 3-0 nylon interrupted sutures. Apply sterile dressings and take the patient to the recovery room in a pillow sling.

Postoperative Rehabilitation
An abduction sling should be used at all times for the first 4 weeks except when showering and under guidance of physical therapy. Passive range of motion as the patient tolerates is allowed at this time. At 4 weeks, discontinue sling immobilization and start gentle passive stretching. Begin active-assisted and active range of motion at 6 weeks and strengthening exercises at 8 weeks.

Discussion
ASCR is a relatively new technique that has gained popularity in treating irreparable rotator cuff tears. Although there have been improvements in previous techniques, the procedure remains technically challenging, time consuming, and difficult to reproduce.

A key challenge addressed in this procedure is suture placement and graft management after insertion into the joint space. This particular technique attempts to minimize this problem by doing the majority of the

Fig 5. Viewing medially from Neviaser portal, glenoid anchor placement and graft positioning for superior capsular reconstruction in the right shoulder. The bottom left image shows anchor placement into the superior glenoid posteriorly at the PM location using the inverted sutures in that location. The top right image shows the medial aspect of the graft with both knotless glenoid anchors secured at the PM and AM locations. (AM, anterior medial; PM, posterior medial.)
graft preparation and suture placement on the back table. Advantages and disadvantages of this technique are listed in Table 2, whereas pearls and pitfalls are listed in Table 3. The limitations of this technique include increased time preparing and measuring the graft on the back table, as precise planning is needed before pulling the graft into the subacromial space; fixing the graft from medial to lateral without being able to adjust the implants as they have been predetermined for their location; and difficulty visualizing the medial glenoid anchor insertion from standard portals in the subacromial space.

Ideally, the inverted sutures should streamline anchoring by decreasing graft twisting and material in the subacromial space while providing a low-profile construct. By doing more work outside the body and inverting sutures, this technique aims to simplify a difficult procedure and increase reproducibility as well as efficiency.

### Table 2. Advantages and Disadvantages of the Surgical Technique

| Advantages | Disadvantages |
|------------|---------------|
| Knotless technique avoids passing sutures through a thick graft once in the subacromial space. | Precise planning of all measurements must be complete before pulling the graft into the subacromial space. |
| Passing the graft from medial to lateral allows for a controlled introduction of the graft and avoids twisting or entanglement of sutures. | Must fixate the graft from medial to lateral without the ability to adjust the implants as they have been predetermined for their location. |
| A Neviser portal is an excellent way to pull the graft into the subacromial space and visualize the medial knotless anchors in the glenoid during insertion. | Visualizing the medial glenoid anchor insertion can be difficult from standard portals in the subacromial space. |

### Table 3. Pearls and Pitfalls of the Surgical Technique

| Pearls | Pitfalls |
|--------|---------|
| Spinal needles left in anchor hole to easily identify location. | Drilling holes and then placing anchors later may cause difficulty with angle of anchor insertion. |
| Accurate measurements of all landmarks and perimeter of graft results in a reproducible perfect fit in the defect. | Precise measurements of the implant locations and graft preparation on the back table are the most time-consuming portion of the procedure that cannot be avoided. |
| Anterior, lateral, posterior, and Neviser portals are necessary for the procedure. | Avoid attempting knotless fixation of the graft without first placing other sutures in alternative portals during suture management. |
References

1. Anley CM, Chan SK, Snow M. Arthroscopic treatment options for irreparable rotator cuff tears of the shoulder. *World J Orthop* 2014;5:557-565.

2. Mihata T, Lee TQ, Watanabe C, et al. Clinical results of arthroscopic superior capsule reconstruction for irreparable rotator cuff tears. *Arthroscopy* 2013;29:459-470.

3. Hirahara A, Andersen W, Panero A. Superior capsular reconstruction: Clinical outcomes after minimum 2-year follow-up. *Am J Orthop* 2017;46:266-278.

4. Ishihara Y, Mihata T, Tamboli M, et al. Role of the superior shoulder capsule in passive stability of the glenohumeral joint. *J Shoulder Elbow Surg* 2014;23:642-648.

5. Mihata T, McGarry MH, Pirolo JM, et al. Superior capsule reconstruction to restore superior stability in irreparable rotator cuff tears. *Am J Sports Med* 2012;40:2248-2255.

6. Mihata T, McGarry MH, Kahn T, Goldberg I, Neo M, Lee TQ. Biomechanical role of capsular continuity in superior capsule reconstruction for irreparable tears of the supraspinatus tendon. *Am J Sports Med* 2016;44:1423-1430.