Technical Note

Primary Distal Tibia Allograft for Restoration of Glenohumeral Stability with Anterior Glenoid Bone Loss

Jordan L. Liles, M.D., Phob Ganokroj, M.D., Annalise M. Peebles, B.A., Mitchell S. Mologne, B.S., and CAPT Matthew T. Provencher, M.D., M.B.A., M.C., U.S.N.R., (ret.)

Abstract: Recurrent shoulder instability with glenoid bone deficiency remains an increasing risk for failed shoulder stabilization surgery. Numerous free bone block procedures for primary treatment of anterior shoulder stability have been introduced as an alternative for the Latarjet procedure, including both autografts and allografts. Among such options is the fresh distal tibial allograft (DTA), a dense weightbearing bone without donor site morbidity and excellent conformity to the native glenoid. The aim of this Technical Note is therefore to describe our surgical technique for use of fresh DTA as a free bone block choice in the setting of primary anterior glenoid reconstruction in a patient with recurrent shoulder instability.

Recurrent shoulder instability with glenoid bone deficiency remains an increasing risk for failed shoulder stabilization surgery.[1-3] Although the Latarjet procedure has long been accepted as the standard of care for this pathology,[4,5] it is not without complications; these include limited postoperative range of motion or development of glenohumeral arthritis because of the nonanatomic nature of the coracoid bone block.[6] Numerous free bone block procedures for anterior shoulder stability have been introduced as an alternative for the Latarjet procedure, including both autografts and allografts.[6] Among such options is the fresh distal tibial allograft (DTA), a dense weightbearing bone without donor site morbidity and excellent conformity to the native glenoid.[7]

The fresh DTA glenoid reconstruction for recurrent shoulder instability has shown improvement in functional outcomes with high allograft healing rate, minimal graft resorption rate, and a low recurrent instability that was similar to the well-known Latarjet procedure.[5,8] In their matched cohort analysis, Frank et al.[5] illustrated that patients treated with DTA for glenoid bone loss had significantly improved subjective and functional outcomes, with an overall recurrent instability rate of only 1%. Although treatment of anterior glenoid bone loss with the DTA procedure for failed Latarjet has been described in prior literature, to our knowledge there has not yet been a technique described for DTA as a primary surgery for treatment of anterior glenoid bone loss. As such, it is essential to provide a modern technique that optimizes graft union and subsequent clinical outcomes. The aim of this Technical Note is therefore to describe our surgical technique for use of fresh DTA as a free bone block choice for primary anterior glenoid reconstruction in a patient with recurrent shoulder instability.

Technique

A detailed video with demonstration of the surgical technique described in the following may be reviewed (Video 1).

From the Steadman Clinic (J.L., P.G., M.T.P.), and the Steadman Philippon Research Institute (A.M.P., M.S.M., M/T.P.), Vail, Colorado, U.S.A., and the Faculty of Medicine Siriraj Hospital (P.G.), Bangkok, Thailand

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received December 27, 2021; accepted February 6, 2022.

Address correspondence to CAPT Matthew T. Provencher, M.D., M.C., U.S.N.R., Steadman Philippon Research Institute, The Steadman Clinic, 181 W Meadow Dr, Ste 400, Vail, CO 81657, U.S.A. E-mail: mprovencher@thesteadmanclinic.com

2212-6287/211823

https://doi.org/10.1016/j.eats.2022.02.006

Approach

The patient is placed in the standard beach chair position with the body at approximately 45°. The case is started by performing a standard diagnostic arthroscopy to evaluate for coexisting intra-articular pathology. After this, a Bankart incision and standard deltopectoral approach is used to gain access to the anterior glenoid.

Subscapularis Split

The subscapularis tendon is then exposed by releasing adhesions superiorly and inferiorly with Metzenbaum scissors. Medial adhesions are then cleared with a Cobb elevator. The subscapularis split is made using a 15 blade in line with the fibers of the subscapularis, at approximately the 60%/40% split of the tendon (Fig 1). The split should be made medially to the level of the musculotendinous junction and avoid over medialization of the split.

Capsulotomy

An inverse L-capsulotomy is then performed using a 15 blade with the apex of the "L" superomedially. The medial limb of the capsulotomy is 1 cm in length and at the glenoid neck. The lateral limb of the capsulotomy should be extended laterally to the point where the fibers insert on the humeral head. A stay suture is placed in the superomedial corner of the capsule to help with capsular retraction and mobilization (Fig 2).

