Technical Note

Arthroscopic Anatomic Glenoid Repair Using Distal Tibial Allograft and an Inferior-to-Superior Capsular Shift

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Abstract: Traumatic anterior dislocation of the shoulder accounts for the vast majority of shoulder dislocations. Recurrence following initial traumatic dislocation is common, and the risk is increased by the presence of both bony and soft-tissue damage. Arthroscopic procedures have been described to address each of these etiologies individually but have not provided a technique to address bony and soft tissue pathology concurrently. This paper describes an all-arthroscopic, anatomic glenoid repair using distal tibial allograft with an inferior-to-superior capsular shift, addressing significant glenoid bone loss and capsular laxity with a single operation.

Introduction (With Video Illustration)

The glenohumeral joint has the greatest range of motion and greatest rate of dislocation of all the joints in the human body, representing an estimated 50% of all dislocations.[1,2] Up to 96% of these are traumatic anterior dislocations, in which posterior-to-anterior forces lead to avulsion of associated bone and soft-tissue structures including bony and non-bony Bankart and Hill–Sachs lesions.[1-5]

Normal glenohumeral joint integrity is maintained through the static and dynamic anatomic stabilizers of the joint capsule and scapulothoracic musculature.[6] The likelihood of recurrent dislocation is increased in the presence of anatomic sequelae of traumatic dislocation, including elongation and laxity of the anterior capsule and associated ligaments,[7] in addition to glenoid bone loss.[1,8] Each of these features must be addressed surgically to avoid failure of initial revisions.[9] Importantly, these anatomic pathologies contribute substantially to the high rates of recurrent dislocation, which arises in 21% to 39% of patients.[10,11]

Arthroscopic procedures have been used as minimally invasive and efficient means of decreasing rates of recurrent dislocation following traumatic anterior dislocation.[1] Here, we build upon previously described techniques of arthroscopic anatomic glenoid repair using a distal tibial allograft (DTA) in the lateral decubitus position.[12] Through the use of an inferior-to-superior capsular shift with superior fixation, we address glenoid bone loss, a Bankart lesion, and capsular laxity in the presence of traumatic anterior dislocation with recurrent instability (Video 1).

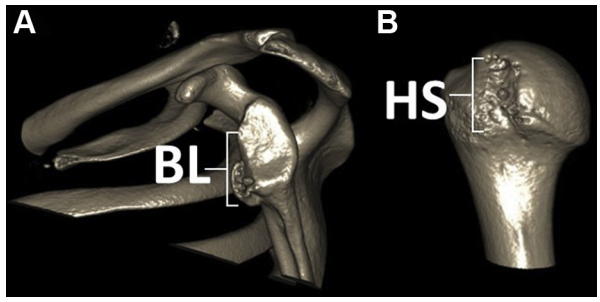

Fig 1. Preoperative 3D CT reconstruction images. (A) Lateral view of a 3D CT reconstruction of the left scapula, showing a bony Bankart lesion (BL) of the glenoid. (B) Posterior view of a 3D CT reconstruction of the proximal left humerus, showing a Hill–Sachs lesion (HS) on the posterolateral region of the humeral head. (3D, 3-dimensional; CT, computed tomography.)

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Table 1. Preoperative Assessment

History
Mechanism of injury
Documentation of previous episodes of instability
Documentation of previous treatments or surgeries
Physical examination
Instability testing
Apprehension
Relocation
Load-and-shift
Sulcus
Radiographic imaging
X-ray
Anteroposterior, axillary, and scapular views
CT
With 3D reconstruction
3D modeling
3D printing of CT reconstructions
Proximal Humerus
Scapula

3D, 3-dimensional; CT, computed tomography.

Indications and Imaging

This technique is indicated for a history of traumatic anterior dislocation of the shoulder with recurrent instability. Diagnostic imaging, and 3-dimensional computed tomography reconstruction identified both a bony Bankart, and Hill–Sachs lesion (Fig 1). Diagnostic arthroscopy via the posterior portal identified laxity with complete shoulder dislocation, completely torn labral capsular tissue and confirmed the presence of a bony Bankart lesion on the anteroinferior rim of the glenoid and a Hill–Sachs lesion on the head of the humerus.

Technique

Preoperative Assessment

A thorough preoperative assessment is conducted as described in Table 1.

Patient Positioning

The surgery is performed in the lateral decubitus position, rotated approximately 30° to align the surface of the glenoid parallel to the floor and is maintained using a vacuum bean bag positioner. A pneumatic limb positioner (Spider 2; Smith & Nephew, Memphis TN), is used to abduct the left arm to 60° in balanced suspension, as shown in Fig 2.

Portal Placement and Diagnostic Arthroscopy

A surgical marker is used to mark relevant bony landmarks (scapular spine, acromion, acromioclavicular joint, clavicle, and coracoid process), as shown in Fig 3. Diagnostic arthroscopy is then performed using a standard posterior portal to directly visualize the bony deficit identified in preoperative diagnostic imaging.

Fig 2. Superior view of the patient in the left lateral decubitus position, rotated to align the articular surface of the glenoid surface parallel to the floor (approximately 30°). The arm is held in balanced suspension, in approximately 60° of abduction.

Anterosuperior and anteroinferior portals are created under direct visualization from the posterior portal. The

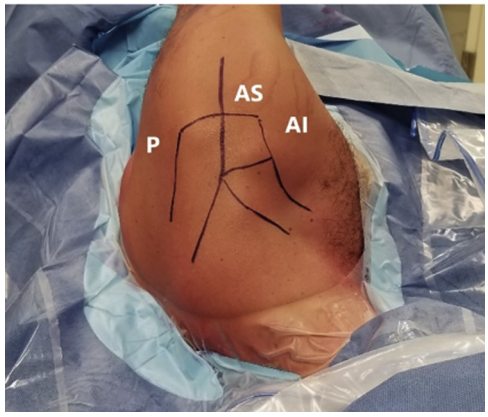

Fig 3. Superior view of the surface markings on the shoulder with the patient in the left lateral decubitus position. Marking was performed for the purpose of guiding posterior (P), anterosuperior (AS), and anteroinferior (AI) portal placement, relative to surface bony landmarks (scapular spine, acromion, acromioclavicular joint, clavicle, and coracoid process).

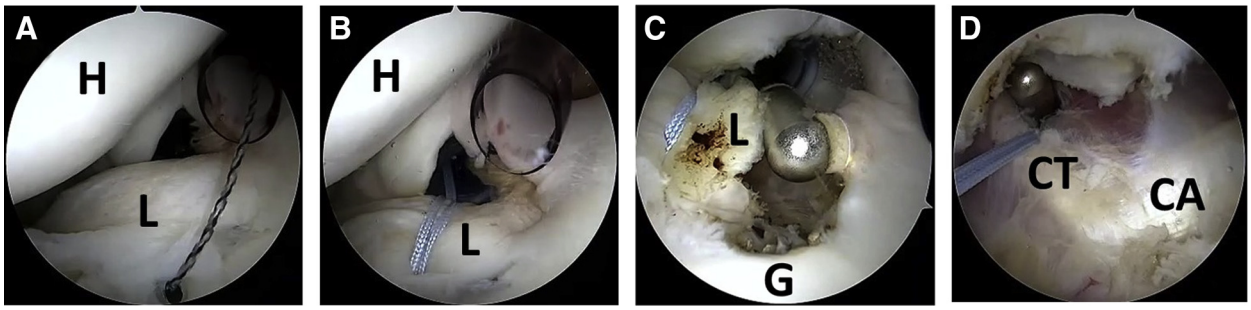

Fig 4. Traction suture placement and capsular transection in left shoulder in lateral decubitus position viewed from the posterior portal. (A) The suture passer is placed in the anterosuperior labrum for passage of the traction suture. (B) A racking hitch knot is used to secure the traction suture to the anterosuperior labrum. (C) Transection of the anterosuperior glenohumeral capsule superior to the traction suture. (D) Transection is continued until the conjoint tendon and coracoacromial ligament are visualized. (CL, coracoacromial ligament; CT, conjoint tendon; G, glenoid; H, humerus; L, labrum.)

anterosuperior portal is placed to provide a clear view of the anterior rim of the glenoid, while the anteroinferior portal is placed to allow access to the 6-o'clock position on the glenoid. All portals are then maintained via cannula placement.

Glenoid Preparation

A traction suture is placed in the anterosuperior labrum 2 cm below the 12-o'clock position through the anteroinferior portal using a standard technique with a suture passer to create a loop with a racking hitch knot (Spectrum II; ConMed, Utica, NY). This suture allows for control and subsequent manipulation of the labrum. The anterosuperior glenohumeral capsule is then transected superior to the traction suture, continuing until the coracoacromial ligament and conjoint tendon are visualized (Fig 4). This optimizes the view from the anterosuperior portal and is a vital step to prepare for the inferior to superior shift in the latter part of the procedure. The traction suture is then tucked adjacent to the outside surface of the canula to ensure that it does not interfere as the procedure progresses.

The arthroscope is then moved to the anterosuperior portal. Using the anteroinferior portal for instrument access, a shaver is used to remove any adhesions to the coracoid neck and release the labrum from the anterior glenoid rim from the 12- to 6-o'clock position (Fig 5). A 4-mm burr (STONECUTTER; Smith & Nephew) is then used for debriding and decortication to expose healthy, bleeding bone with minimal ridges on the anteroinferior edge of the glenoid. The midpoint of the decorticated anterior rim is marked using the shaver to inform subsequent tunnel placement and proper alignment of the graft (Fig 6).

Graft Preparation

Bone graft is harvested from DTA. Graft size is determined through a combination of preoperative imaging as well as direct measurement of the bony defect during diagnostic arthroscopy.

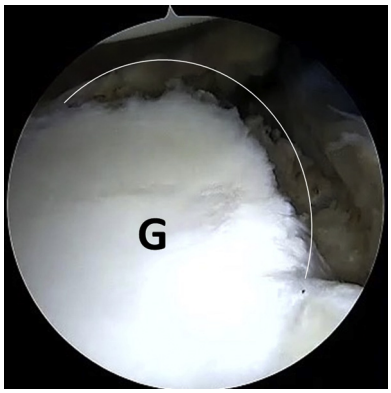

Fig 5. Labral release from the anterior glenoid rim from the 12- to 6-o'clock position using a shaver, viewed from the anterosuperior portal; Shoulder: left; Position: lateral decubitus. (G, glenoid.)

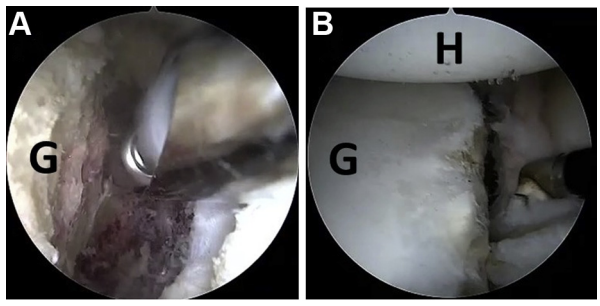

Fig 6. Decortication of the anterior glenoid rim in left shoulder in lateral decubitus position viewed from the anterosuperior portal. (A) A burr is used to debride and decorticate the anterior glenoid rim, exposing healthy, bleeding bone. (B) Once decortication is complete, the midpoint of the anterior glenoid rim is marked using a shaver. (G, glenoid; H, humerus; M, midpoint marking.)

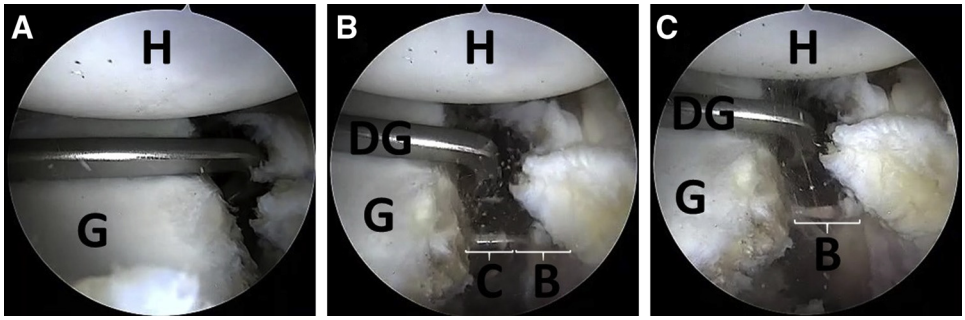

Fig 7. Transglenoid tunnel placement in left shoulder in lateral decubitus position viewed from the anterosuperior portal. (A) The drill guide is placed at the level of the midpoint marking through the posterior portal, perpendicular to the anterior rim of the glenoid. (B) The drill bit and cannula are advanced past the anterior surface of the glenoid. (C) The drill is retracted so that the anterior edge of the cannula is aligned with the anterior surface of the glenoid. (C, cannula; DB, drill bit; DG, drill guide; G, glenoid; H, humerus.)

Once harvested, a pair of holes are drilled into the graft (10-mm apart), using a 2.8-mm drill, parallel to the articular surface of the tibial plafond. A suture with a round ENDOBUTTON (Smith & Nephew) is passed through each of the holes to allow for later reduction at the site of the debrided and decorticated anteroinferior glenoid rim. This process has been previously described in further detail by McNeil et al.[12]

Transglenoid Tunnel Placement

A drill guide (Double Glenoid Drill Guide; Smith & Nephew) is placed through the posterior portal and hooked onto the anterior rim of the glenoid at the level of the midpoint marking, perpendicular to the decorticated anterior rim (Fig 7). In this position, pressed flat against the articular surface, it is used to guide the placement of small incisions in the posterior surface of the shoulder for drilling.

Transglenoid tunnels are then drilled superiorly, and inferiorly to the drill guide using a cannulated drill bit (in each of the small incisions). Advancing and retracting the drill in order to align the anterior edge of the cannula with the anterior edge of the glenoid.

Suture Anchor Placement

Two double-tail suture anchors are placed on the anterior edge of the glenoid using a Q-FIX (Smith & Nephew): one below the inferior transglenoid tunnel, and one just superior to the midpoint marking and inferior to the superior tunnel (Fig 8). Once secured,

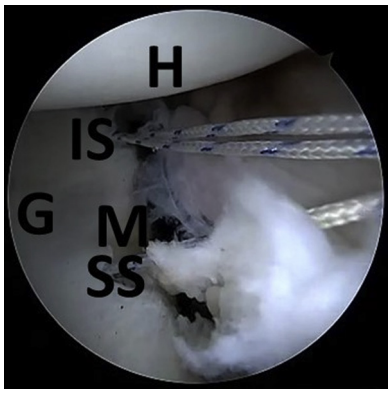

Fig 8. Suture anchor placement in left shoulder in lateral decubitus position viewed from the anterosuperior portal. Two suture anchors are placed on the anterior edge of the glenoid. The inferior suture anchor is placed just below the inferior transglenoid tunnel, and the superior suture anchor is placed just superior to the midpoint marking. (G, glenoid; H, humerus; IS, inferior suture anchor; M, midpoint marking; SS, superior suture anchor.)

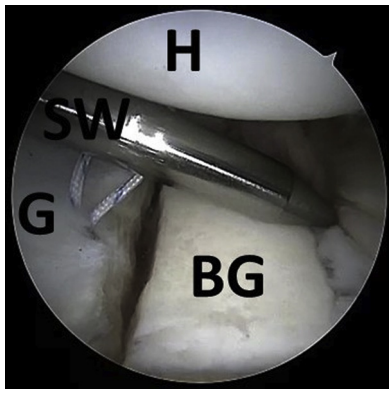

Fig 9. Graft reduction in left shoulder in lateral decubitus position viewed from the anterosuperior portal. The bone graft is passed through the anteroinferior portal and reduced to the native glenoid to align the articular surfaces of each. A switching stick, lying adjacent and parallel to the articular surface of the glenoid is used to align the graft and prevent lateralization. (BG, bone graft; G, glenoid; H, humerus; SW, switching stick.)

