Technical Note

Distal Radius Allograft for Glenoid Reconstruction in Anterior Shoulder Instability With Significant Glenoid Bone Loss

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Abstract: Critical glenoid bone loss in the setting of glenohumeral instability presents a challenging problem for shoulder surgeons. In these cases, bone augmentation procedures are necessary to reconstruct the native glenoid and to maintain stability and function. Although the Latarjet procedure has good outcomes, the coracoid is not always large enough for full reconstruction of the glenoid. Alternative structural graft techniques have been developed over the years, including distal tibia allograft and iliac crest autograft, yet both of these techniques have several limitations. Due to the supply constraints associated with current graft options, introducing other options that mitigate these limitations is beneficial. In this technique and the accompanying video, we introduce the use of a distal radius allograft for glenoid reconstruction in the setting of glenohumeral instability. The distal radius allograft has a radius of curvature more closely matching that of the native glenoid, with anatomic features that can allow for enhanced glenohumeral stability, making it a promising option for this challenging problem.

Many studies in the literature have thoroughly explored clinical and biomechanical characteristics of various autograft and allograft options for anterior glenoid reconstruction in the setting of anterior glenohumeral instability with glenoid bone loss.[1-6] One of the most studied and well-established bone augmentation procedures in the setting of shoulder instability with glenoid bone loss is the Latarjet procedure.[6,7] The Latarjet remains the preferred method for bony augmentation by many surgeons because many reports have shown consistent outcomes and high return to sports rates.[6-8] However, the Latarjet is not able to accommodate all glenoid bone defects, especially those that are more severe and have a more complex presentation. In these instances, larger bone graft options should be considered to help reconstruct the glenoid.[4,9-12]

Numerous options for bone grafts are available for glenoid reconstruction, but each comes with its own clinical benefits and negatives in addition to challenges related to supply availability and financial constraints.[4,6,7,9,10] As such, exploring other graft options can hold immense value in the setting of shoulder instability with severe bone loss. One recent cadaveric study conducted by Khan et al.[13] explored the use of the distal radius allograft (dRad) as a reconstruction option in the setting of severe anterior glenoid bone loss and noted several advantages to other available graft options. The clinical application of this reconstruction option would constitute a valuable addition to the repertoire of shoulder surgeons. In this work, we describe a clinical technique that uses a dRad to reconstruct the glenoid in the setting of anterior shoulder instability and severe glenoid bone loss.

Surgical Technique

General anesthesia is administered, and after intubation, the patient is placed in the beach chair position at approximately 45° to 60° of elevation. The surgical site is prepped and draped according to standard protocols. An articulating arm holder is used to secure the

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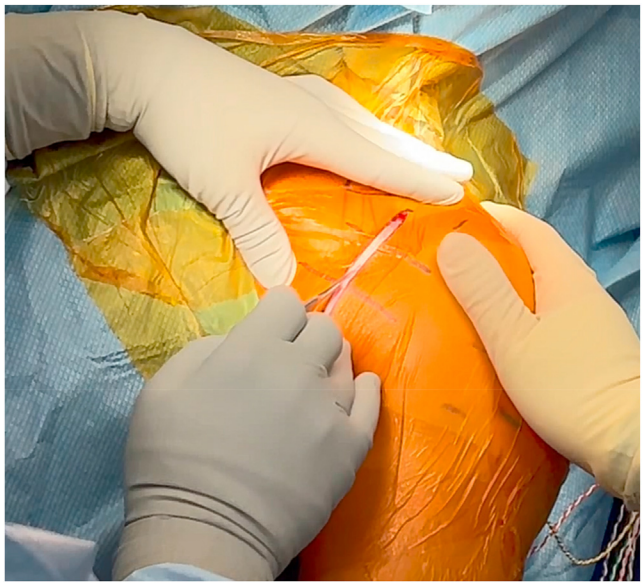

Fig 1. A deltopectoral approach using an anterior axillary incision is used to perform the procedure (left side).

operative extremity of the patient. Intraoperative nerve monitoring is commonly used by the senior author (J.A.A.), and an ultrasound-guided interscalene nerve block is administered postoperatively.

