Technical Note

Arthroscopic Anatomic Glenoid Reconstruction With Distal Tibial Allograft and Hybrid Fixation

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Abstract: Glenoid grafting is the standard surgical treatment for recurrent shoulder instability with significant glenoid bone loss. Arthroscopic anatomic glenoid reconstruction using a distal tibial allograft for anatomic glenoid reconstruction has recently been gaining attention. This article describes the use of a hybrid graft fixation technique with 1 suture-EndoButton device and 1 compression screw in arthroscopic anatomic glenoid reconstruction using distal tibial allograft.

It has been well acknowledged that glenoid bone loss (GBL) is a risk factor for failure after arthroscopic Bankart repair.[1] Burkhart and De Beer[1] have previously reported higher redislocation rates with Bankart repair in patients who had an inverted-pear glenoid shape. Several bony augmentation procedures have been developed to address GBL, including the Latarjet procedure, which is considered the standard surgical treatment.[1] In both open and arthroscopic Latarjet techniques, the coracoid is harvested and grafted to the anterior glenoid through a subscapularis split, which disrupts the native anatomy.

Different approaches and surgical techniques avoiding subscapularis damage have been developed in recent years,[2] including an all-arthroscopic Eden-Hybinette procedure.[3] Arthroscopic reconstruction techniques have shown better visualization and more accurate graft positioning at the anterior glenoid rim, in addition to a lower rate of complications.[4] Arthroscopic anatomic glenoid reconstruction (AAGR) with a distal tibial allograft (DTA) was first described using 2 compression screws.[2] Later, the same technique was developed with the use of 2 suture-EndoButton devices (Smith & Nephew, Memphis, TN), which is technically less demanding and uses only the routine Bankart repair portals.[5,6] However, isolated EndoButton graft fixation is not a rigid fixation, which potentially could lead to hardware failure and secondary graft displacement. Thus, additional fixation with a compression screw could be beneficial. The objective of this Technical Note is to describe a hybrid fixation technique for AAGR with DTA using 1 EndoButton and 1 compression screw for the treatment of anterior shoulder instability with GBL in the setting of a failed Bankart repair. The detailed surgical steps are presented in Video 1 and Table 1.

Surgical Technique

Preoperative Planning

The patient is assessed thoroughly with a complete history outlining previous episodes of dislocation, provoking maneuvers, type of injury (traumatic vs nontraumatic), and previous shoulder operations. Then, a standard physical examination of the shoulder is performed assessing anterior instability using the anterior apprehension, Jobe relocation, release/surprise, and load-and-shift tests. Rotator cuff integrity and strength are also assessed. Finally, hypermobility and hyperlaxity are documented using the Beighton score.

Shoulder imaging including anteroposterior, axillary, and trans-scapular Y views and a computed tomography scan with 3-dimensional reconstruction is obtained for preoperative planning. These images can be used to assess GBL, bone stock, the degree of resorption, nonunion or

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Table 1. Steps of Arthroscopic Anterior Glenoid Reconstruction Hybrid Technique Using DTA

1. The patient is placed in a 30° semi-lateral position.
2. The arm is placed in a pneumatic arm holder, and standard landmarks are drawn.
3. A diagnostic arthroscopy is performed through the posterior portal.
4. The anteroinferior portal is created, and the rotator interval is opened.
5. The anterosuperior portal is created and used as the primary viewing portal.
6. The anteroinferior glenoid is debrided and the capsulolabral tissue is elevated to expose the anterior glenoid rim and neck.
7. The glenoid width and height are measured to assess bone loss.
8. The graft is prepared using the posterolateral corner of a DTA. The ipsilateral distal tibia is preferred. One EndoButton is loaded with the suture tails.
9. The main arm of a double-bullet drill guide is inserted through the posterior portal and placed at the desired position on the glenoid neck.
10. One tunnel is created using a 2.8-mm drill distal to the main arm.
11. Monofilament sutures are passed through the tunnel and retrieved through the anteroinferior portal.
12. A 1.8-mm Q-Fix anchor is inserted on the anteroinferior labrum.
13. The DTA is shuttled in through the enhanced anteroinferior portal using the monofilament sutures so that the lead sutures of the graft exit the skin posteriorly.
14. The EndoButton is loaded on the exit suture posteriorly, and the graft is tensioned to 100 N after confirmation of positioning.
15. The far-medial (Halifax) portal is created through the inside-out technique.
16. The main arm of the double-bullet drill guide is inserted again through the posterior portal.
17. A tunnel is created using a drill bit proximal to the main arm.
18. The drill bit is retrieved through the Halifax portal.
19. A cannulated 3.5-mm compression screw is passed through the Halifax portal to secure the graft.
20. The anteroinferior labral tissue is reattached to the native glenoid similarly to a Bankart repair.

