Technique for Double Row Superior Capsule Reconstruction with Dermal Allograft

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Abstract: Superior capsular reconstruction (SCR) is increasingly being used as a procedure for addressing irreparable rotator cuff tears. The procedure was initially described for failed rotator cuff repairs where the retears are severely retracted and when grade 3-4 fatty infiltration and atrophy exist. The SCR procedure can also be considered for irreparable rotator cuff tears in patients that are either too young or too high demand to be appropriate candidates for arthroplasty. Early short and medium term follow up studies support SCR with favorable outcomes compared with other salvage procedures.

The biomechanical principle for superior capsular reconstruction (SCR) is based on restoring superior stability and recreating the downward force absent from the torn rotator cuff/superior capsule complex. When the dynamic superior stabilizers (supraspinatus) and static stabilizers (superior capsule) are insufficient, superior instability can result in proximal migration of the humeral head. This produces shoulder weakness and inappropriate shoulder kinematics resulting from undertensioning, inhibition, and inefficiency of the deltoid. The abnormal shoulder kinematics often leads to rotator cuff tear arthropathy from abnormal contact pressure and shearing forces across the gleno-humeral articulation. Reconstruction of the superior capsule restores the superior restraint of the humeral head, thereby restoring congruency and stability, resulting in improved deltoid working length and optimized function.

The technique for SCR is still evolving with multiple variations currently being used by shoulder surgeons internationally. In this paper, we present our current technique for SCR.

Surgical Technique

Setup
Preoperative positioning is surgeon’s preference, beach chair versus lateral. The senior authors both perform this procedure in the beach chair position. A standard diagnostic arthroscopy is performed. If, after extensive mobilization, the rotator cuff is determined to be irreparable, we then proceed with a superior capsule reconstruction (Fig 1, Video 1).

Portal Placement
The standard portals include anterior, posterior, lateral/50-yard line, anterolateral, posterolateral, and Neviaser (Fig 2). In addition to these standard portals, we often use percutaneous accessory portals through stab holes for suture management, anchor placement, and to aid with graft passage.

Debridement of Irreparable Rotator Cuff
Irreparable nonviable rotator cuff tissue is debrided and care is taken to maintain healthy infraspinatus and anterior rotator interval tissue for side-to-side repair of the remaining rotator cuff to the ArthroFLEX dermal graft (Arthrex, Naples, FL).

Glenoid Preparation
We debride the superior aspect of the glenoid and labrum from the 10 to 2 o’clock position approximately...
1 cm medial to the articular surface to prepare for anchor placement. Drill holes are placed for anchors at the 10, 12, and 2 o’clock positions on the glenoid approximately 5 mm medial to the articular surface, aiming medially to avoid penetration of the joint. Although the 12 o’clock anchor pilot hole is typically drilled thru the Neviaser portal, the 10 and 2 o’clock holes are usually placed through accessory portals. In the 12 o’clock drill hole, we place a 3.9-mm Knotless Corkscrew (Arthrex) to aid in later graft advancement (Fig 3).

**Greater Tuberosity Preparation**

With the drill holes placed in the glenoid, we then proceed to preparing the greater tuberosity (GT). The GT is debrided and the remaining cuff tissue removed, as is residual bursa. To mitigate against compromised visualization, care is taken not to violate the deltoid fascia. In addition to partial decortication with the shaver, microfracture of the GT footprint is performed with a PowerPick (Arthrex) to enhance tissue integration. Depending on anterior to posterior footprint, 2 versus 3 medial row SwiveLock (Arthrex) anchors loaded with FiberTape (Arthrex) are placed just lateral to the articular margin for the SpeedBridge versus Expanded SpeedBridge construct.

**Measurements for Graft Preparation**

Once glenoid drill holes have been created and the greater tuberosity medial row anchors have been placed, we measure the lengths of each of the 4 sides of...
the allograft construct. Additionally, the distance between each drill hole on the glenoid and each anchor in the GT is measured to perforate the dermal graft accordingly. Different techniques have been described to measure the aforementioned distances including flexible gauges versus suture technique (Figs 4 and 5).

Graft Preparation

With the measurements documented, the dermal graft is cut to size on the back table. Five to 8 mm is added to each dimension to prevent suture cutout (Fig 6). To control for creep and stretch relaxation, the graft is held in 4-corner traction when cutting to size.

We perforate the graft to facilitate passage of sutures with a sterile hole punch. One FiberSnare is placed in each of the 3 medial perforations. Typically, 2 perforations are made in the anterior and posterior aspect of the graft for side-to-side interval closure anteriorly and posteriorly with remaining rotator cuff at the end of the case. These perforations are marked with a surgical marker for easier identification in the subacromial space (Table 1).

