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Instability of a Reverse Total Shoulder Arthroplasty Treated with a Novel Allograft Capsule Reconstruction: A Case Report

Running Title: Novel Allograft Reconstruction for Unstable RTSA

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Instability after reverse total shoulder arthroplasty (RTSA) is a complex and multifactorial problem which, if inadequately addressed, can result in a nonfunctional upper extremity. Causes of instability include inadequate restoration of arm length, lack of soft tissue tension, component malposition, bony impingement, liner wear, infection, and axillary nerve dysfunction.\textsuperscript{1,4-6} For the referral surgeon, altering the position of the components and assuring appropriate arm length and soft tissue tension can resolve the majority of unstable RTSAs; however, there remain cases where the patient continues to have instability. In these cases, patients are routinely treated with conversion to hemiarthroplasty or explant of the prosthesis which results in reliable pain control, but decreased function of the arm.\textsuperscript{3,7} We describe here our procedure for soft tissue reconstruction of an unstable RTSA which had radiographically appropriate implant position and arm length but continued to have dislocations. To the best of our knowledge, this is the first case report of a soft tissue reconstruction for an unstable reverse total shoulder arthroplasty. The patient gave consent to share the information from their surgical case for publication.

**Keywords:** Reverse total shoulder arthroplasty; Instability; Allograft; Dislocation; Complication; Revision; Revision shoulder arthroplasty

**Case Report:**
The patient is a 75-year-old female with a body mass index (BMI) of 39, diabetic neuropathy, a history of frequent falls, and a reliance on her upper extremities to assist in transfers, who sustained a right proximal humerus fracture 5 years previously from a ground level fall. After an initial trial of conservative management, the patient underwent RTSA and tuberosity repair with a fracture specific cemented stem due to pain and limited function. She subsequently sustained an anterior dislocation within two weeks of surgery while reaching for an object. Over the next four years she underwent a variety of revision procedures in an attempt to provide a stable shoulder including: increase in polyethylene thickness, explant of prosthesis, hemiarthroplasty, re-revision RTSA with allograft-prosthesis construct, re-explant of prosthesis, and re-revision RTSA with proximal humeral replacement prosthesis. After each of the revision procedures the patient did well, but sustained a recurrent anterior dislocation within several weeks. She subsequently presented to our institution with an anteriorly unstable prosthesis with a concurrent radial nerve palsy [Figure 1]. Bilateral full length humeral radiographs with were obtained which showed appropriate length of the humeral prosthesis, equivalent to the contralateral arm. Computed Tomography (CT) imaging of the shoulder showed appropriate alignment of the components without scapular fracture or component lucency. An EMG demonstrated a recovering radial nerve and a normal axillary nerve. Aspiration of the shoulder and labs were negative for infection. Given her pain and inability to use the arm, a discussion was had with the patient about the ultimate goals for her shoulder which were simply to have use of the arm below the level of the shoulder. After the discussion, the patient elected to proceed with revision RTSA with allograft capsule reconstruction of the shoulder.