DTA, distal tibial allograft.

malunion, and the presence of a Hill-Sachs lesion. Attention is paid to the previous hardware position in revision cases. Surgical indications include anterior shoulder instability with significant GBL, a failed previous stabilization procedure for anterior instability involving soft tissue, or a previous failed bony reconstruction.

Positioning and Preparation

The patient is placed in the lateral decubitus position using a beanbag with a 30° posterior tilt to make the glenoid horizontal. The patient's arm is placed in a pneumatic positioner (Spider 2; Smith & Nephew) and is abducted 60° in a balanced suspension. Skin landmarks are drawn, including the acromion, scapular spine, clavicle, acromioclavicular joint, and coracoid. Arthroscopic posterior, anterosuperior (AS), and anteroinferior (AI) portals are also located and marked (Fig 1).

Evaluation and Debridement

Diagnostic arthroscopy is performed through a standard posterior portal according to Snyder's technique.[7] The AI portal is created using an outside-in technique. Next, a rotator interval release is performed using a thermal probe to visualize the acromioclavicular ligament, the tip of the coracoid, and the conjoined tendon. The AS portal is then created and used as a viewing portal for the following surgical steps; a cannula is placed in the posterior portal to serve as an outflow, maintaining low intra-articular pressure. By use of the AS portal as a viewing portal, a suture is passed through the AI portal across the detached labrum at the 3-o'clock position to serve as a traction stitch and help visualize the bone bed and the area where the graft will be placed. A labral elevator is then used to elevate the labrum and scar tissue off the anterior glenoid rim to expose the glenoid neck and any previously placed bone graft and/or hardware in case of revision surgery. A switching stick is introduced through the posterior portal and used to retract the subscapularis in the inferior direction. At this point, the anterior glenoid is cleared from soft tissue and can be rasped and decorticated to provide a bleeding surface for graft union. The dimensions of the glenoid are measured with a

Fig 1. The patient is positioned in the lateral decubitus position with 30° posterior tilt to make the glenoid horizontal. The skin is prepared with chlorhexidine and draped with 2 split shoulder drapes. The arm is placed in a pneumatic positioner and abducted 60° in balanced traction. The skin anatomic landmarks and portal sites are marked on a right shoulder. (AI, anteroinferior portal; AS, anterosuperior portal; H, Halifax [far-medial] portal; P, posterior portal.)

