Arthroscopic Technique for Distal Tibial Allograft Bone Augmentation With Suture Anchor Fixation for Anterior Shoulder Instability

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Abstract: Recurrent instability associated with glenoid bone loss is a commonly encountered problem after anterior shoulder dislocation. Surgical management with bony augmentation can be achieved with several allograft or autograft options. Fixation strategies also vary, including screw, suture button, or suture anchor fixation. Concerns exist regarding screw fixation because of the technical difficulty of a medial portal establishment, as well as the potential for graft osteolysis. Suture button fixation for osteochondral graft fixation has been previously described. However, no description of graft fixation using suture anchors exists. We describe an arthroscopic technique for glenoid augmentation using distal tibial allograft with suture anchor fixation.

The role of glenoid bone loss in recurrent shoulder instability after shoulder dislocation is well recognized.[1-5] Previous literature has defined "critical" bone loss, or the amount of bone loss associated with recurrent instability, as 15% to 20% of the bony glenoid.[5-7] Several surgical management options exist to manage this bone loss and mitigate the risk of recurrent instability, including the Latarjet, coracoid transfer, iliac crest bone craft, distal clavicle autograft, and Bristow procedures.[8-14] Most of these procedures have been described with screw fixation, which presents technical and potential long-term concerns. Achieving a perpendicular orientation for ideal screw placement arthroscopically is technically demanding. Additionally, when screw fixation is performed, caution must be taken to avoid injury to the adjacent axillary, musculocutaneous, and suprascapular nerves.[15-17] Other concerns involve graft osteolysis and symptomatic hardware.[18-22] Because achieving bony augmentation through an open technique presents a unique set of complications, arthroscopic techniques have been described more recently.[18,23-27] However, concerns with arthroscopic fixation techniques have persisted.[28,29] Suture anchors have shown promising biomechanical results when compared with screw fixation and remain a reliable option for the management of anteroinferior glenohumeral instability.[30,31] Suture anchor fixation may be a promising alternative to avoid the concerns associated with traditional screw fixation.

In this report, we describe a technique for arthroscopic suture anchor fixation of distal tibia osteochondral allograft. The aim is to detail the rationale and technical aspects of osteochondral bone augmentation of glenoid bony defects using suture anchor fixation. The benefits of this technique include the use of a standard arthroscopic approach for graft delivery that obviates working medially to the coracoid or requiring a subscapularis split. Additionally, this technique uses an approach as well as instrumentation with which the surgeon is familiar.

Surgical Technique

Step 1: Preoperative Workup

The standard workup for recurrent glenohumeral instability primarily includes a detailed history and physical examination. Advanced imaging is obtained to closely assess soft-tissue integrity, as well as evaluate for and quantify glenoid bone loss. The amount of bone

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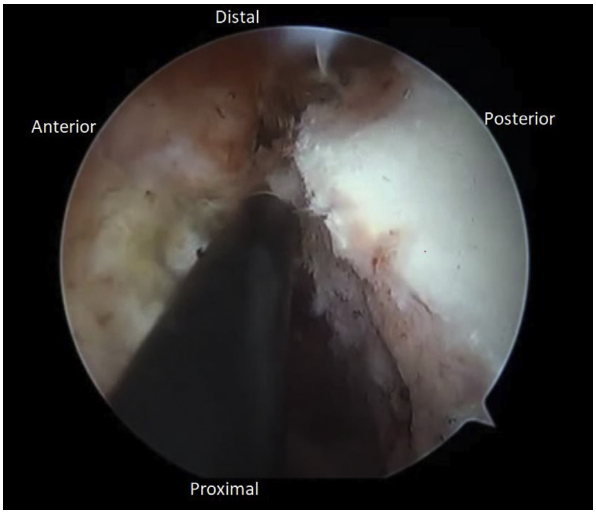

Fig 1. View from the anterosuperior portal of a right shoulder in the lateral decubitus position showing the glenoid (right) and liberated capsule and labrum (left).

loss is calculated on magnetic resonance imaging or computed tomography in each patient. The results of this workup are used to determine the patient's candidacy for the procedure; we use glenoid bone loss of 20% as a relative indication for bony augmentation. This imaging is also used to determine the size of graft necessary to restore the shoulder to an on-track deformity and re-create a native anatomic perfect circle.