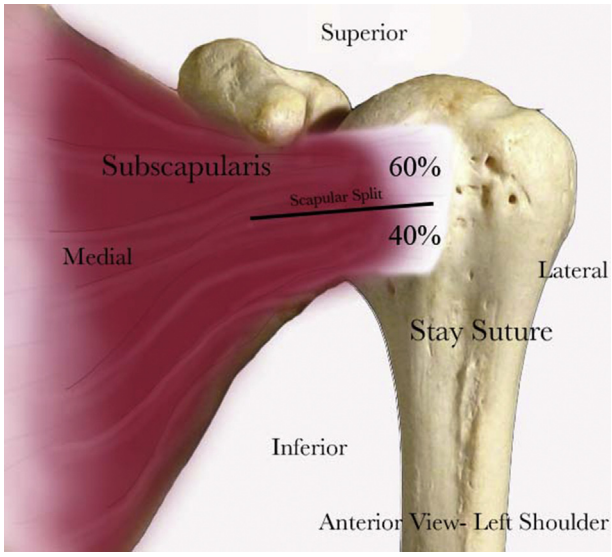

Fig 1. Drawing of the left shoulder (in beach chair position), viewed from anterior. When performing the subscapularis split, the split should be made in line with the fibers of the subscapularis tendon and at the 60%/40% separation (60% of the tendon above the split, 40% of the tendon below the split). It should be taken medially to the level of the conjoined tendon to avoid damage to the upper subscapular nerve.

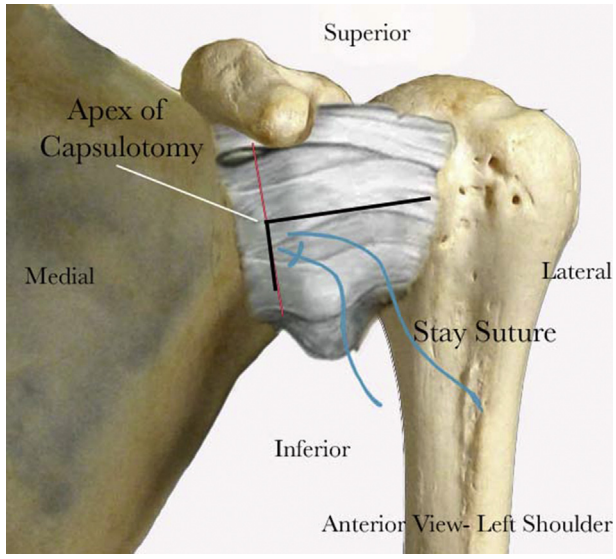

Fig 2. Drawing of the left shoulder (in beach chair position), viewed from anterior. The capsulotomy should be made so that the horizontal limb is in line with the subscapularis split, and the vertical limb is extending inferiorly at the level of the glenoid neck. This reduces risk of damage to the underlying cartilage. A suture can be placed in the apex of the capsule to improve visualization and retraction.

Axillary Nerve Neurolysis

Metzenbaum scissors and blunt dissection are used to palpate and release the axillary inferior to the subscapularis tendon and at the inferior aspect of the glenoid. This portion of the procedure is necessary because of scar entrapment and risk of axillary nerve palsy given the retraction placed along the anterior and inferior portion of the glenoid.

Glenoid Preparation

A Fukuda retractor is placed into the glenohumeral joint and used to retract the humeral head. A Cobb elevator is used to elevate the scarred capsule from the anterior glenoid. The capsule should be elevated as inferior as possible to aid with inferior graft placement. At this point, the humeral head should be examined for high-grade chondromalacia or deep wedge defects to determine whether grafting of the humeral head is required. The glenoid is then prepared for the distal tibia allograft with a high-speed burr and flattened using a powered rasp. Debridement should be continued until the surface is flat, and cortical bleeding has been encountered. At this point, a graft template block is placed on the glenoid to check exposure and adequate glenoid preparation.

Graft Preparation

On a back table, the implantable graft should be cut to size from the distal tibia allograft. Our preferred technique is using the GraftMaster system (Arthrex, Naples, FL). Once the graft is cut and removed from the distal

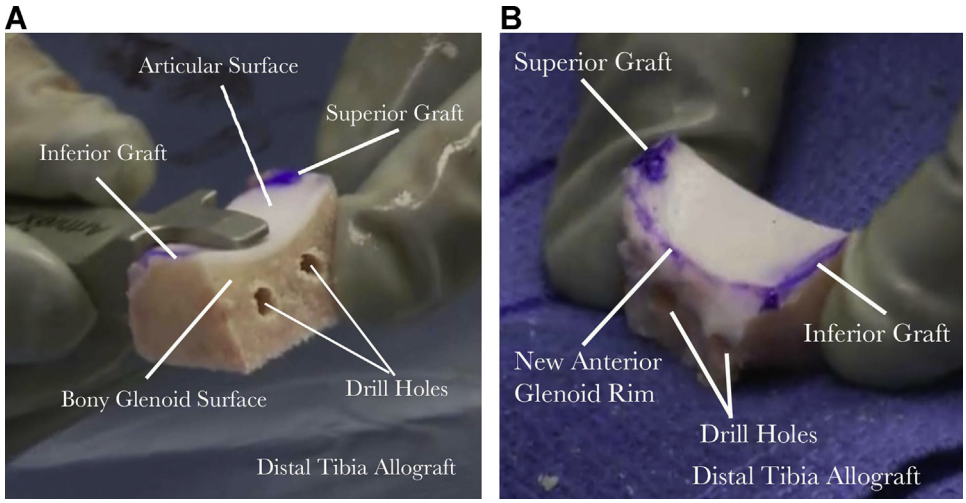

Fig 3. The distal tibial allograft after preparation, (A) viewed from medial to lateral and (B) viewed from the front aspect of the graft. The completed distal tibia allograft will have two 4.0 mm drill holes through the center in an anterior to posterior direction. The graft surface that will be placed 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.

tibia (Fig 3), a pulse lavage is used to remove any remnant bone marrow. Next, we prefer to soak the graft in leukocyte-rich, platelet-rich-plasma for 10 minutes. The graft is then inserted into the patient's shoulder and can be provisionally fixed in place using Kirshner wires. Multiple angles should be viewed and palpated to ensure the graft is appropriately positioned without a stepoff at the glenoid surface before screw fixation.

Graft Fixation

The 2.5 mm drill guide is then centered into the predrilled superior graft hole and a 2.5 mm drill is used to create the glenoid screw holes. An appropriately sized 3.75 mm fully threaded, non-cannulated screw with a screw washer, loaded with a high tensile suture, is inserted through the graft and into the glenoid. This process is repeated for the inferior screw. The screws are sequentially tightened by hand until the graft is fixed (Fig 4). Final evaluation of graft position and shoulder stability examination should take place before closure.

Capsular Repair

The preloaded suture washers are then used to repair the anterior capsule directly to the bone graft. The remaining capsule is then repaired with a high-tensile, permanent suture.

Subscapularis Repair

The subscapularis is repaired using 3 figure-of-eight no. 2 high-tensile suture. Repair of the subscapularis is performed laterally to the conjoined tendon. The rotator interval is closed with a no. 2 high-tensile suture. The fascia, deep dermal, and dermal layer are then closed according to surgeon preference.

Rehabilitation

After surgery the patient is limited in passive external rotation to 30° for the first 3 weeks. After this, the patient may progress with a therapist toward full active and passive range of motion.

Discussion

Although the Latarjet procedure has proven to be an excellent surgical option to restore shoulder stability in cases of anterior glenoid bone loss, complications

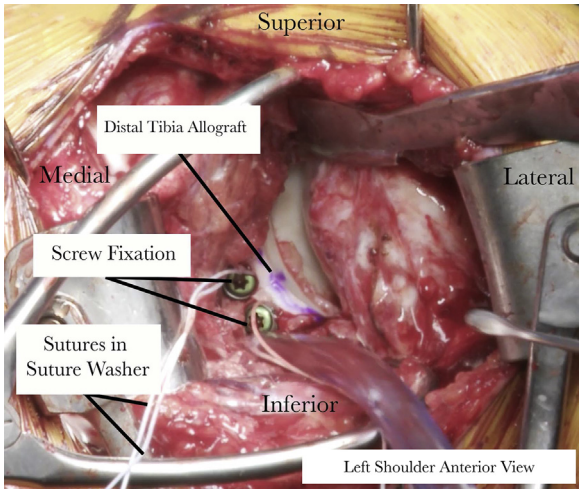

Fig 4. Operative photograph of the left shoulder (in beach chair position), viewed from anterior. Once the graft is placed and secured using two 4.0 mm fully threaded, noncannulated screws, joint surface congruity and joint stability can be assessed. The suture washers and loaded sutures provide a stable fixation point for the anterior capsule and remnant labrum to be reattached.