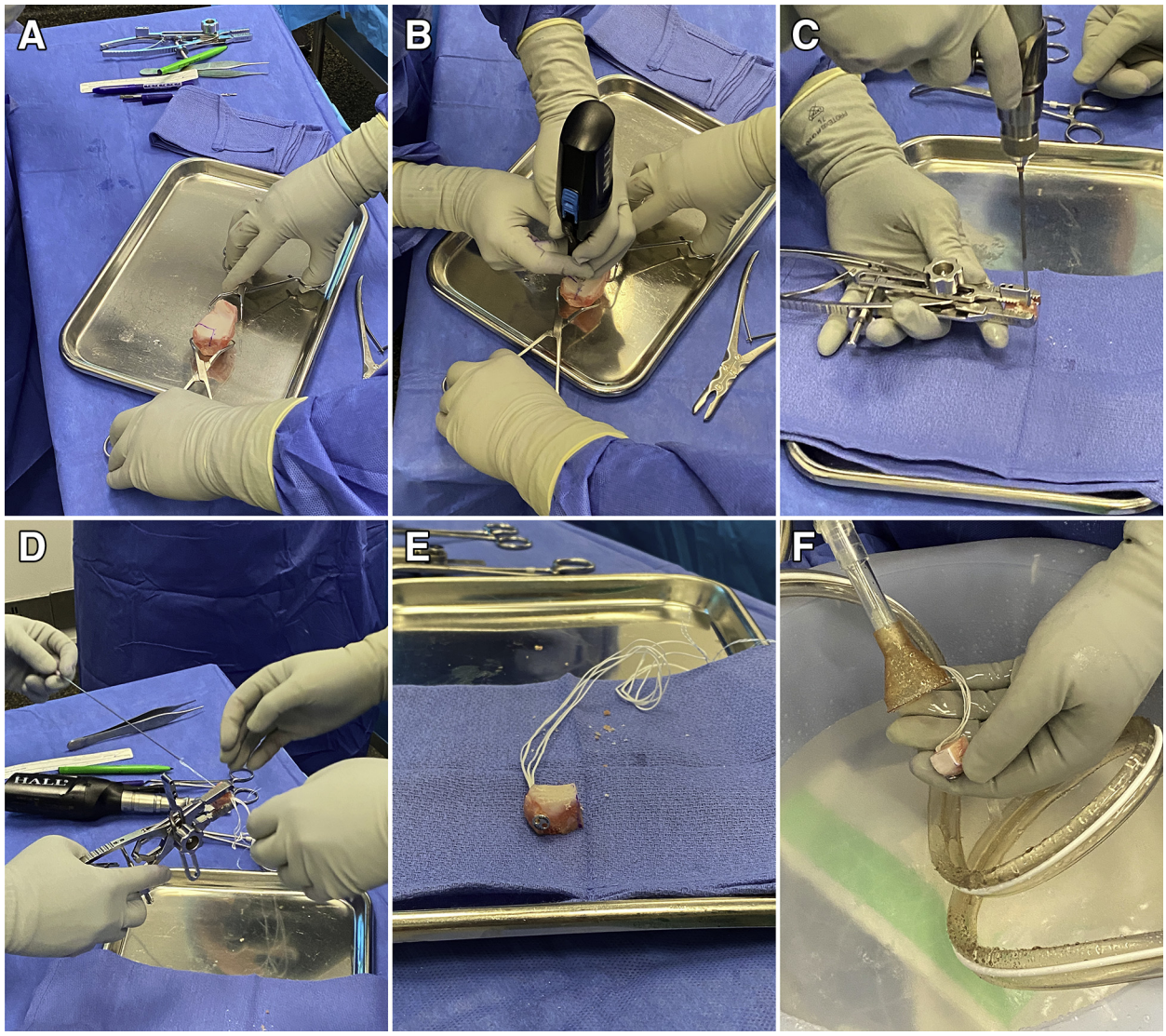

Fig 2. Distal tibial allograft preparation. (A) The dimensions of the graft are marked at the posterolateral corner: 10 mm of width and 20 mm of height with a thickness of 15 mm. (B) The graft is held with 2 clamps while it is sawed. (C) The graft is held with the Graft Prep Tool, and the most superior hole is drilled. (D) With a suture-retrieving device, the suture tail ends of an EndoButton implant are passed through the drilled hole in the graft. (E) The EndoButton is placed on the graft. (F) The graft is thoroughly irrigated.

calibrated probe to calculate the required graft size. The bare spot is used as the reference center of the native glenoid.[8]

Graft Preparation

A frozen nonirradiated DTA (Capital District Health Authority Regional Tissue Bank, Halifax, Nova Scotia, Canada) is used for the reconstruction. The ipsilateral distal tibia is preferred to use for graft preparation, as previously described.[2] The dimensions are marked based on the intraoperative measurements, usually with 10 mm of anteroposterior width, 20 mm of superoinferior height, and a thickness of 15 mm (Fig 2 A and B). The posterolateral corner of the graft is used based on its contour that best replicates the native contour of the glenoid and provides 3 cortical surfaces. The graft is then held with the Graft Prep Tool (Smith & Nephew), and 1 hole is drilled in the inferior area of the graft (Fig 2C). By use of a suture-retrieving device, the suture tail ends of the EndoButton are placed through the drilled hole (Fig 2 D and E). As a final step, the graft is thoroughly irrigated (Fig 2F).

Graft Placement and Tensioning

A double-bullet drill guide (Smith & Nephew) is inserted through the posterior portal, and the aiming arm is placed at the 3-o'clock position on the glenoid

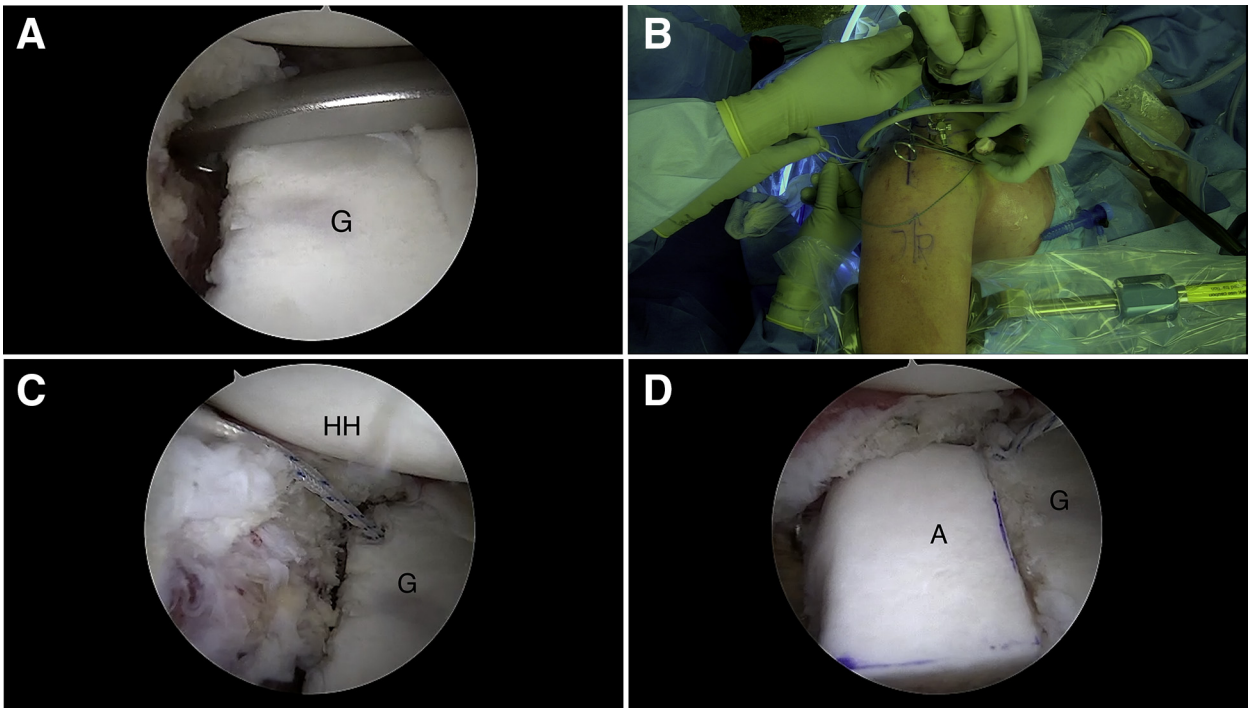

Fig 3. Graft positioning in a right shoulder with the patient in the lateral decubitus position. (A) With viewing from the anterosuperior portal, the double-bullet drill guide is positioned at the 3-o'clock position of the anterior glenoid rim through the posterior portal at the glenoid's anterior edge. (B) An exterior view shows that the suture tails from the posterior portal are used to shuttle the construct through the enlarged anteroinferior portal. (C) With viewing from the anterosuperior portal, a 1.8-mm Q-Fix suture anchor is placed in the anteroinferior glenoid rim for capsulolabral tissue repair (Bankart repair) after the graft is fixated. It is important to pay attention to the direction and avoid coalescence with the tunnel. (D) With viewing from the anterosuperior portal, the graft is advanced while tension is maintained before it is positioned flush at the anterior glenoid rim. (A, distal tibial allograft; G, anterior glenoid surface; HH, humeral head.)

anterior edge (Fig 3A). A small incision is made, and the drill guide is ratcheted against the posterior glenoid as the aiming arm is being stabilized against the anterior glenoid rim. A 2.8-mm tunnel is drilled through the glenoid from posterior to anterior using the distal side of the main arm of the drill guide corresponding to the drill hole made in the graft. The drill is then removed, and a No. 1 looped monofilament suture is passed through the sleeve and retrieved anteriorly through the previously enlarged AI portal. This suture is used to shuttle the suture tails of the EndoButton-graft construct through the predrilled glenoid hole (Fig 3B). A 1.8-mm Q-Fix suture anchor (Smith & Nephew) is placed in the AI glenoid rim after predrilling. It is important to pay attention to avoid coalescence with the glenoid tunnel (Fig 3C). This anchor will be used to repair the capsulolabral tissue after the graft is set in place. The graft is then advanced by pulling the EndoButton suture tails from the posterior portal. Slight tension is maintained on the sutures throughout the advancement until the bone block is positioned flush with the glenoid (Fig 3D). The EndoButton is loaded onto the suture tails and subsequently tensioned using a suture-tensioning device up to 100 N, as described by Taverna et al.[9]