Step 2: Surgical Positioning

An examination under anesthesia is performed once general anesthesia is obtained. The patient is then positioned in the lateral decubitus position using a beanbag. The arm's position is held in standard fashion at our institution with a padded arm sleeve (STAR sleeve; Arthrex, Naples, FL), along with devices for traction and lateral distraction. Standard posterior, anterosuperior, and mid-glenoid portals are established.[32] The posterior portal is established initially to allow subsequent portals to be placed under direct visualization by an outside-in technique. Of note, this posterior portal is enlarged such that it can accommodate a standard Latarjet 6-mm offset guide (Arthrex).

Step 3: Diagnostic Arthroscopy and Glenoid Preparation

A diagnostic arthroscopy is performed to thoroughly assess the present pathology. Preoperative imaging is correlated with intraoperative visualization to focus on the area of bone loss. To confirm a minimum of 20% bone loss, a probe is placed through the posterior portal for intra-articular measurement while the arthroscope is placed anteriorly. Capsular and aggressive labral liberation is performed (Fig 1, Video 1). The anterior glenoid surface is prepared for graft placement by

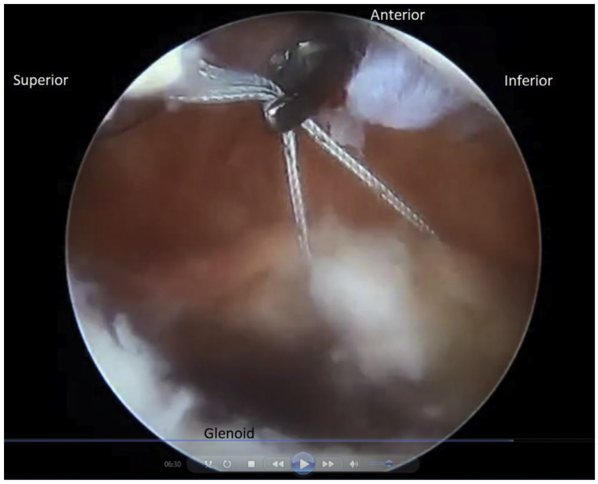

Fig 2. View from the posterior portal of a right shoulder in the lateral decubitus position showing percutaneous retrieval of the anterior retraction stitch previously passed through the anterior labrum from the mid-glenoid portal.

debridement down to viable bone with an emphasis on creating a flush surface to receive the graft. Care is taken to confirm adequate space for graft fixation inside the liberated labrum. A single suture is placed through the anterior labrum and retrieved percutaneously. This suture allows later retraction that is performed to facilitate graft delivery (Fig 2, Video 1).

While viewing from the anterosuperior portal, the surgeon places the Latarjet guide from the posterior portal until the flange sits flush on the glenoid and the guide is in direct bony contact posteriorly (Fig 3, Video 1). The flange should be perpendicular to the long axis of the glenoid. Kirschner wires are then placed through the posterior guide until they are visualized to be at the