An anterior axillary incision for a deltopectoral approach is used (Fig 1). Dissection is carried down through the skin and subcutaneous tissues. The cephalic vein is identified and mobilized laterally. The conjoint tendon is identified and the clavipectoral fascia is incised. Blunt dissection is used to develop the subconjoint plane, and the axillary nerve is palpated. A blunt Hohmann retractor is then placed anteriorly over the glenoid neck to protect the axillary nerve (Video 1).

The fat is cleared off the subscapularis for adequate visualization of the upper and lower borders (Fig 2A). A Cobb elevator and a 15-blade are used to create a split in the subscapularis parallel to its fibers at approximately the midpoint of the tendon (Fig 2 A and B). A cobb elevator is then used to separate the subscapularis muscle fibers from the underlying joint capsule. A 15-blade is used to create a vertical capsulotomy at the level of the glenoid articular surface (Fig 3A). This is widened by spreading with Mayo scissors (Fig 3B). Next, a partial capsulectomy is performed using electrocautery to visualize the glenoid defect. A blunt Hohmann retractor is placed into the glenohumeral joint to retract the humeral head posteriorly. All soft tissues are debrided from the glenoid neck. A high-speed burr is then used to prepare a bleeding bony surface for later graft apposition and placement. The defect size is measured with a ruler (Video 1).

On a back table, a sterilely processed and irradiated dRad is prepared (Fig 4A). A micro-sagittal saw is used to cut the distal third portion of the radius to facilitate graft preparation. The distal radius graft is then visualized from its articular surface. The midway point between the dorsal and volar articular surface is marked with a marking pen, and a line is drawn straight between the 2 surfaces, with the intention of using the dorsal articular side for the graft (Fig 4B, Video 1). Dimensions of the graft with regard to length, width, or height depend on surgeon preference and patient characteristics; however, it is advisable to overestimate the size of the graft at this stage, and then adjust after provisionally fixing it into the surgical glenoid. The micro-sagittal saw is used to cut the graft according to the measured size (Fig 4C). The dorsal surface of the dRad tapers in the metaphyseal region, and this should

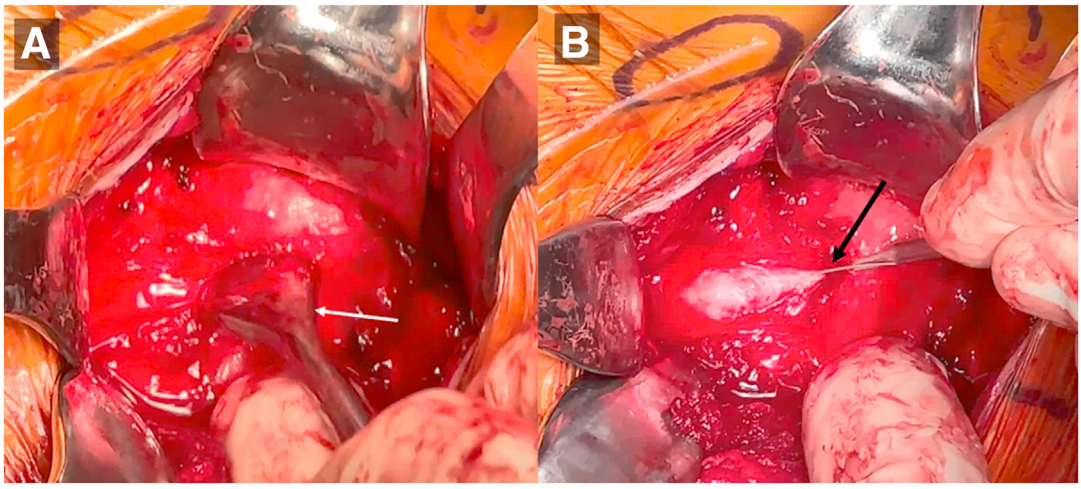

Fig 2. (A) A Cobb elevator (white arrow) is used to clear the fat off the subscapularis and prepare for the midway incision. (B) A 15-blade (black arrow) is used to introduce an incision parallel to the fibers of the subscapularis at approximately the midpoint of the tendon (deltopectoral approach, axillary incision, left side).