Halifax Portal, Screw Insertion, and Capsulolabral Repair

The far-medial portal, also known as the Halifax portal, is created using an inside-out technique.[2] The arm is placed in an adducted position with the elbow flexed to 90° to release tension and medialize the conjoined tendon. Then, the switching stick is advanced through the posterior portal, parallel to the glenoid, proceeding superior to the subscapularis and lateral to the conjoined tendon before penetrating the skin.[2] A slotted cannula is placed through this portal. The double-bullet drill guide is again positioned over the graft through the posterior portal. Another small incision is made, and the bullet is ratcheted against the posterior glenoid. The 2.8-mm drill and sleeve are used again through the glenoid from posterior to anterior in the proximal area of the graft (Fig 4). A 3.5-mm titanium cannulated screw is finally introduced through the Halifax portal to complete the fixation (Fig 5). The previously mobilized capsulolabral complex is now

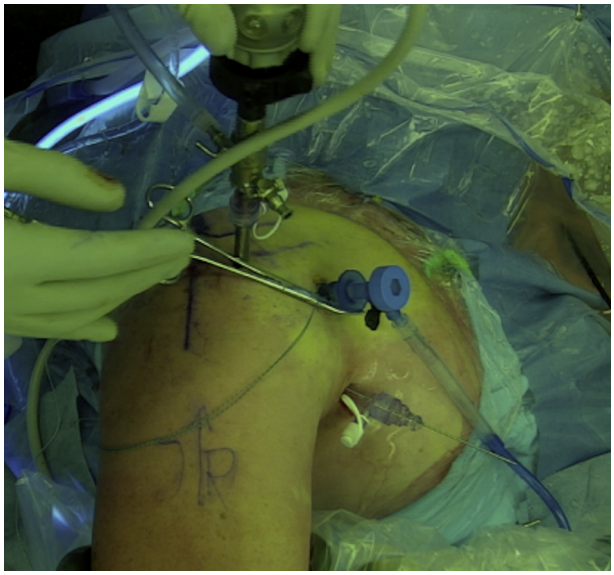

Fig 4. A right shoulder is shown with the patient in the semi-lateral position. A 2.8-mm drill and sleeve are used through the glenoid in a posterior-to-anterior fashion in the proximal portion of the graft. Then, the guidewire is passed from the posterior to the far-medial portal through the hole for screw placement.

repaired over the graft on the native glenoid similarly to a Bankart repair. The portals are closed, and the arm is placed in a neutral rotation sling. The steps for this surgical technique are summarized in Table 1, and our pearls and pitfalls are presented in Table 2.

Postoperative Management

A shoulder immobilizer brace is used for the first 2 weeks with passive range-of-motion exercises. Rotator cuff and deltoid isometric exercises are then progressively introduced with external rotation limited to neutral for the first 6 weeks. Active range of motion is usually not recommended before 6 weeks. After 6 weeks, patients can progress to full range of motion and begin active-assisted exercises. Patients often have regained full passive and active range of motion by 12 weeks postoperatively.

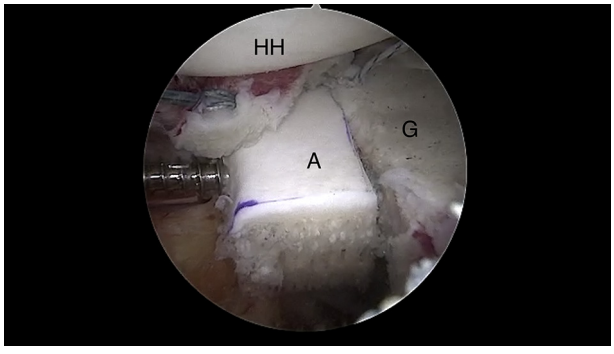

Fig 5. A right shoulder is shown with the patient in the semi-lateral position with viewing from the anterosuperior portal. After positioning of the guidewire is assessed, a 3.5-mm titanium cannulated screw is placed through the graft and glenoid rim to complete the fixation from the far-medial (Halifax) portal. Full compression should be easily achieved for complete fixation. (A, distal tibial allograft; G, anterior glenoid surface; HH, humeral head.)

Table 2. Pearls and Pitfalls of Technique

Pearls
The technique results in an all-anatomic glenoid reconstruction.
Compromise of subscapularis function is avoided.
Capsulolabral augmentation and soft-tissue balancing are allowed.
Pitfalls
Familiarity with the Halifax portal is required.
Splitting the subscapularis and damaging the neurovascular bundle are avoided.
It may be difficult to obtain the optimal drilling trajectory in revision cases with previous glenoid hardware.

Discussion

This article describes a hybrid fixation technique for AAGR with a DTA, using combined fixation with 1 screw and 1 EndoButton. The described construct uses both rigid and dynamic implants for graft fixation, trying to obtain the benefits of both systems, which could be ideal between either 2 compression screws or 2 EndoButtons with previously described techniques.[2,3]

AAGR with DTA was developed by Wong and Urquhart,[2] with a reported faster learning curve[10] and with better graft positioning than the arthroscopic Latarjet procedure.[11,12] However, graft resorption is reported with both techniques.[2,12] This complication could be in part related to the fixation techniques because graft resorption seems to be common among different types of grafts regardless of the fixation technique used. Moreover, the use of excessive compressive stress on the graft as observed with compression screws has recently been shown to correlate with graft osteolysis.[13] Thus, the optimal fixation construct for glenoid reconstruction is not yet established because high complication rates were observed whether using only rigid fixation with screws or using dynamic fixation with EndoButtons.[2,3,14]

In addition, pain and irritation from hardware after glenoid grafting using compression screws are not uncommon. Roulet et al.[15] reported unexplained anterior pain in 21 of 461 cases (4.6%) after open Latarjet procedures and showed complete or partial pain relief after screw removal of screws in all patients. Similarly,

Table 3. Advantages and Disadvantages of Technique

Advantages
All-arthroscopic technique
Versatile technique
Minimally invasive technique
Disadvantages
Allograft cost and unavailability
Technically demanding procedure
No long-term outcomes available

7% of our patients had to undergo revision surgery for hardware removal.[16] Thus, surgeons have opted for alternative fixation techniques, including isolated suspensory fixation with EndoButtons,[5,6] trying to limit hardware complications and avoid potential revision surgery for hardware removal while maintaining good functional outcomes and obtaining reliable graft fixation, as shown by Boileau et al.[17]

The use of nonrigid fixation with EndoButtons in the setting of AAGR has also proved safe and effective, mainly in cases of failed Latarjet procedures with previous compression screws.[5,6] In addition, the medial Halifax portal, described with rigid fixation,[2] could be avoided because this technique does not require direct anterior access to the glenoid neck. However, there are increasing concerns regarding graft stability and implant failure with the isolated use of EndoButtons as compared with compression screws.[18] Cortical button fixation showed lower resistance to direct load compared with standard compression screws with graft displacement and gap formation at the glenoid-graft interface in cadaveric models.[18] This could place the patient at risk of early graft displacement and secondary complications. Therefore, we believe that adding a compression screw could maintain graft positioning and avoid EndoButton failure. However, AAGR with DTA using hybrid fixation has its own limitations. The main limitation is the current lack of clinical outcomes in patients treated for shoulder instability with glenoid grafting using the described fixation method (Table 3). Second, this method can become technically demanding mainly in the setting of revision surgery because it would be difficult to drill the glenoid with a posterior starting point because previous hardware could block the optimal trajectory. Other limitations include the unavailability and cost of grafts, given that DTA might not be easily obtained in some institutions. Furthermore, this procedure is technically demanding, requiring more in-depth preoperative planning.

In conclusion, the currently described hybrid technique could balance both previously described fixation techniques, combining the benefits of both rigid and dynamic stabilization while possibly minimizing the effect of double-screw fixation. Although the surgical technique requires arthroscopic proficiency, following the surgical steps as described would make the learning curve easier than that of the arthroscopic Latarjet procedure. We believe that this technique could re-create a safe and well-balanced glenoid reconstruction construct. However, more studies with clinical and radiologic outcomes are needed to validate its safety and reliability in patients with recurrent shoulder instability.

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