



Fresh Distal Tibial Allograft: An Updated Graft Preparation Technique for Anterior Shoulder Instability

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Abstract: Fresh distal tibia allograft (DTA) has been gaining popularity among surgeons as an anatomic reconstruction option for the treatment of significant glenoid bone loss. Fresh DTA results in a clinically stable joint with excellent clinical outcomes and minimal graft resorption, and it has similar outcomes as the Latarjet procedure. Proper graft preparation and fixation are critical to ensuring optimal outcomes. The purpose of this Technical Note is, therefore, to describe our updated technique for DTA preparation that highlights precise cutting anatomy, sizing options, and use of orthobiologics to optimize distal tibia graft union to the native glenoid surface.

Introduction

Recurrent anterior glenohumeral instability remains a growing concern, largely due to its complex pathology of osseous defects. In the setting of recurrent instability, further attritional bone loss along the glenoid rim has been reported at rates as high as 90%, compromising the static restraints of the glenohumeral joint.^{1,2} While a variety of bone-grafting procedures has been described for glenoid reconstruction, postoperative complications, such as graft resorption

and osteolysis due to nonanatomic restoration of the anterior glenoid profile can occur.^{3,4} For such reasons, use of fresh distal tibia allograft (DTA) has been gaining popularity among surgeons. A fresh DTA graft contains the robust cartilaginous surface that allows both

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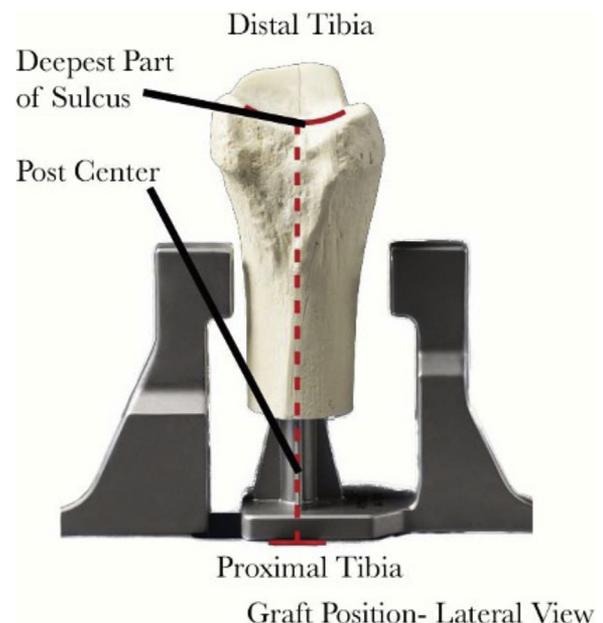


Fig 1. The distal tibia graft should be positioned over the post so that the deepest portion of the sulcus is in line with the center of the post. This will ensure that the graft is cut congruently and allow for best match with the anterior glenoid.



Fig 2. When the graft is positioned, it should be rotated so that the surgeon is facing the lateral aspect of the graft. Prior to placing the cutting blocks and performing graft cuts, the cartilage margins should be marked to ensure the prepared graft has a stable cartilage margin.

anatomic and osteoarticular restoration of the glenoid, maintaining excellent conformity to the humeral head throughout a full arc of motion.^{5,6}

While glenoid reconstruction with DTA has a proven clinical success with excellent outcomes and minimal graft resorption comparable to the Latarjet procedure,^{7,8} postoperative complications can occur due to graft resorption and malposition. Proper graft preparation and fixation are, therefore, critical to ensuring optimal outcomes. Makihara et al.⁹ highlight that postoperative changes in glenoid graft depend on whether and where bone union occurs; an improperly sized bone graft can result in nonanatomic fixation of the anterior osseous profile leading to osteoarthritis and also impair proper blood flow to aspects of the graft, causing bone resorption. Although distal tibia graft preparation has been described in prior literature, it is essential to provide updated techniques that optimize bone union and subsequent clinical outcomes. The purpose of this Technical Note is, therefore, to describe our updated technique for DTA preparation that

highlights precise cutting anatomy, sizing options, and use of orthobiologics to ensure excellent distal tibia graft union to the native glenoid surface.

Surgical Technique

A detailed video with demonstration of the surgical technique described in the following may be reviewed ([Video 1](#)). For this technique, a DTA graft is used from a donor cadaveric source (JRF Ortho, Centennial, CO).

Graft Positioning

Graft preparation begins by placing the intramedullary portion of the distal tibia allograft over the cutting jig post. An Arthrex workstation (Arthrex, Naples, FL) is used to securely fix the allograft in a safe position, allowing for graft preparation. The deepest portion of the lateral sulcus should be in line with the post ([Fig 1](#)). The graft is then secured with spanning Kirschner wires (K-wires). Graft size can then be estimated by placing the template against the graft.

Graft Preparation: Anterior to Posterior Sizing

The cartilage margin at the anterior and posterior aspect of the graft is then marked, as well as planned lateral graft cut ([Fig 2](#)). Using the first cutting block, the surgeon uses a sagittal saw to make the “CUT #1” slot, to remove the peroneal tubercle. The cutting block should be kept in the same position, and the angled cut should then be made using the “CUT #2” slot, which is

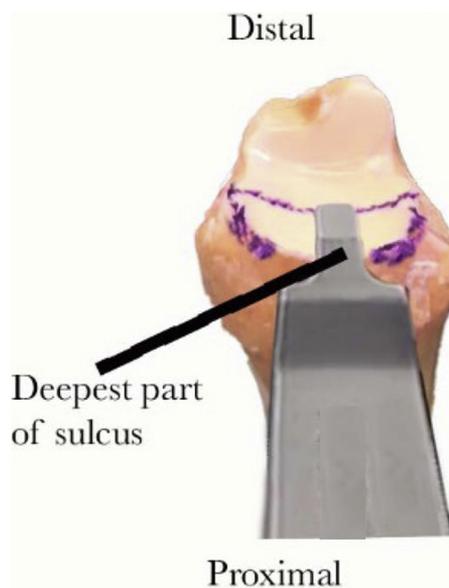


Fig 3. With the graft positioned, a parallel drill guide with extension is placed so that the extension is flush with the cartilaginous surface and at the deepest portion of the sulcus. This will prevent the screws from being placed too close to the articular surface, which may result in screw penetration.

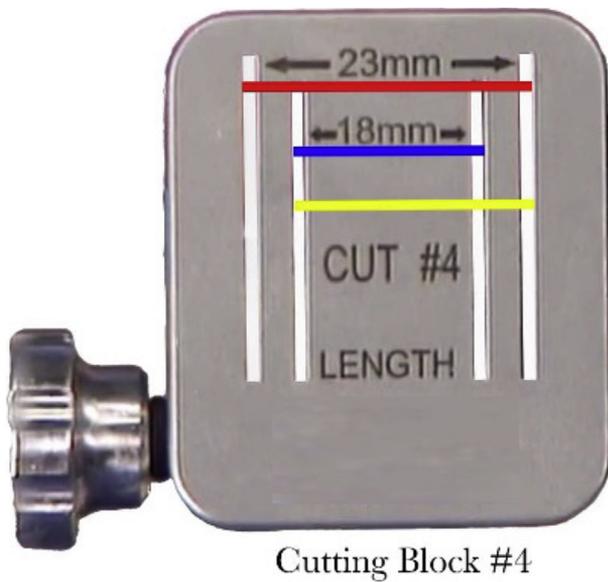


Fig 4. The fourth cutting block will have four total cutting slots; two “outer” slots closest to the edge of the block and two “inner” slots closer to the center of the block. The cutting slots will set the superior to inferior length of the graft. With this block fixed, there are three different sized grafts, which can be cut: A 23-mm graft can be cut using both the outer cutting slots (red line); an 18-mm graft can be cut using both of the inner cutting slots (blue line); and a 21.5-mm graft can be cut by using the outer slot on one side of the block and the inner slot on the other side of the block.

determined by the preoperative template. While using the sagittal saw and drill during graft preparation, irrigation should be used to keep the cells viable.

Graft Preparation: Graft Drilling

A parallel guide with a finger projection is placed over the graft so that the guide is centered on the graft and at the sulcus of the graft (Fig 3). Two K-wires are inserted

through the guide and overdrilled using a 4-0 cannulated drill bit.

Graft Preparation: Medial to Lateral Sizing

The third cut (“CUT#3”), which sets the medial to lateral depth of the graft, is made by placing the saw blade on top of the cutting block. Prior to making a cut, a free graft guide will be placed to ensure an appropriate depth of graft. The saw must be always kept parallel and in contact with the cutting block.

Graft Preparation: Superior to Inferior Sizing

The cutting block for the fourth cut (“CUT#4”) is secured just on top of the graft. The cutting block will allow for three variations in graft size, from superior to inferior. Using the innermost slots, the surgeon creates an 18-mm graft. Using the outer slots, a 23-mm graft will be created; using one inner slot and one outer slot will create a 21.5-mm graft (Fig 4).

Graft Separation

The parallel guide is then used to remove the graft from the distal tibia. The free graft guide can be used to compare the prepared graft to the template. A sagittal saw can be used to bevel the anterior edges of the graft prior to fixation to complete graft preparation (Fig 5).

Irrigation and Insertion

A pulse lavage can be used on the graft to remove remnant bone marrow and mitigate the risk for cross-reactivity and inflammatory responses following transplantation. The graft is then soaked in orthobiologic (Greyledge Technologies, Vail, CO). Prior to graft insertion, two or three K-wires are drilled through the graft. Once the graft is positioned appropriately, the K-wires are advanced to provisionally fix the graft in place. The pearls and pitfalls associated with the DTA preparation technique are listed in Table 1.

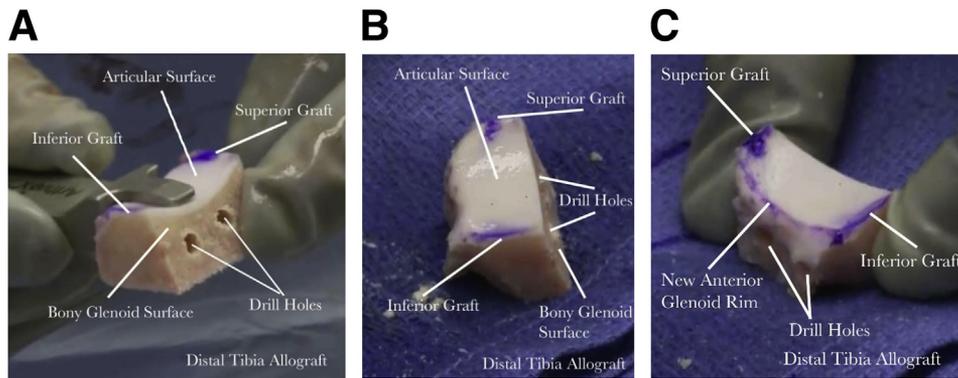


Fig 5. The completed distal tibia allograft will have two 4.0 mm drill holes through the center in an anterior to posterior direction. The graft surface which will be placed against the native glenoid will be angled, based on cutting block used. The new anterior glenoid rim will correspond to the lateral surface of the distal tibia. (A-C) Multiple views of the prepared distal tibia allograft can be seen.

Table 1. Pearls and Pitfalls of Preparation Technique of Distal Tibial Allograft for Anterior Shoulder Instability

Pearls	Pitfalls
<p>The distal tibia should be centered over the graft post with the deepest portion of the sulcus in line with the midpoint of the post.</p> <p>Use copious irrigation when making cuts with sagittal saw to keep osteochondral allograft cells viable.</p> <p>The closer the cutting block is to the distal tibia allograft, the more secure it will be. Tighten the cutting block with a Kocher clamp prior to performing any cuts.</p> <p>If a graft is longer in the superior/inferior direction, an additional screw can be safely used.</p> <p>Irrigate the graft for 10 minutes with pulse lavage to remove all remnant bone marrow.</p> <p>Platelet-rich plasma, if available, can be used for graft soaking prior to insertion.</p>	<p>Failure to template appropriately preoperatively may result in inadequate graft size or inadequate graft angulation.</p> <p>Incomplete soft tissue/capsular release will result in superior placement of graft as well as a more horizontal screw trajectory.</p> <p>Performing a full-depth cut prior to scoring the cartilaginous surface can result in vibration-induced motion of the distal tibia graft and graft jig. This may alter the graft position and cause the cuts to be in the wrong plane or trajectory.</p> <p>Drilling the glenoid drill holes without provisionally fixing the graft in place may result in an incongruous surface. Adjustment of the graft position following glenoid hole placement can cause enlarged/connected drill tunnels and prevent screw purchase.</p>

Discussion

Management of significant glenoid bone loss in chronic anterior shoulder instability remains a challenge. In their recent systematic review, Gilat et al. found no significant difference between the Latarjet procedure and the free bone block (FBB) procedure in rates of recurrent instability, osteoarthritis, return to sports, and other complications.¹⁰ Both procedures provided significant improvement in clinical outcome after surgeries. However, primary complications in the FBB groups were persistent pain and donor site morbidity (pain and numbness).¹⁰ DTA is the preferred choice in FBB procedure with many advantages, including no donor site morbidity, restoration of a large glenoid defect, excellent articular congruency with the humeral head, restoration of biomechanics of the glenoid, and a robust option for treatment following a failed Latarjet procedure.^{5,11} Moreover, fresh DTA glenoid reconstruction for recurrent shoulder instability has shown an improvement in functional outcome at an average follow-up of 45 months, with a high

allograft healing rate of 89%, minimal graft resorption (3%), and no case of recurrent instability.⁸ A recent matched cohort analysis showed that DTA had excellent outcomes after surgery with low recurrent instability rates, similar to the well-accepted Latarjet procedure.⁷

Optimal allograft position placement in the setting of glenoid bone loss has been shown to have superior healing and graft incorporation rates.⁸ As opposed to using free-hand graft preparation techniques, which have been reported to have a high learning curve and demand substantial surgical experience,⁵ detailed preoperative planning and use of the precise surgical devices for graft preparation can be used to achieve excellent outcomes. Incorrect cuts may compromise the congruency for restoring the native joint mechanics and increase risk of intraoperative complications, such as graft fracture or articular cartilage injury.¹¹ Our technique for DTA preparation has several advantages. First, to accommodate the specific glenoid version, the allograft is angle cut by the cutting block ("CUT#2") that is determined preoperatively. Second, a parallel drill guide with extension will prevent the screw penetration to the articular surface. This guide is also used to transport the allograft to the glenoid neck for an optimal positioning and facilitate leveling to the native glenoid. Lastly, the cutting block ("CUT#4") for superior to inferior sizing cut has three variable graft lengths: 18, 21.5, and 23 mm. These variations of cutting lengths will facilitate an optimal size of allograft reconstruction. The advantages and disadvantages associated with the DTA preparation technique are listed in [Table 2](#).

This preparation technique for fresh DTA is a safe method and has precise cutting steps for an optimal shape and size of the graft. The best fit allograft position may improve clinical outcomes and promote superior graft healing.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
To accommodate the patient specific glenoid version by the cutting block (CUT#2)	Availability of instruments in some regions
Prevent screw penetration to the articular surface by a parallel drill guide	High cost
Facilitate for an optimal position and leveling to the native glenoid during graft transportation	
Have variable cutting length ("CUT#4")	
To protect surgeons from direct injury	

References

1. Piasecki DP, Verma NN, Romeo AA, Levine WN, Bach BR Jr, Provencher MT. Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management. *J Am Acad Orthop Surg* 2009;17:482-493. <https://doi.org/10.5435/00124635-200908000-00002>.
2. Provencher MT, Bhatia S, Ghodadra NS, et al. Recurrent shoulder instability: Current concepts for evaluation and management of glenoid bone loss. *J Bone Joint Surg Am* 2010;92:133-151. <https://doi.org/10.2106/jbjs.J.00906> (Suppl 2).
3. Boehm E, Minkus M, Moroder P, Scheibel M. Massive graft resorption after iliac crest allograft reconstruction for glenoid bone loss in recurrent anterior shoulder instability. *Arch Orthop Trauma Surg* 2020;140:895-903. <https://doi.org/10.1007/s00402-020-03380-z>.
4. Zhu YM, Jiang CY, Lu Y, Li FL, Wu G. Coracoid bone graft resorption after Latarjet procedure is underestimated: A new classification system and a clinical review with computed tomography evaluation. *J Shoulder Elbow Surg* 2015;24:1782-1788. <https://doi.org/10.1016/j.jse.2015.05.039>.
5. Provencher MT, Ghodadra N, LeClere L, Solomon DJ, Romeo AA. Anatomic osteochondral glenoid reconstruction for recurrent glenohumeral instability with glenoid deficiency using a distal tibia allograft. *Arthroscopy* 2009;25:446-452. <https://doi.org/10.1016/j.arthro.2008.10.017>.
6. Decker MM, Strohmeyer GC, Wood JP, et al. Distal tibia allograft for glenohumeral instability: Does radius of curvature match? *J Shoulder Elbow Surg* 2016;25:1542-1548. <https://doi.org/10.1016/j.jse.2016.01.023>.
7. Frank RM, Romeo AA, Richardson C, et al. Outcomes of Latarjet versus distal tibia allograft for anterior shoulder instability repair: A matched cohort analysis. *Am J Sports Med* 2018;46:1030-1038. <https://doi.org/10.1177/0363546517744203>.
8. Provencher MT, Frank RM, Golijanin P, et al. Distal tibia allograft glenoid reconstruction in recurrent anterior shoulder instability: Clinical and radiographic outcomes. *Arthroscopy* 2017;33:891-897. <https://doi.org/10.1016/j.arthro.2016.09.029>.
9. Makihara T, Abe M, Yamazaki M, Okamura K. Bone union of the transferred coracoid graft is the key factor affecting the extent of postoperative graft changes and the clinical results following the modified Bankart and Bristol procedure: A computed tomography scan study. *J Orthop Surg Res* 2019;14:84. <https://doi.org/10.1186/s13018-019-1129-6>.
10. Gilat R, Haunschild ED, Lavoie-Gagne OZ, et al. Outcomes of the Latarjet procedure versus free bone block procedures for anterior shoulder instability: A systematic review and meta-analysis. *Am J Sports Med* 2021;49:805-816. <https://doi.org/10.1177/0363546520925833>.
11. Ferrari MB, Sanchez A, Sanchez G, Akamefula R, Kruckeberg BM, Provencher MT. Use of a cutting instrument for fresh osteochondral distal tibia allograft preparation: Treatment of glenoid bone loss. *Arthrosc Tech* 2017;6:e363-e368. <https://doi.org/10.1016/j.eats.2016.10.010>.