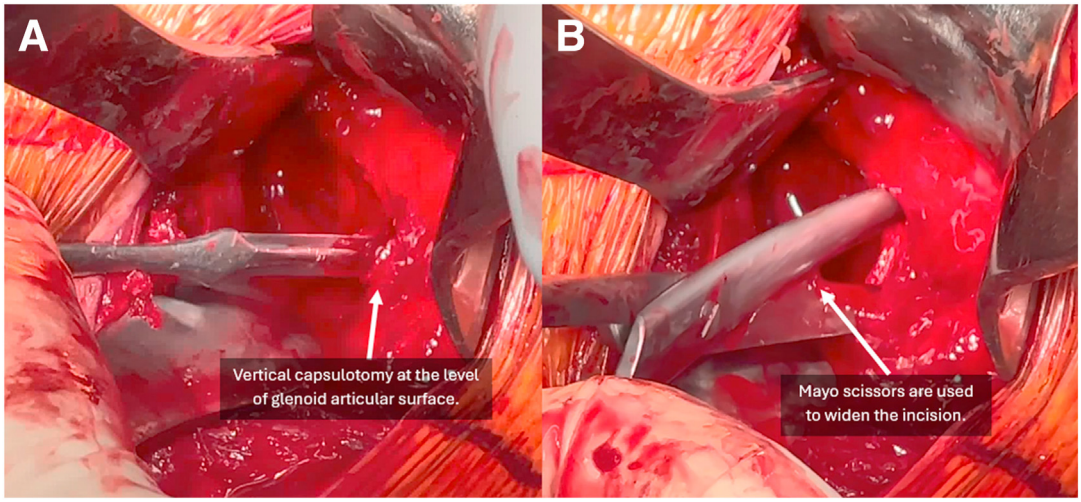

Fig 3. A 15-blade is used to introduce a vertical capsulotomy at the glenoid articular surface (A), and the incision is then widened using Mayo scissors (B) (deltopectoral approach, axillary incision, left side).

be left intact because it can key into the anterior-medial scapular neck and provide a broad contact surface area for potential graft healing (Video 1).

The graft is then placed into the defect and provisionally fixed with 2 Steinman pins (2.00 mm diameter) placed tri-cortically. Threaded 4.0 cannulated K-wires are used for screw placement using a 4.0 cannulated screw (Fig 5A). Alternatively, noncannulated 4.0 screws can be used with a washer. The wires are then over-drilled for partially threaded canulated screws for lag by design fixation. The cannulated screws with a washer are then placed over the K-wires (Fig 5B). In certain cases, when a cadaver graft with soft tissue attachments and the dorsal carpal ligaments are preserved, these can be repaired to the humeral anterior capsular attachment with a No. 2 FiberWire (Arthrex) suture to perform an anterior capsular repair (Video 1).

The split in the subscapularis is then closed with interrupted figure-of-eight sutures (Fig 6A). Shoulder