The patient was placed in the beach-chair position and the prior deltopectoral incision was extended distally to the mid humerus. The prosthesis appeared stable with good soft tissue
tension of the deltoi
d and strap muscles. The tuberosities and rotator cuff attachments were
absent. External and internal rotation of the humerus did not show any evidence of impingement
in either adduction or abduction. The arm was stable to anterior and posterior shuck in adduction.
Humeral retroversion was approximately 30°. Implants were stable without evidence of
loosening. With external rotation and traction, the arm was dislocated. The modular body of the
humerus as well as the glensphere were removed, allowing full access to the joint. The superior
locking screw of the glenoid baseplate was removed to facilitate suture passage across the
glenoid vault. The posterior aspect of the glenoid was then dissected free to allow for suture and
graft passage. On the back table, an Achilles tendon allograft was prepared by placing a #2 high
tension suture in a Krakow configuration along the tendinous portion of the graft. Then two 2.0
mm drill holes were made from anterior to posterior, 5-7 mm from the face of the glenoid, from
approximately 1-2 o’clock on a right shoulder, exiting out the posterior aspect of the glenoid
[Figure 2]. Using a Hewson suture passer, the two suture ends from the tendinous portion of the
allograft were retrieved and used to shuttle the graft onto the posterior aspect of the glenoid
[Figure 3]. These sutures were then tied anteriorly over a suture button to fix the posterior limb
of the graft. Then, a single double-loaded 5.5 mm suture anchor was placed anteriorly, 5-7 mm
medially from the glenoid face, from 4-5 o’clock for anterior fixation of the graft. A 40 mm
glenosphere was then impacted onto the glenoid baseplate. A slit was made in the mid-portion of
the allograft to allow passage of the humeral component. This opening was sewn peripherally
around the edge with #2 suture to mitigate wear of the allograft against the component [Figure
4]. The humeral component, without the humeral tray, was placed through the slit in the
allograft. The humeral tray was subsequently impacted onto the humerus with attention paid to
not entrap the allograft. The shoulder was then reduced and the graft tensioned anteriorly with
the arm in 45° of abduction and 0° of external rotation by holding the fan-shaped anterior limb of the graft onto the anterior glenoid. The arm was then taken through an arc of motion looking for 90° of forward flexion (FF), 45° of external rotation (ER), and internal rotation (IR) to the hip to ensure that a functional range of motion of the shoulder can be achieved without significant tension of the graft [Figure 5]. The location on the anterior limb of the graft where appropriate tension was achieved is marked for passage of the anterior sutures. Then, the suture tails from the suture button, as well as from the suture anchor, are passed through the anterior limb of the graft in a mattress configuration and tied to affix the graft to the anterior glenoid. After final graft fixation, passive ROM without significant tension on the graft was measured at 110° of FF, 50° of ER and IR to the hip. If there is excessive laxity around the humeral component, additional sutures can be placed to narrow the slit in the allograft to further constrain the humerus [Figure 6]. The incision was then closed in a standard fashion. In the postoperative period, the patient was kept in an abduction pillow for 6 weeks with pendulum exercises only. At 6 weeks the patient was allowed to come out of the sling to do progressive ROM under the guidance of physical therapy. Final evaluation at 1 year revealed a stable shoulder joint with active FF of 30°, ER of 10°, and IR to the hip. Her passive ROM was 90° of FF, 50° of ER, and IR to the hip consistent with our intra operative measurement [Figure 7]. Her previous radial nerve palsy had fully resolved. She had pain of 3/10 on VAS scale and was able to perform limited activities of daily living (ADL) below the level of the shoulder and was overall satisfied with the procedure.

Discussion:
The surgical management of the unstable RTSA is frequently challenging with reported failure rates between 15%-40%.\textsuperscript{1,3,4} After ruling out infection and axillary nerve dysfunction the surgeon often must address a variety of potential challenges including arm length, bony impingement, component malposition, component wear, and soft tissue laxity. However, there are some instances where after these concerns have been addressed the prosthesis remains unstable. Options for remediation at that point are limited and include conversion to hemiarthroplasty or resection arthroplasty, both of which are associated with restricted function.\textsuperscript{3,7} Recently Tashjain et al described a technique for revision RTSA for instability where cerclage suture is used to secure the humeral component to the glenosphere.\textsuperscript{8} Our technique is similar in that it is an attempt to provide an additional level of constraint to prevent the dissociation of the humeral and glenoid component. However, our technique uses an Achilles tendon allograft which allows for the possibility of biologic incorporation onto the anterior and posterior surfaces of the glenoid. Additional graft choices such as hamstring, fascia lata, or dermal extra-cellular matrix graft would be possible as well, however the broad expanse of the Achilles tendon permits a slit in the graft which allows for functional ROM of the prosthetic without tensioning the graft. This last point is important as avoiding tension on the graft except for the extremes of motion may prevent failure of fixation in osteoporotic bone and improve the chances of biologic ingrowth of the graft. A similar type of technique has been described by Bava et al for the unstable hemiarthroplasty, but to our knowledge this is the first time it has been applied to the RTSA.\textsuperscript{2} Potential disadvantages of this procedure include the risk of infection when using allograft, failure of the graft to incorporate, and over constraint of the prosthesis; however, careful attention to graft placement and infection mitigation may limit these risks.
Conclusion:

Allograft capsule reconstruction for recalcitrant RTSA instability can result in a stable, useable shoulder for patients who are willing to accept limited ROM and function of the extremity.

References:


**Figure 1:**
Preoperative Anterior-Posterior (AP) radiograph.

**Figure 2:**
A: Sagittal view of the face of the glenoid showing the location of suture passage and suture anchor placement. * Indicates the thick tendinous portion of the Achilles tendon allograft.  
B: Coronal view of the glenoid.

**Figure 3:**
The Achilles tendon allograft being docked in the posterior aspect of the glenoid.

**Figure 4:**
The central slit in the allograft with #2 suture reinforcement prior to placement of the humeral component.

**Figure 5:**
Placement of the humeral component through the slit in the allograft and tensioning of the graft.

**Figure 6:**
Final construct with the allograft sewn to the anterior glenoid. The blue arrow indicates additional sutures used to close down the slit in the allograft and increase the constraint of the construct.

**Figure 7:**
Passive and Active postoperative range of motion at 1 year.
Passive ROM:

Active ROM: