Technical Note

Anterior Capsule Augmentation and Posterior Glenohumeral Capsular Reconstruction With Human Dermal Allograft for Multidirectional Shoulder Instability

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Abstract: Recurrent multidirectional shoulder instability is a common clinical presentation in certain demographics and sporting groups. One such demographic is patients with connective tissue disorders (CTD) such as Ehlers-Danlos syndrome (EDS), in whom shoulder pathologies are exacerbated owing to ligamentous laxity. Features of this laxity can present as both anterior and posterior shoulder instability, which are problematic sources of shoulder pain. Many patients with these injuries require surgical anterior and/or posterior glenohumeral reconstruction. Surgical reconstruction for posterior capsular defects can be challenging and has higher failure rates compared with anterior capsular reconstruction methods. Management can be especially difficult for patients with CTDs, and there is a requirement for the development of novel surgical techniques. Human acellular dermal allografts have been found to be particularly useful for patients with CTDs compared with other methods that use the patient's own tissue for the repair. This note and surgical video describe an all-arthroscopic technique for a combined anterior capsule augmentation and posterior glenohumeral capsular reconstruction, using a human acellular dermal allograft for EDS patients with multidirectional instability.

Multidirectional instability is a problematic source of shoulder pain for patients. This issue can be difficult to treat clinically and is compounded for patients with connective tissue disorders such as Ehlers-Danlos syndrome. A multitude of treatment options are available for patients with multidirectional instability.[1] Currently, there is an absence of high-level evidence supporting the effectiveness of these methods, and the best treatment option for patients with Ehlers-Danlos and recurrent shoulder dislocations is unknown. In this Technical Note, we describe an anterior capsule augmentation and posterior glenohumeral capsular reconstruction with a human dermal allograft for multidirectional shoulder instability for patients with Ehlers-Danlos syndrome.

Anterior shoulder dislocations account for 95% to 97% of dislocations, whereas posterior shoulder dislocations account for only 2% to 10%.[2–4] Although uncommon in the general population, posterior dislocation is frequent in select sporting groups and demographics.[5] The most frequent cause of recurrent posterior shoulder instability is cumulative microtrauma to the posteroinferior shoulder complex, which is observed in certain activities in which the shoulder is repetitively placed in a flexed and internally rotated position.[3] In the case of patients with connective tissue disorders, posterior instability can be atraumatic, and these patients are predisposed to dislocation and subsequent capsular injury resulting from generalized ligamentous laxity.[3]

Recurrent posterior dislocation of the shoulder is often undiagnosed, and surgical repair can be technically challenging in nature.[3] Nonsurgical options such as physiotherapy are the mainstay of treatment for most recurrent posterior dislocation cases; however,

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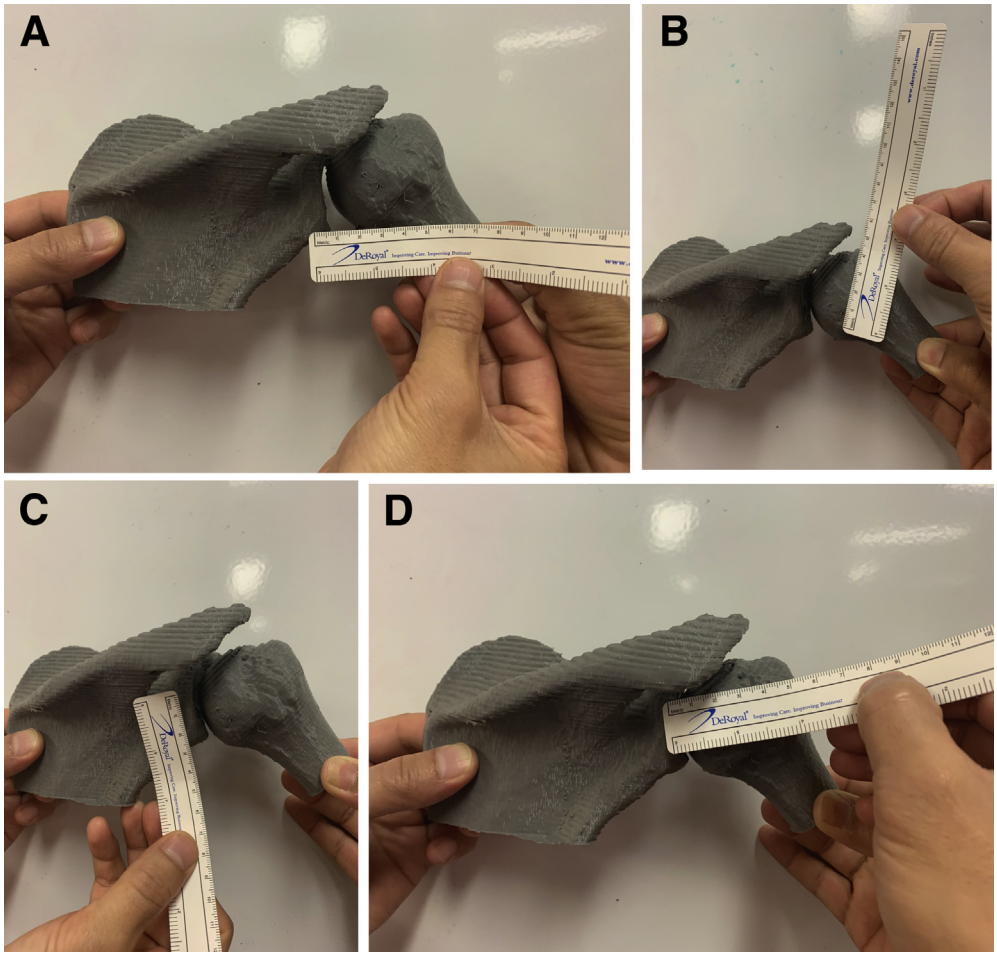

Fig 1. A 3-D printed model of the right shoulder using dimensions from patient imaging is used in preoperative and intraoperative planning to measure graft dimensions. The ruler is present to provide scale and is shown in centimeters. (A) Posterior view of inferior glenoid to humerus measurement. (B) Posterior view of humerus measurement. (C) Posterior view of superior to inferior glenoid measurement. (D) Posterior view of superior glenoid to humerus measurement.

surgery may be indicated if these initial treatments fail.[4] For capsular reconstruction options, multiple surgical techniques have been described.[1] Historically, open procedures have been used for surgical treatment; however, arthroscopic treatment for posterior shoulder instability has increased in surgical application.[4]

Surgical management for patients with connective tissue disorders often requires the development of

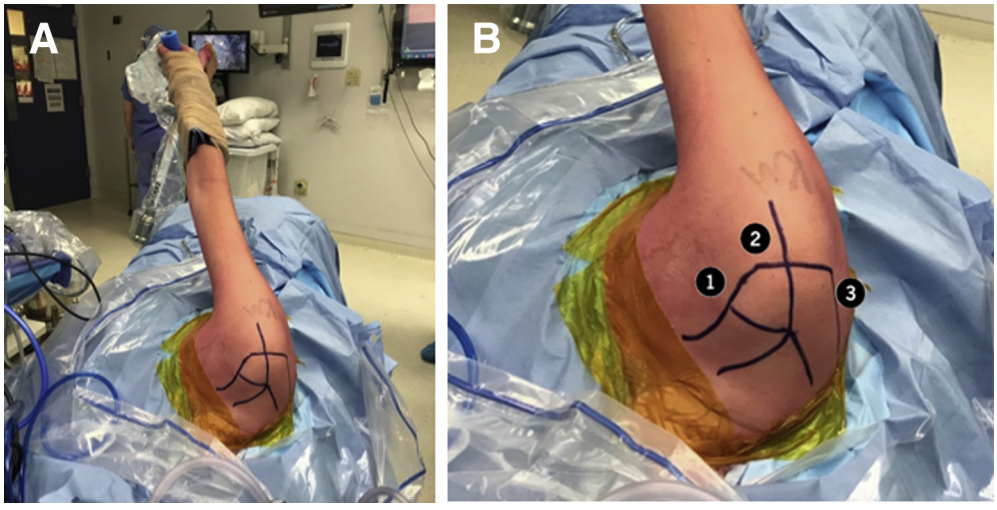

Fig 2. (A) Positioning of patient in left lateral decubitus position with right arm positioned in pneumatic limb holder. (B) Surgical landmarks and marking of arthroscopic portals; the anteroinferior portal (1) is created using an outside-in technique, slightly inferior to the coracoid, the anterosuperior portal (2) is located in the rotator interval just anterior to the biceps tendon, and the posterior portal (3) is located 2 cm inferior to the posterolateral corner of the acromion.

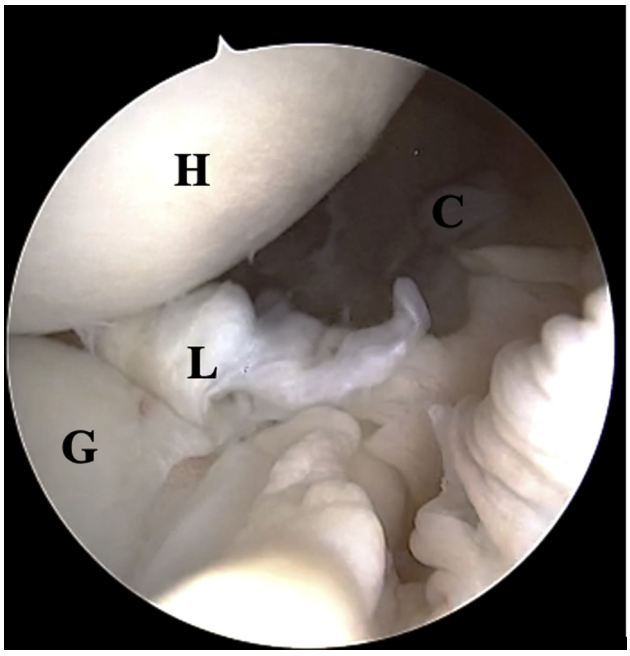

Fig 3. Preoperative view through the anterosuperior portal showing the unrepaired posterior capsular defect in the right shoulder. (C, capsule; L, labrum; G, glenoid; H, humerus.)

novel techniques to circumvent the unique features that define the disorder. Shoulder instability for Ehlers-Danlos patients is often characterized by the generalized ligamentous laxity associated with the condition.[6] These patients often have a patulous and redundant capsule with an increased glenohumeral volume that contributes to the recurrent shoulder dislocations these patients experience.[6] Treatment for recurrent shoulder dislocation often involves Bankart repairs and/or tendinous allografts and autografts. Whereas these methods use the patient's own tissue for the repair, alternative options such as human acellular dermal allografts are available.[7] Human acellular dermal allografts are particularly advantageous for patients with connective tissue disorders, as the patient's own tissue is compromised and thus is not optimal for use in the reconstruction.

The aim of this work is to describe the surgical technique for an all-arthroscopic anterior capsule augmentation with combined posterior glenohumeral capsular reconstruction, using a human acellular dermal allograft for patients with Ehlers-Danlos syndrome.

Surgical Technique

Preoperative Assessment

Preoperative clinical assessment is completed using our previously described technique.[8] Initial imaging of the shoulder consists of anteroposterior, axillary, and trans-scapular Y-views, as well as a computed tomography scan to identify glenoid bone loss. Magnetic resonance imaging is performed to access capsulolabral injury. To assist in preoperative and intraoperative planning, a 3-D reconstruction model of the shoulder is printed using computed tomography data (Fig 1).

Anesthesia and Patient Positioning

General anesthetic and antibiotic prophylaxis are administered. With the assistance of a beanbag positioner, the patient is positioned in the left lateral decubitus position and rotated posteriorly 30° to align the surface of the glenoid parallel with the floor. The arm is held in a SPIDER Limb Positioner (Smith & Nephew, London, UK) and abducted 60° with slight traction

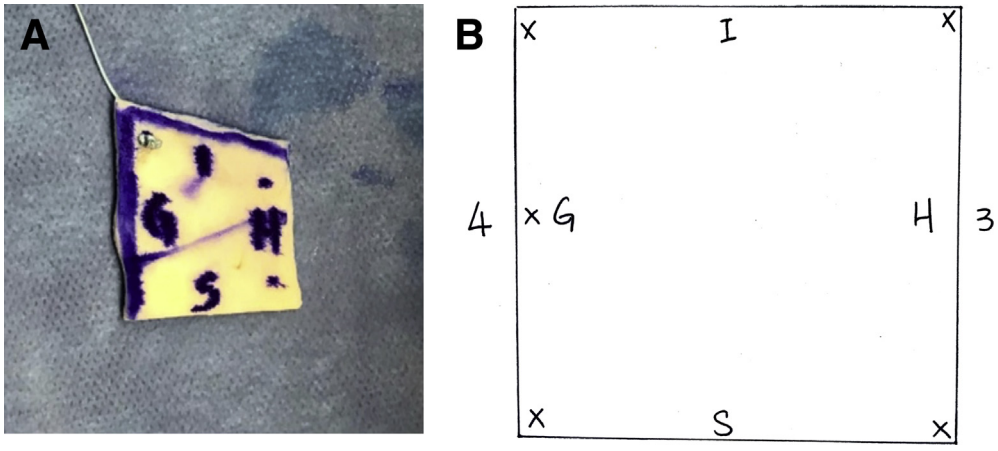

Fig 4. (A) Preparation on side table of the human acellular dermal allograft for the posterior capsular reconstruction using preoperative and intraoperative measurements. (G, glenoid; H, humerus; I, inferior; S, superior.) (B) Intraoperative map to cut the human acellular dermal allograft to 3 cm for the humeral attachment and 4 cm for the glenoid attachment with the proposed suture attachments based on preoperative and intraoperative measurements. (G, glenoid; H, humerus; I, inferior; S, superior, X, proposed suture attachment.)

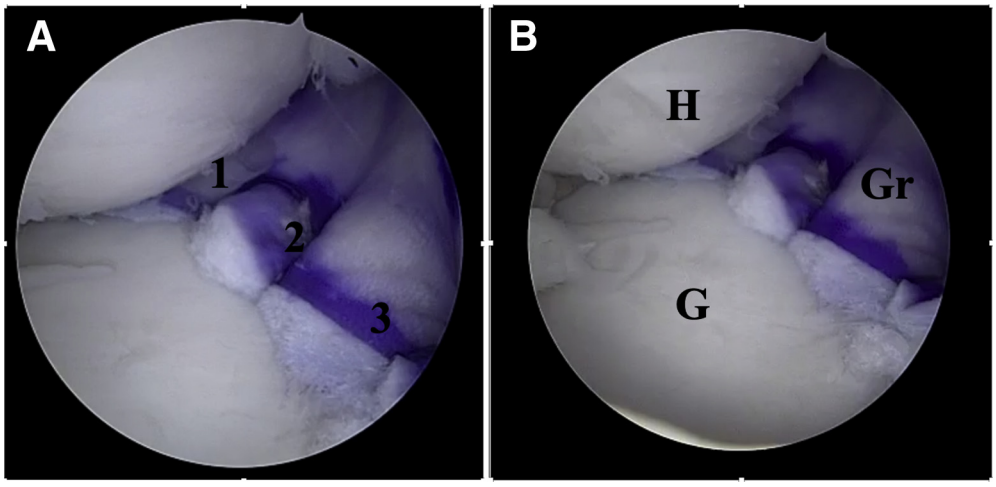

Fig 5. (A) Arthroscopic view through the anterosuperior portal showing the graft tensioned against the glenoid and humeral head in the right shoulder. (1, first glenoid anchor; 2, second glenoid anchor; 3, third glenoid anchor, G, glenoid; Gr, graft; H, humerus.) (B) Arthroscopic view through the anterosuperior portal showing final graft placement for the posterior capsule reconstruction. (G, glenoid; Gr, graft; H, humerus.)

(Fig 2A). Landmarks are drawn on the skin to mark the 3 arthroscopic portals; anterosuperior, anteroinferior, and posterior (Fig 2B).

The complete surgical technique is shown in Video 1. Diagnostic portals are placed in standard fashion for shoulder arthroscopy using predrawn skin landmarks (Fig 2B). Initial diagnostic arthroscopy is carried out through the posterior portal. The previous anterior capsular reconstruction with dermal allograft is visualized to be stable. The previous posterior capsular plication is visualized through the anterosuperior portal and seen to be stretched (Fig 3). A 10-mm passport cannula (Arthrex, Naples, FL) is placed in the posterior portal to allow for graft insertion. Hardware from the previous posterior capsule plication is removed. A Bankart knife is used to elevate the labrum off the chondral rim of the posterior glenoid. A shaver or burr is used to decorticate the glenoid while the bare area of the humeral head, adjacent to the rotator cuff, is decorticated using a curette. This allows for the repair to be completed back onto a healthy bleeding bone bed.

To allow for measurement of the graft dimensions, the shoulder is placed in neutral rotation with 60° of abduction. The distance from the posterior glenoid to the humeral head bare area is measured using a calibrated probe to estimate the graft size and is compared with preoperative and 3-dimensional (3D) model dimensions (Fig 1).

Humeral Anchor Placement

Using the 3D model for measurement and a spinal needle to landmark anchor placement positions, 2 double-loaded Q-fix anchors (Smith & Nephew) are inserted percutaneously at the most inferior aspect and superior aspect of the humerus.

Graft Preparation and Insertion

The GraftJacket allograft acellular human dermal matrix graft (Wright Medical Technology, Arlington, TN) is prepared on the back table, measuring 3 × 4 cm (Fig 4A, B). The graft is passed through a 10-mm passport cannula to the posterior aspect of the glenoid

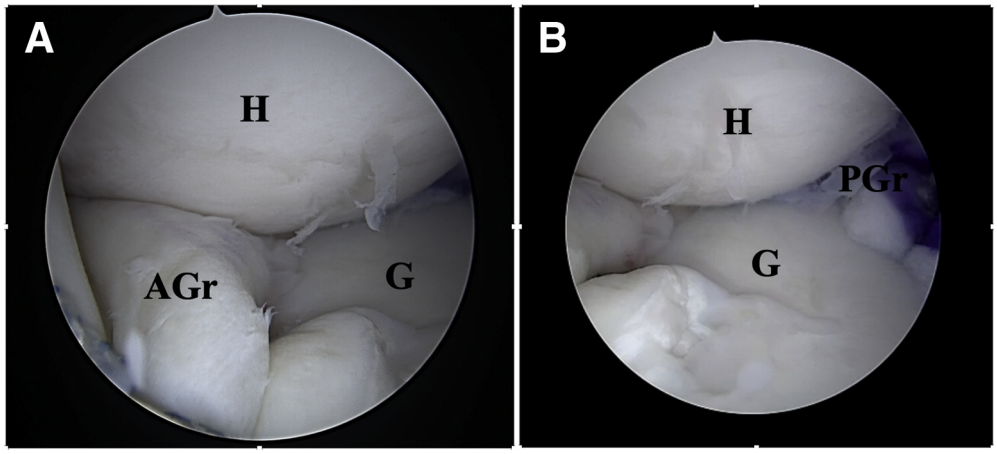

Fig 6. (A) Arthroscopic view of the construct through the anterosuperior portal showing anterior graft in the right shoulder. (AGr, anterior graft; G, glenoid; H, humerus.) (B) Final arthroscopic view of the construct through the anterosuperior portal showing the anterior and posterior grafts. (AGr, anterior graft; PGr, posterior graft; G, glenoid; H, humerus.)

Table 1. Rehabilitation

Time	Activity
• 0 to 2 Weeks	• Sling immobilization • Wrist and elbow range-of-motion exercises • Postoperative day 5: start passive shoulder range-of-motion on initial visit to physiotherapy
• 2 to 6 Weeks	• Continue passive shoulder range-of motion exercises • Pendulum exercises
• 6 to 12 Weeks	• Active range-of-motion exercises • Discontinue use of sling immobilization
• 12 Weeks Onward	• Continue with range-of-motion exercises • Progressive strengthening exercises

using the double-loaded anchors to push the graft in and gain access to the shoulder. To reduce the graft, a double pulley technique is used with 2 circumferential sutures to hold it in place.

Glenoid Anchor Placement

Using the 3D model for measurement and a spinal needle to landmark anchor placement positions, 3 single-loaded 1.8-mm Q-fix glenoid anchors are inserted percutaneously into the posterior glenoid at the 6, 9, and 11 o'clock positions (Fig 5A).

Securing the Graft

With the graft inserted and tensioned, the humeral anchors are first used to secure the graft. Starting with the most inferior humeral anchor, both suture limbs from 1 anchor (1 short-tailed interference knotted and 1 free end) are passed out the posterior portal. Stick knots are tied above the graft. To secure the graft, an SMC (Seoul Medical Center) knot is used, followed by 3 stacked half-hitches. This process is then repeated for the other humeral anchor. Once the glenoid anchors are inserted, the same process is used for the 3 glenoid anchors, moving from inferior to superior to ensure that suture or graft entanglement does not occur (Fig 5B).

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
• Arthroscopic technique, minimally invasive	• Skill-dependent nature of procedure
• Superior postoperative range of motion, improved recovery time, less postoperative pain, and lower recurrence rates compared with open procedures	• Cost of the acellular dermal allograft
• Use of allograft tissue for patients with connective tissue disorders	• Need for careful suture management during graft insertion
• No harvest site morbidity	• Potential for long operating time if graft or suture entanglement occurs
• Achieves reduction of the glenohumeral joint	• Long-term clinical outcome studies are currently unavailable
• Maintains native anatomy (vs arthroplasty or osteotomy)	

Table 3. Pearls and Pitfalls

Pearls	Pitfalls
• Use of 3-dimensional printed model for preoperative and intraoperative measurements	• Recurrent instability can occur when bone loss is not recognized
• Suture anchors are useful for poor-quality bone and future revisions	• Possibility of inaccurate measurement of the injury can result in a poorly tensioned graft
• Systematic suture management using multiple suture colors with corresponding diagram prevents entanglement	• Patient adherence is important during postoperative rehabilitation

Anterior Augmentation

The previous anterior capsular reconstruction is reassessed, and it is seen that 1 corner of the graft is not secure on the glenoid. An additional 1.8-mm Q-fix anchor is placed in the glenoid to further secure the prior reconstruction (Fig 6).

Rehabilitation

Rehabilitation is completed under the direction of physiotherapy. The recommended course of physiotherapy follows our previously described regimen.[7] The timelines and techniques are outlined in Table 1.

Discussion

We describe the combined anterior capsule augmentation with posterior capsular reconstruction for patients with recurrent posterior instability using a human acellular dermal allograft. For capsular reconstruction with dermal allografts, the graft is expected to incorporate into the native capsule and thus effectively dissipate posterior directed forces on the shoulder.[8] Given the uncommon nature of posterior instability, few studies on these types of repairs have been completed, and long-term outcomes are unknown.[8] General recurrence rates for posterior instability of 3% to 25% have been reported.[3,9–11] Despite some studies reporting higher rates of recurrence, other researchers have shown that patients with posterior instability treated arthroscopically, compared with open procedures, had superior outcomes with respect

to stability, recurrence of instability, patient satisfaction, return to sport, and return to previous level of play.[9,12]

The advantages and disadvantages along with the pearls and pitfalls of this technique are outlined in Tables 2 and 3. The described technique is advantageous because of its arthroscopic nature, which has been shown to have superior outcomes, lower recurrence rates, and higher return to sport compared with open procedures.[11,12] Arthroscopy also provides better visualization of the defect initially and throughout the subsequent repair process.[13] In addition, by using a human acellular dermal allograft for the repair, in contrast to other methods such as tendinous allografts and autografts, there is no donor site morbidity and native anatomy is maintained. These grafts also allow for adequate reduction of the glenohumeral joint because of their superior strength in comparison to tendinous grafts.[7] Finally, human acellular dermal allografts are particularly useful for patients with connective tissue disorders, as the reconstruction is not completed using patient tissue, which is compromised in conditions such as Ehlers-Danlos syndrome.

A number of limitations to this technique exist. The procedure is technically challenging in nature and requires careful suture management to ensure that graft or suture entanglement does not occur, as this can lead to increased operative time. Another important consideration is the increased cost of human acellular dermal allografts compared with other graft options, and these grafts may not be covered by all public health care plans. Long-term outcomes are also unknown for these procedures, and future work must focus on elucidating these results.

In conclusion, this note describes the surgical technique for an all-arthroscopic anterior capsule augmentation with combined posterior glenohumeral capsular reconstruction.

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