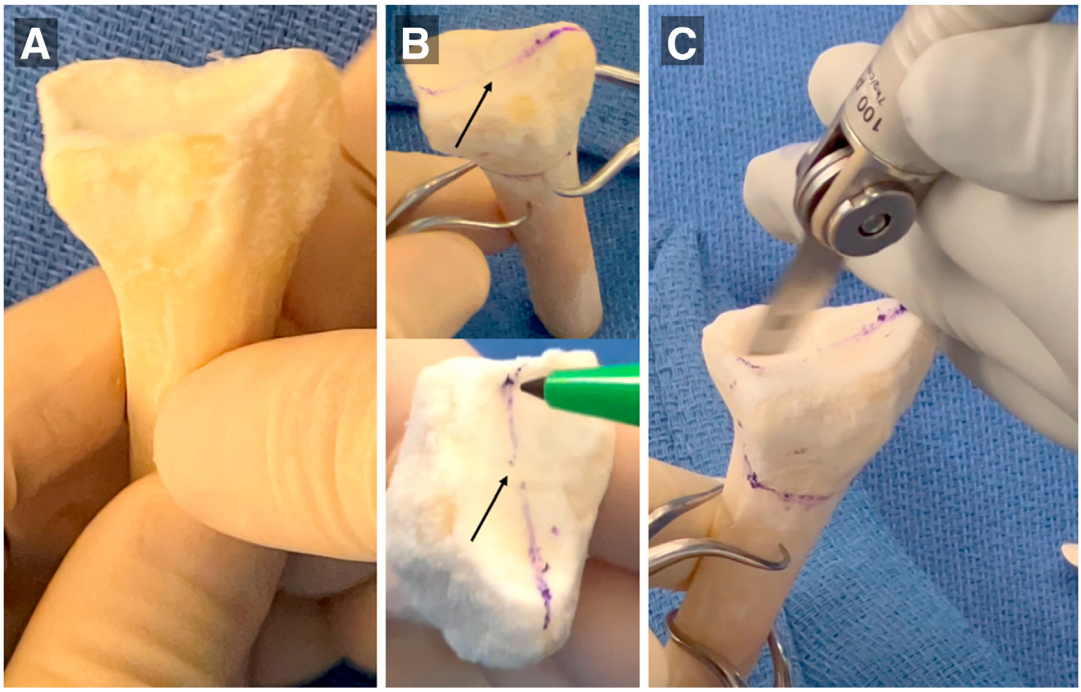

Fig 4. (A) The distal radius allograft is prepared sterilely on a back table. (B) A marked line (black arrow) along the midpoint of the graft (between the dorsal and volar articular surface) is drawn. (C) A micro-sagittal saw is then utilized to cut the graft according to the appropriate size.

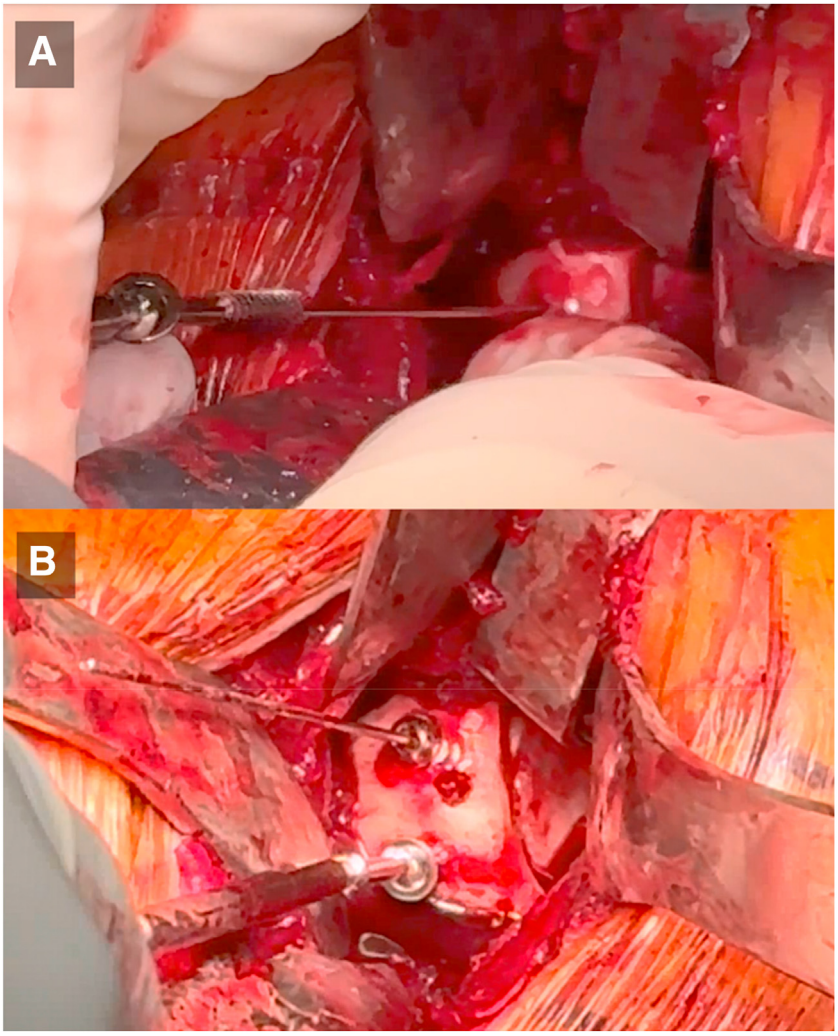

Fig 5. (A) Threaded 4.0 cannulated K-wires are used for the placement of a 4.0 cannulated screw. (B) K-wires are then over-drilled for partially threaded canulated screws for lag by design fixation, and the cannulated screws with a washer are then placed over the K-wires (deltopectoral approach, axillary incision, left side).

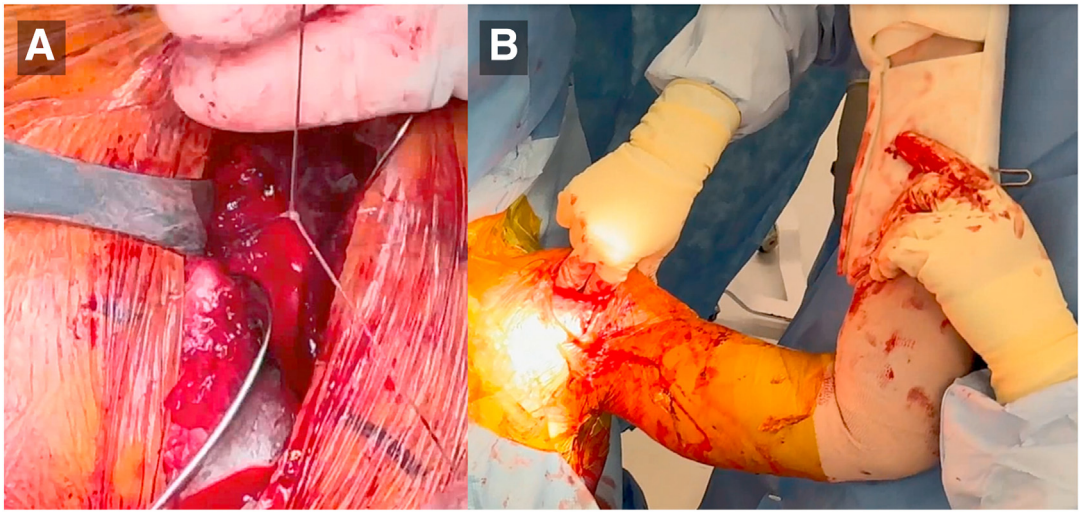

Fig 6. The split in the subscapularis is then closed with interrupted figure-of-eight sutures (A), and shoulder stability is then assessed before closing (B) (deltopectoral approach, axillary incision, left side).

stability is then assessed (Fig 6B, Video 1). The patient is placed into an abduction sling with a pillow postoperatively.

Discussion

Our technique demonstrates the use of the dorsal articular surface of the distal radius as an allograft reconstruction option in the setting of anterior glenoid bone loss. Introducing the dRad into the shoulder proved to be a straightforward technique that can help surgeons manage significant glenoid bone loss in challenging patients. This graft incurs the innate benefits of other allograft options but with the added benefits of being more congruent with the curvature of the native glenoid and potential to provide a more anatomic anterior buttress to prevent recurrent instability.[13]

Khan et al. conducted a cadaveric study to explore the use of the dorsal dRad as an option for glenoid reconstruction.[13] The authors compared the anatomic features, radius of curvature (ROC), and bone mineral density of the dRad to that of the distal tibia allograft. They found the dRad to be more anatomically congruent with the native glenoid in multiple planes, and its ROC to be better aligned with that of the glenoid compared with the distal tibia.[13] As such, the construct was shown to be more anatomic according to both cadaveric measurement and computed tomography (CT) analysis.[13] In addition, bone mineral density assessment on CT showed similar values between the native glenoid and the dRad, further supporting its use for glenoid reconstruction.[13] Another feature noted in the study is the presence of an anterior lip given the anterior-to-posterior acute ROC in the dRad, which is absent in the distal tibia allograft.[13] This anterior lip can provide a buttress that protects against anterior translation, incurring additional stability to the presenting patient.[13] Furthermore, the dRad cortical surface tapers and therefore can sit flush with the anterior-medial scapular neck. This can provide stability and increases contact surface area for potential healing of the graft. Finally, the dorsal cortical surface is left intact in the dRad and therefore can provide greater potential screw purchase anteriorly.