Table 1. Pearls and Pitfalls of Superior Capsule Reconstruction with Arthrex ArthroFLEX Allograft

| Pearls | Pitfalls |
|--------|----------|
| - Gemini cannula serves as a visualization and working cannula, soft-tissue retractor |
| - A leather punch can be used to perforate the graft to facilitate suture passage |
| - We typically use 2 sutures for side-to-side repair both anteriorly and posteriorly |
| - We fold the graft (burrito-like) with a cuff grasper and push it into the cannula while simultaneously pulling the cinched FiberLinks to facilitate atraumatic insertion |
| - Leave a 2 to 3-mm rim of allograft outside your sutures so as not to tear through the graft with your sutures |
| - We run a FiberTape as a “rip-stop” around the periphery of the allograft to prevent tears (Fig 6) |
| - Care should be taken during graft insertion to avoid suture entanglement |
| - Be careful not to violate the subdeltoid fascia because the subacromial space may collapse on you later in the case |

Graft Advancement

The graft is protected from the skin and possible bacterial contamination with either a surgical towel or an occlusive dressing. The anterior and posterior medial cinched FiberSnare sutures and the central sutures from the 3.9-mm Knotless Corkscrew are then passed through the 12 mm × 3 cm PassPort (Arthrex) (located in the anterolateral portal) and then are retrieved out the anterior, posterior, and Neviaser portals, respectively (Fig 7). These sutures will be used to help

![Fig 5. Right shoulder, viewing from the lateral portal shows measurement for length of allograft medially.](image)

![Fig 6. Back table preparation of the Arthrex ArthroFLEX allograft.](image)

![Fig 7. Sutures in the anterior, posterior, and middle aspect of the graft are shuttled through the anterior, posterior, and Neviaser portals, respectively.](image)
advance and control the graft into the subacromial space. The graft is then introduced into the shoulder with advancement of the central Knotless Corkscrew suture and sequentially pulling the medial margin sutures while pushing the graft through the PassPort cannula with a cuff grasper (Fig 8). Once the graft has been inserted into the subacromial space, the glenoid fixation is undertaken.

**Glenoid Fixation**

The graft is first fixed at the 12 o’clock position with a knotless technique to the glenoid using the previously placed 3.9-mm Knotless Corkscrew anchor (Fig 9). The 2 peripheral medial cinched FiberSnare sutures are secured to the 10 and 2 o’clock positions with knotless 2.9-mm PushLock anchors (Arthrex) (Fig 10).

Cuff graspers, probes, and manipulation of the controlling sutures in the lateral portion of the graft can aid in visualization.

**Greater Tuberosity Fixation**

Once the graft is securely fixed to the glenoid, it is attached laterally. This starts with passage of the FiberTape (previously placed via 2 to 3 SwiveLock anchors into the GT) through the prepunched holes of the graft. This can be done with suture passing instruments or through prepassed shuttling sutures. The arm is held in approximately 30° of abduction when tensioning the graft while passing the lateral FiberTape sutures. Next, the 2 to 3 pairs of FiberTapes are crisscrossed and loaded onto 2 to 3 4.75-mm SwiveLock anchors laterally in a SpeedBridge or Expanded SpeedBridge format.
respectively. Working from anterior to posterior, the anchors are placed for the lateral row in the humerus. With the lateral row complete, we proceed with final tensioning of the middle glenoid anchor with the 3.9-mm Knotless Corkscrew anchor (Fig 11). This allows for confirmation that the graft placement provides adequate anterior coverage and desired depression of the humeral head.

Side-to-side Repair

Once the graft is fixed to both the glenoid and the greater tuberosity, a side-to-side repair is performed (Fig 12) to attach the graft to any remaining healthy infraspinatus or rotator interval tissue. The decision for side-to-side repair needs to be made before the graft is prepared on the back table so as to make the perforations in the graft. We then pass suture through these perforations, which have been marked with a surgical marker, and tie arthroscopic knots completing the construct (Fig 13).

Discussion

Irreparable rotator cuff tears continue to be a problem facing orthopaedic surgeons. These cuff tears have been treated with debridement and hemi-arthroplasty, both of which have their own complications. Reverse total shoulder arthroplasty also offers surgeons an opportunity to aid patients with irreparable rotator cuff tears, but may not be the best option for younger and active patients or patients with little to no arthritis. The superior capsule reconstruction procedure is technically demanding and has a steep learning curve, which is why we limited our practice to patients unwilling or unable to proceed with tendon transfers and or shoulder arthroplasty (Table 2). We offer our technique for superior capsule reconstruction as a surgical option for the younger, higher demand patient without significant degenerative changes for the management of irreparable rotator cuff tears.

Table 2. Advantages and Disadvantages of Superior Capsule Reconstruction with Arthrex ArthroFLEX Allograft

| Advantages                                      | Disadvantages                                      |
|------------------------------------------------|---------------------------------------------------|
| - Minimally invasive procedure                 | - Technically demanding procedure                 |
| - Restores native gleno-humeral congruency and stability | - Steep learning curve                           |
| - Maintains osseous structures                 | - Difficult suture management                     |
|                                                 | - Less proven track record vs arthroplasty        |

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