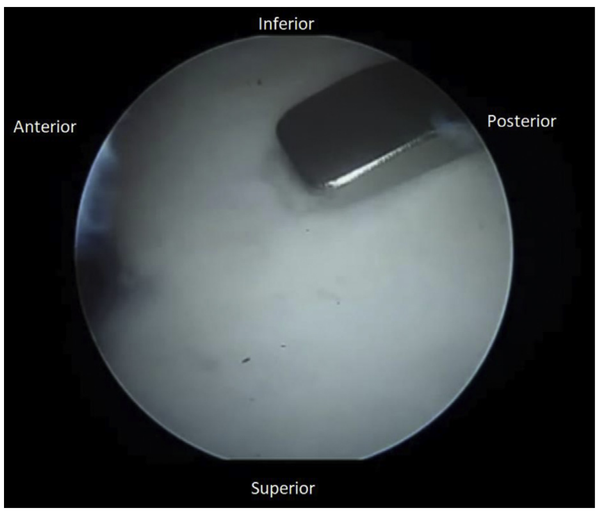

Fig 3. View from the anterosuperior portal of a right shoulder in the lateral decubitus position showing the arthroscopic Latarjet guide inserted through the posterior portal sitting flush on the glenoid surface.

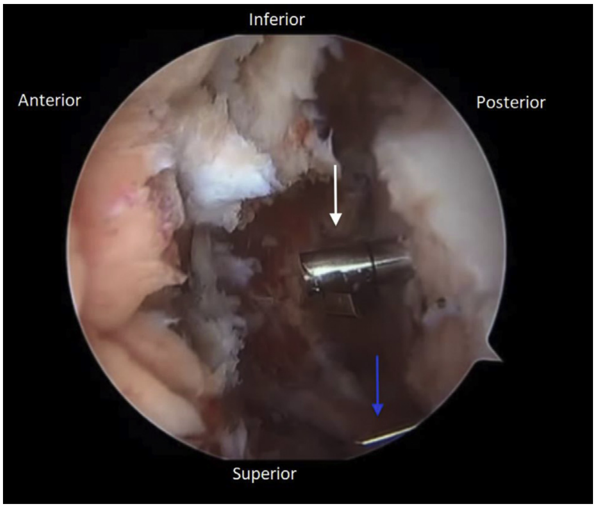

Fig 4. View from the anterosuperior portal of a right shoulder in the lateral decubitus position showing placement of the FlipCutter (white arrow) through a drill hole posteriorly with planing of the anterior glenoid surface to prepare the graft bed. The superior K-wire (blue arrow) placed through the Latarjet guide is still in place.

anterior margin of the glenoid. These wires should be placed parallel to each other, parallel to the glenoid surface, and with a 6-mm offset. After the guide is removed, the wires are over-drilled using a 3.5-mm cannulated drill. Next, the top-hat sleeves from the FlipCutter drills (Arthrex) are placed over the cannulated drills, which are then removed, leaving the FlipCutter top hats in place. The inferior FlipCutter is then placed into the top hat and advanced across the glenoid from posterior to anterior until it is visualized. Regarding the FlipCutter setting, the ideal size would be 16 mm; however, 13 mm is currently the largest size available and is therefore the size we use. The FlipCutter is spun and gently retracted until a perfectly rounded "flush cut" is obtained in the inferior half of the glenoid (Fig 4, Video 1). This process is repeated through the superior drill hole, which should create a similarly flush cut that is parallel to and slightly overlapping the inferior FlipCutter. This should result in a nearly perfect planning cut of the anterior glenoid without any significant step-off along the superior-to-inferior axis. The FlipCutters are then removed and replaced with a FiberStick (Arthrex) such that there is a passing stitch from posterior to anterior through each of the drill holes (Fig 5, Video 1).

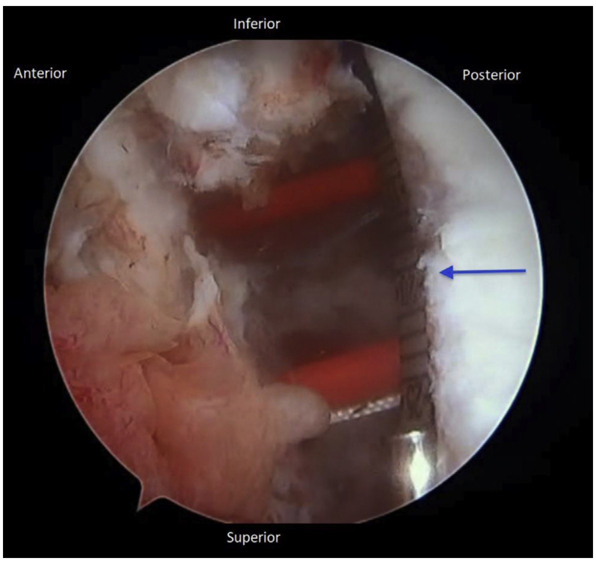

Fig 5. View from the anterosuperior portal of a right shoulder in the lateral decubitus position with passing sutures placed from posterior to anterior, with the bone measurement guide (blue arrow) in place from the mid-glenoid portal to measure graft size. The measurement guide is used to measure the glenoid bony defect to confirm accurate graft sizing.

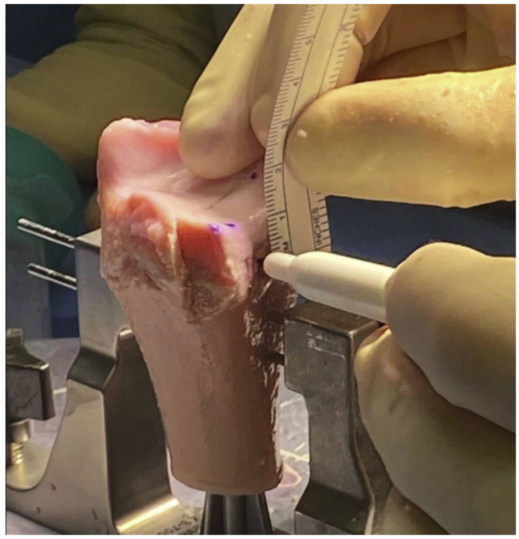

Fig 6. Preparation of distal tibial allograft.

Step 4: Graft Preparation

Although several grafts are available, the distal tibial allograft is our graft of choice and is detailed in this report. The distal tibial allograft is a versatile graft that has the distinct advantage of a chondral component. The tibial allograft is cut to the appropriate size as guided by preoperative imaging and intraoperative visualization. Typically, an 8-mm graft is sufficient to restore glenoid bone loss of approximately 30%.[1,6]

The graft should be cut and prepared according to the predetermined size required (Fig 6, Video 1). Typically, the graft should be roughly 25 mm long, 1 cm deep, and 1 cm wide. By use of the same Latarjet offset guide that was used on the glenoid, 2 drill holes are created, oriented parallel to the long axis of the graft. The previously used Kirschner wires and cannulated drills are again used to ensure that the graft tunnels exactly match the tunnels in the glenoid. Two 2.6-mm

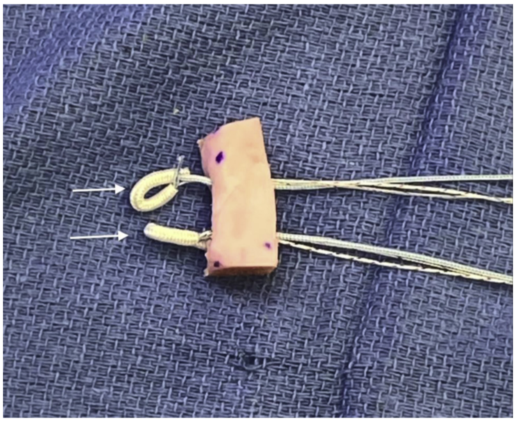

Fig 7. Prepared distal tibial allograft with suture anchors (white arrows) in place. By use of the Latarjet offset guide, 2 drill holes are created, oriented parallel to the long axis of the graft. Two 2.6-mm FiberTaks are then loaded in a retrograde manner through the graft holes with the tails of the suture anchors passed from anterior to posterior through the graft, outside the shoulder.

FiberTaks (Arthrex) are then loaded in a retrograde manner through the graft holes such that the tails of the suture anchors are passed from anterior to posterior through the graft, outside the shoulder (Fig 7, Video 1). The FiberTak loops, through which a trailing stitch is then placed, remain on the anterior aspect of the graft.

Step 5: Graft Delivery and Fixation

First, the mid-glenoid portal is replaced with a large 16-mm cannula (Arthrex) (Fig 8, Video 1). The 2 passing stitches that were previously placed through the

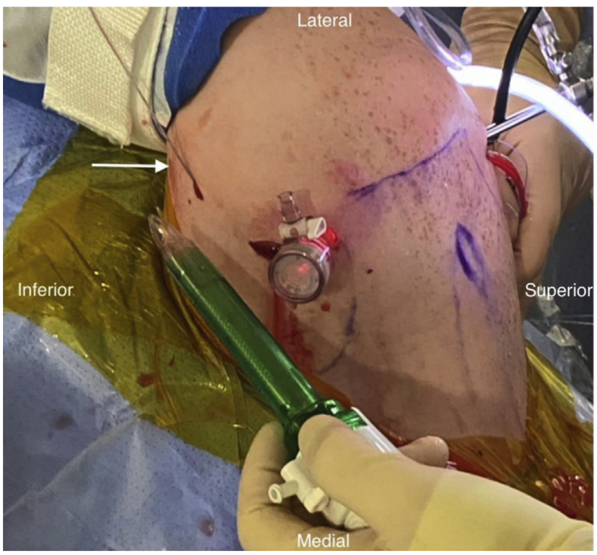

Fig 8. View of the right shoulder in the lateral decubitus position showing the large 16-mm cannula prior to insertion in the enlarged anterior mid-glenoid portal, with the retraction stitch (white arrow) as noted through the mid-glenoid portal attached to the anterior labrum.

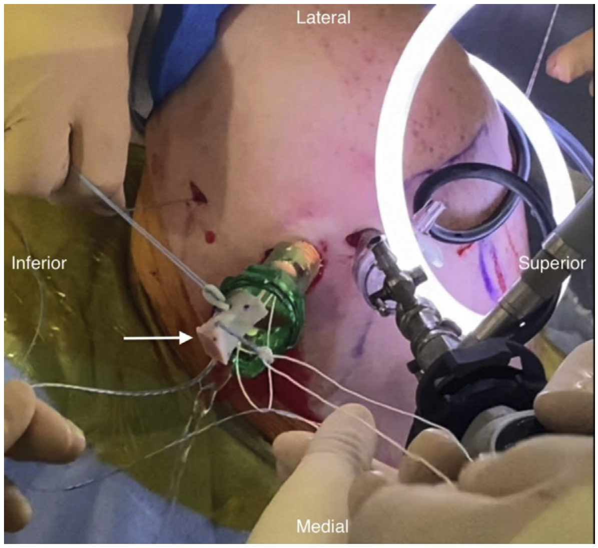

Fig 9. The distal tibial allograft (white arrow) is being shuttled in through the enlarged mid-glenoid portal while viewing is performed intra-articularly from the anterosuperior portal in a right shoulder in the lateral decubitus position.

glenoid are then retrieved through the mid-glenoid portal. The inferior passing stitch is tied around the tails of the inferior FiberTak, which is then repeated for the superior FiberTak. With the camera in the anterosuperior portal, the passing sutures are pulled from the back, delivering the tails of the FiberTaks through the glenoid in a retrograde fashion. This allows the glenoid to be delivered through the large mid-glenoid portal (Fig 9, Video 1). By use of both the posterior sutures and the anterior sutures through the loops of the FiberTaks, the graft can be maneuvered and its placement can be fine-tuned until it is flush against the

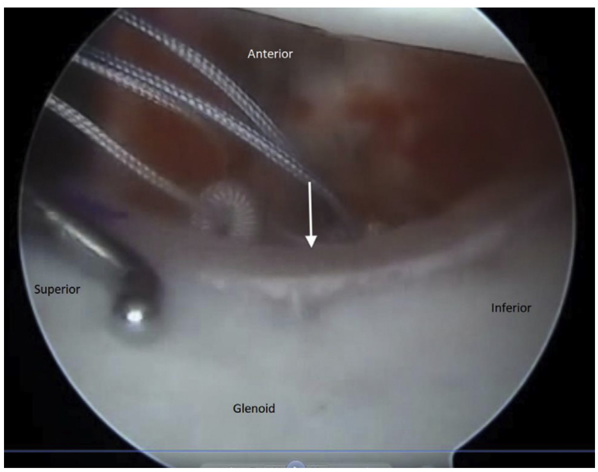

Fig 10. View from the posterior portal of the distal tibial allograft in position (white arrow) on the anterior glenoid in a right shoulder in the lateral decubitus position. The trailing stitches are outside the mid-glenoid portal, and the probe is through the anterosuperior portal.

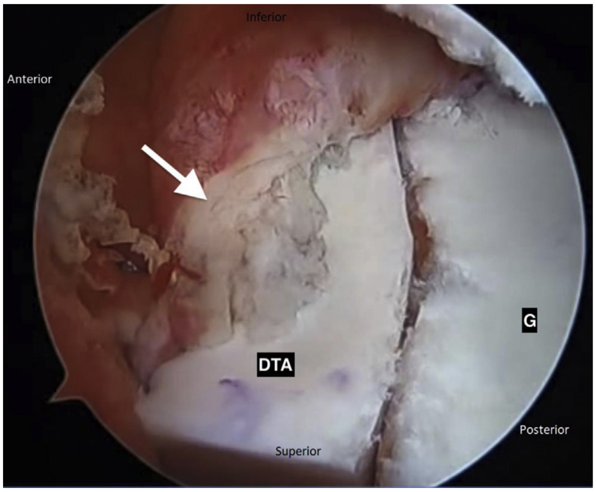

Fig 11. View from the anterosuperior portal of a right shoulder in the lateral decubitus position showing the final distal tibial allograft (DTA) in place adjacent to the native glenoid (G) with the repaired capsulolabral tissue (white arrow) in place over the graft.

native glenoid. Posteriorly, the inferior FiberTak passing suture is passed through the loop end of the superior FiberTak and delivered through the superior anchor. Likewise, the superior passing suture is placed through the loop of the inferior FiberTak loop and delivered through the inferior anchor. This creates a double-mattress self-locking mechanism. Finally, the passing sutures are progressively and alternatively tensioned until the graft is compressed to the desired position on the glenoid. There should be nearly anatomic alignment between the cartilage surfaces of the graft and glenoid (Fig 10, Video 1).

Step 6: Labral Restoration and Closure

Once the graft is positioned appropriately, attention is turned to the labrum. The sutures previously placed through the anterior loops are now passed through the native anterior labrum, which repairs the native labrum to the anatomic anterior aspect of the graft (Fig 11, Video 1). Arthroscopic instruments are then removed, and the skin is closed and dressed in standard sterile fashion.

Step 7: Rehabilitation Protocol

The patient follows our institution's standard Latarjet protocol. This includes use of a sling in neutral rotation for 6 weeks with pendulum movements allowed immediately postoperatively, with a graduation to passive motion at 3 weeks. The goal timeline for compete return of range of motion is 8 weeks. Also at 8 weeks, imaging is obtained to evaluate graft incorporation. If radiographic evidence of incorporation is present, active range of motion is initiated. Strengthening is added at 16 weeks, and a full return to activity is permitted at 6 months once final radiographs are obtained.

Discussion

Glenoid bone loss is a complex issue that is centrally implicated in recurrent shoulder instability after primary dislocation.[3,7] Specifically, bone loss ranging from 15% to 20% is deemed critical and has been independently associated with an increased risk of recurrent instability events.[2,33] In cases with glenoid bone loss greater than that which can be managed with a coracoid graft, bone grafting procedures are preferred.[34] Various treatment strategies exist, with options including an open approach versus an arthroscopic approach, in addition to various graft options (Table 1). Each of these is associated with respective benefits and drawbacks. The optimal procedure would be one that is technically viable, financially responsible, available arthroscopically, and reproducible and that uses a bone graft that allows for robust osseous and chondral augmentation.

In terms of arthroscopic management of glenoid bone loss, the most commonly cited options include the Latarjet procedure, iliac crest autograft, distal tibial allograft, and distal clavicle autograft.[8,23,24,26,35] Fixation options also vary between screw, suture button, and suture anchor fixation. Metal screws are traditionally used for fixation, and this technique is supported by clinical and biomechanical studies.[36,37] The traditional screw fixation technique has benefits of biomechanical stability and technical viability.[28] However, concerns associated with screw fixation exist,

Table 1. Advantages and Disadvantages of Common Glenoid Bone Grafts and Coracoid Transfer Procedures

	Advantages	Disadvantages
Iliac crest autograft	Anatomic restoration of contouring, incorporation, availability, cost	No chondral surface, donor-site morbidity risk
Distal clavicle autograft	Osteochondral, availability, incorporation, cost	Donor-site morbidity, prior AC arthritis as limiting factor
Latarjet or Bristow coracoid transfer	Availability, cost, sling effect	Nonanatomic solution, technically challenging, no chondral surface
Distal tibial allograft	Osteochondral, restoration of contouring, no donor-site morbidity	Incorporation, cost, availability

AC, acromioclavicular joint.

Table 2. Pearls and Pitfalls of Arthroscopic Suture Anchor Fixation of Distal Tibial Allograft for Shoulder Instability

Pearls	Pitfalls
A sufficiently wide exposure should be obtained.	Inadequate exposure of the glenoid and labrum should be avoided. Failure to expose or properly prepare the native bone will result in difficult graft placement and inadequate conformity.
The same drill guide should be used for the glenoid and for the graft to ensure proper matching and alignment.	Failure to manage sutures may result in tangling and may prevent graft passage.
Accurate FlipCutter placement should be ensured, with slight overlapping of the superior and inferior cuts and care taken to avoid any step-off.	Failure to create flush and accurate FlipCutter cuts may result in poor graft positioning or mal-seating.
Handheld tensioners should be used to apply generous pressure to ensure graft conformity.	Failure to appropriately tension the graft may result in poor congruity of the construct.

including an increased risk of osteolysis, neurovascular damage, and symptomatic hardware in up to 46% of patients.[15,19,38] Accordingly, screw-less fixation methods such as suture buttons or suture anchors are appealing options. Fixation with suture buttons has been described in the literature and has biomechanical strength similar to screw fixation but is technically demanding, with a reported learning curve of 30 operative cases.[29,39] Fixation with suture anchors may be an appealing alternative that also has shown adequate biomechanical strength.[31]

This report describes the rationale, technique, and limitations of arthroscopic management of glenoid defects using an osteochondral allograft. The outlined technique involves a distal tibial allograft. It is important to note that suture anchors can be used in the fixation of other grafts, such as coracoid, iliac crest, or distal clavicle graft, per the treating surgeon's preference. Benefits of the reported technique include stable biomechanical fixation, a limited risk of graft osteolysis, a decreased risk of symptomatic hardware, and elimination of the need for the far-medial portal. Limitations include the potential for an increased learning curve, cost, and issues associated with graft choice including bony incorporation. Table 2 presents pits and pitfalls of our procedure. Long-term studies are needed to analyze the clinical outcomes of suture anchor fixation, in addition to tracking any consequences of glenoid reactions to all-soft suture anchors that have been noted in cases of labral repair.[40]

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