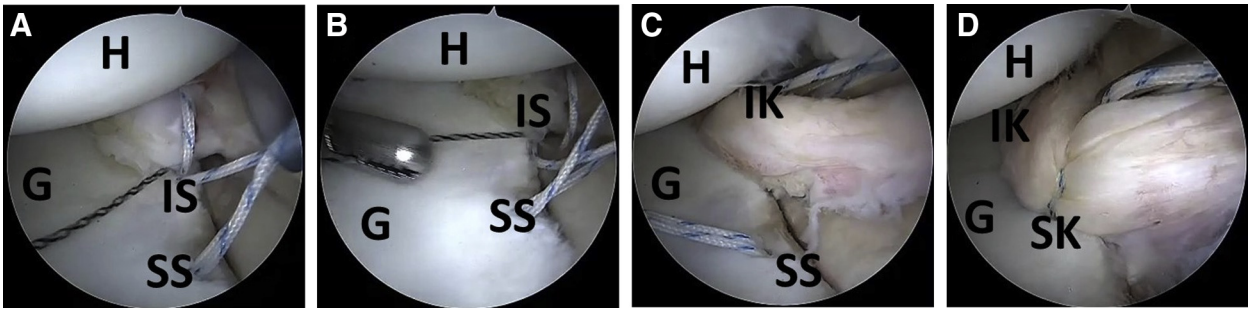

Fig 10. Capsular shift in left shoulder in lateral decubitus position viewed from the anterosuperior portal. (A) A curved suture passer is passed inferiorly, below the level of the most inferior suture tail of the inferior suture anchor. (B) The suture passer is retrieved through the posterior portal to thread the most inferior tail of the inferior suture anchor through the anteroinferior portal. (C) The suture tails of the inferior suture anchor are tied with a modified clinch knot. (D) The process is repeated with the superior suture anchor tails, yielding a bumper of capsular tissue at the margin of the native glenoid and graft. (G, glenoid; H, humerus; IK, inferior knot; IS, inferior suture anchor; SK, superior knot; SS, superior suture anchor.)

the sutures are received through the posterior portal to avoid interfering with the next steps.

Graft Passage and Reduction

To accommodate graft passage, the cannula is removed from the anteroinferior portal and the incision is widened. Monofilaments are passed through each transglenoid cannula from posterior to anterior and received through the anteroinferior portal, and then used to pass suture tails from the ENDOBUTTON suture through the transglenoid tunnels to be received from the posterior portal.

The graft is passed through the dilated anteroinferior portal. Once adjacent to the anterior glenoid, a large switching stick is used to align the articular surfaces of graft and glenoid and prevent lateralization. The graft is further reduced to the anterior glenoid with tensioning of the ENDOBUTTON sutures (to 100N), each secured with a Nice knot. Fine adjustments to graft alignment can be made using the switching stick and probe throughout the reduction maneuver (Fig 9).

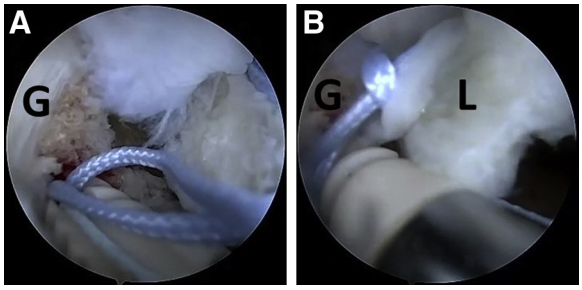

Fig 11. Reattachment of the superior labrum in left shoulder in lateral decubitus position viewed from the anterosuperior portal. (A) The traction suture tails are loaded in a suture anchor and placed in a drill hole at the edge of the superior rim of the glenoid. (B) The loaded suture anchor is rotated counter-clockwise to tension the labral tissue. (G, glenoid; L, labrum.)

Bankart Repair With Inferior-to-Superior Shift

The anteroinferior cannula is replaced, and the 3 most superior suture tails are retrieved through the anteroinferior portal. Tension is then applied to the traction suture, shifting the capsular tissue superiorly and tensioning the tissue. Maintaining tension on the traction suture, a spectrum curved suture passer is threaded inferiorly and passed below the level of the most inferior anchor on the glenoid. It is then retrieved through the posterior portal and used to thread the most inferior suture tail of the inferior anchor through the anteroinferior portal. Both suture tails of the superior anchor are then retrieved via the posterior portal.

The suture tails of the inferior anchor are tied and fastened using a knot pusher and needle driver with a modified clinch knot, to create a bumper of capsular tissue at the margin of native glenoid and graft. The process is repeated with the superior suture anchor, ensuring that suture passage hooks underneath the capsular tissue. A knot cutter (Katana; ConMed Linvatec) is used to trim the tails of both knots to 2 mm (Fig 10).

Reattachment of the Superior Labrum

Traction suture tails are loaded into a suture anchor (BIORAPTOR knotless 2.9 mm; Smith & Nephew), and a hole is drilled into the edge of the superior rim of the glenoid, adjacent to the biceps tendon. The loaded suture anchor is placed into the drill hole and rotated counterclockwise, tensioning and pulling the capsular tissue to the glenoid rim at which point a mallet is used to drive the anchor into the bone. Tails are then cut to 2 mm using a knot cutter (Fig 11).