The decreased availability of allograft bone graft options in the setting of significant glenohumeral instability necessitates the need for other options that can provide anatomic and robust reconstructions.[5] The free bone block graft options used today for glenohumeral instability include the iliac crest autograft and the distal tibia allograft.[4,9,10,14] Both these options have their limitations: the iliac crest is associated with significant pain and morbidity at the graft harvest site,[9,10] and the distal tibia has limitations associated with its morphological incongruence with the glenoid.[14,15] Accordingly, using the dRad for glenoid reconstruction is a valuable addition to anterior glenoid reconstruction options. Additional details about the advantages/disadvantages and pearls/pitfalls of this technique are presented in Tables 1 and 2.

In conclusion, our technique presents an allograft option for anterior glenoid reconstruction in the setting of shoulder instability with glenoid bone loss. The dRad offers a more closely anatomic reconstruction of the glenoid compared with other available graft options with an additional anterior buttress that can help add more stabilization and robustness to the reconstructed glenoid. Prospective clinical studies that explore the use of this graft are necessary to understand and assess the clinical utility of the dRad.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: J.A.A. has received royalties from Osteocentric Technologies, Enovis, Zimmer-Biomet, Stryker, and Globus Medical; holds stocks in Shoulder JAM, Aevumed, Oberd, OTS Medical, Orthobullets, Atreon, Restore 3D; has received research support from Enovis and Arthrex; has received royalties and financial or material support from publishers including Wolters Kluwer, Slack Orthopaedics, and Elsevier; and is board member or holds committee appointments for the American Shoulder and Elbow

Table 1. Advantages and Disadvantages of Using Distal Radius Allograft for Glenoid Reconstruction in Setting of Anterior Glenohumeral Instability

Advantages	Disadvantages
Provides a bony reconstruction of glenoid with critical bone loss with greater potential graft size for larger defects	More invasive than arthroscopic management, requiring subscapularis take down or split for access
Provides anatomic reconstruction that aligns well with the radius of curvature in multiple glenoid planes	Larger intrinsic graft size that can be harder to tailor to smaller glenoid bone defects
Acute dorsal radius of curvature provides a potential anterior buttress to prevent anterior humeral head translation	Potential higher risk of graft nonunion or lack of incorporation compared with autograft options
Bone mineral density is similar to that of native glenoid	Obtaining appropriate graft laterality and size can take time and has associated costs depending on health system
Dorsal radius cortex is maintained to improve screw purchase	
The dorsal cortex of the radius has a natural taper that matches the anterior glenoid neck allowing for a larger surface contact area between graft and native bone	

Table 2. Pearls and Pitfalls of Using Distal Radius Allograft for Glenoid Reconstruction in Setting of Anterior Glenohumeral Instability

Pearls	Pitfalls
Ipsilateral graft laterality should be obtained to utilize the dorsal distal radius cortex	Should not be performed in patients with noncritical glenoid bone loss
Procedure is best suited for patients with at least 15% glenoid bone loss to ensure appropriate graft sizing and contour	Avoid inadequate anterior labrum resection or incomplete capsular release before graft placement to prevent neurovascular injury during glenoid preparation or due to stretch phenomenon during graft placement
Proper host glenoid bone surface preparation and gentle decortication with a burr is vital to appropriately positioning the graft as well as optimizing healing	Upon initial radius graft preparation, it is advisable to overestimate its dimensions to avoid initial under sizing
Perform computed tomography to plan graft size preoperatively and for support in graft selection	With the conjoint tendon intact, nonoptimal screw trajectories with a high alpha angle are a potential pitfall if appropriate exposure and releases are not performed before graft and screw placement
Use 4.0-mm or larger screws and achieve tricortical purchase to achieve adequate graft fixation and stability	Avoid lateralization of the graft relative to the native glenoid because this can predispose to osteoarthritis; directly visualize graft articular reduction before final screw placement

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