Table 2. Postoperative Management Protocol

0-2 weeks postoperative
Sling immobilization
Passive ROM exercises for hand, wrist, and elbow
Gentle passive shoulder ROM beginning postoperative day 3
2-6 weeks postoperative
Sling
Passive shoulder ROM
Consider active-assisted ROM beginning postoperative week 5
6-12 weeks postoperative
Discontinue sling
Active ROM for shoulder
>12 weeks postoperative
Continued active ROM
Progressive limb strengthening

ROM, range of motion.

Postoperative Management

Instructions for postoperative management are given, as described in Table 2.

Discussion

This paper describes an all-arthroscopic anatomic glenoid reconstruction with a bone graft in combination with a Bankart repair and an inferior-to-superior capsular shift. This technique allows for a single anatomic arthroscopic procedure to concurrently address soft tissue and bony pathology. We are able to increase the posterior-to-anterior glenoid width using DTA, augmenting glenoid surface area, and restoring its contour, as well as shift the capsular tissue superiorly in a patient with traumatic anterior dislocation and recurrent instability.

Risks and Complications

Any effort to restore capsular tension carries a risk of over- or under-tensioning of the tissue with the potential to prove ineffective in the former scenario, or to reduce functionality of the joint in the latter.[13] In addition, the use of DTA carries the risk of graft resorption, with ≥50% resorption having been reported in 8% to 16% of patients in 2 small radiographic studies to date.[14,15]

Added Value of This Technique

The present technique addresses 2 major risk factors for failure in the surgical management of anterior glenohumeral instability: capsular hyperlaxity and glenoid bone loss.[7,16] Hyperlaxity has been proposed as an indication for open versus arthroscopic repair,[17] and this technique may thus prompt consideration of arthroscopic repair for novel indications. Previously described techniques for arthroscopic Bankart repair do not address concurrent bony etiology,[16,18] which has been observed in 41% of initial unilateral dislocations and 86% of recurrent dislocations.[19] Given the prevalence of bony pathology and high rates of recurrent dislocation of 60% and 90% in patients >40 and >20 years old, respectively,[1] these techniques may not be suitable for large proportions of patients requiring surgical stabilization of the glenohumeral joint.

Arthroscopic Latarjet techniques with osteotomy of the coracoid process for autografting also have been described and report good outcomes,[20-24] although individual variance in coracoid morphology can lead to suboptimal grafting. The use of allograft may be more reliable in producing a graft a smooth articular surface, and the proper size and contour to restore glenoid integrity. Our team has been developing such techniques, and results have been promising thus far,[12,15,25,26] further evidenced by a recent systematic review showing arthroscopic anatomic glenoid repairs to be safe, and improve functional outcomes in the short-to-medium term, with high levels of patient satisfaction being reported in multiple studies.[27] Further advantages and disadvantages of this technique are described in Table 3, and pearls and pitfalls are described in Table 4.

Conclusions

Here we present a technique for arthroscopic anatomic glenoid repair with an inferior-to-superior capsular shift using DTA to concurrently address bony and soft-tissue pathology, including capsular laxity, for traumatic anterior dislocation and recurrent instability. This approach may yield better outcomes, decrease complication rates, and reduce the need for revisional surgery by virtue of addressing multiple etiologic features associated with failures of surgical stabilization of the glenohumeral joint. Assessment of long-term results using this technique is necessary and should be the focus of future studies.

Table 3. Advantages and Disadvantages of the Technique

Advantages	Disadvantages
All-arthroscopic technique	Feasibility depends on condition of the capsular tissue
Ability to address bony defects and capsular laxity simultaneously	Risk of over- or undertensioning capsular tissue
Capsular transection facilitates the capsular shift, while also optimizing glenoid visualization	Availability and cost of graft may limit applicability of this technique in some centers

Table 4. The Pearls and Pitfalls of the Technique

Pearls	Pitfalls
Arthroscope should be kept parallel to the axis of the articular surface during decortication for proper visualization	Potentially large learning curve associated with performing an arthroscopic repair of this complexity
Superior capsular resection provides full visualization of the glenoid from the anterosuperior portal, while also preparing for the inferior-to-superior capsular shift	Tying and tensioning both ENDOBUTTON sutures requires serial adjustments to compensate for need to adjust each individually
Computed tomography–generated 3D-printed models can help to plan accurate portal placement, avoiding potential morbidity	Proper traction suture placement and capsular transection is integral to the ability to perform the inferior-to-superior capsular shift

3D, 3-dimensional.

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