Table 1. Pearls and Pitfalls

Pearls
Perform a diagnostic arthroscopy prior to open portion of procedure. If additional pathology is present (chondral defects, posterior labral tear, very large Hill-Sachs deformity), additional surgical intervention may be required before/after Latarjet.
Circumferential release of adhesions from subscapularis is critical to allow tendon excursion and visualization of the anterior inferior glenoid
Place arm in internal rotation when performing capsulotomy.
K-wires placed through the graft before insertion allow for provisional fixation in the glenoid. Graft-glenoid surface incongruity can be adjusted more easily with K-wires and does not interfere with screw fixation strength.
A suture washer loaded with a permanent suture can allow a fixed, direct repair of the anterior capsule to the bone graft.
A powered rasp can help improve a uniformly flat anterior glenoid surface.
Pitfalls
If posterior labral tear is encountered, repair this after the open coracoid transfer to prevent labral repair damage caused by the Fukuda retractor.
Incomplete release of adhesions surrounding conjoined tendon and musculocutaneous nerve may prevent nerve mobilization and nerve traction injury to musculocutaneous nerve.
Extending capsulotomy too medial risks injury to the upper subscapular nerve, which exists approximately 43 mm medial to the coracoid base when the arm is in internal rotation and 24 mm medial to the coracoid base when the arm is in external rotation.
Repairing the subscapularis to the level of the coracoid with the arm in maximal external rotation risks a decrease of muscle contraction length, possibly decreasing internal rotation strength and range of motion.

related to the surgical procedure, such as musculocutaneous nerve palsy, graft nonunion, and graft-glenoid incongruity can be significant.[4,9] Given the geometric similarities between the native anterior glenoid and distal tibia, a DTA can serve as an excellent substitution for a coracoid transfer for restoring stability in cases of anterior glenoid bone loss.[10] Graft concavity, cartilage thickness, and weightbearing cortical bone all offer advantages for the distal tibia to serve as a suitable graft.[7] The pearls and pitfalls of the DTA procedure are listed in Table 1.

Studies have shown that DTA transplantation may improve joint congruency and decrease glenohumeral joint forces compared to the Latarjet.[8] Clinically, DTA transplantation yields a stable joint with similar outcomes (Visual Analog, American Shoulder and Elbow Score, Western Ontario Shoulder Instability Index, Single Assessment Numerical Evaluation) as the Latarjet.[7,8,11] Although the Latarjet procedure remains as the "gold standard" for restoration of bony stability, use of the DTA as a primary surgery has many advantages. For patients with lower activity requirements, without presence of coexisting osteoarthritis, or in patients at higher risk for nerve palsy from prior surgeries or chronic injuries, glenoid augmentation with DTA may serve as an excellent surgical alternative with a lower complication and morbidity profile. Additionally, in cases of significant glenoid bone loss (>25%), where a coracoid transfer is only able to restore approximately 10 to 12 mm of bone loss, DTA intervention is favored because of its comparatively larger graft size.[12] In their retrospective cohort study, Provencher et al. illustrate the high success rate of DTA as a primary bony augmentation procedure, reporting significant increase in both subjective and functional outcomes, with no differences between patients who had failed a previous instability surgery and those who underwent DTA as a primary procedure.[8]

This Technical Note is a safe and robust option for primary restoration of anterior glenoid bone loss in a patient with recurrent shoulder instability. This technique used DTA, a dense weightbearing bone without donor site morbidity, as a free bone block to restore glenoid concavity and ensure excellent conformity to the native humeral head.

References

1. 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 (Suppl 2).
2. Arner JW, Peebles LA, Bradley JP, Provencher MT. Anterior shoulder instability management: Indications, techniques, and outcomes. *Arthroscopy* 2020;36:2791-2793.
3. Rabinowitz J, Friedman R, Eichinger JK. Management of glenoid bone loss with anterior shoulder instability: Indications and outcomes. *Curr Rev Musculoskelet Med* 2017;10:452-462.
4. Bhatia S, Frank RM, Ghodadra NS, et al. The outcomes and surgical techniques of the Latarjet procedure. *Arthroscopy* 2014;30:227-235.
5. 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.
6. 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.
7. 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.
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.

9. Parada SA, Shaw KA, Moreland C, Adams DR, Chabak MS, Provencher MT. Variations in the anatomic morphology of the lateral distal tibia: Surgical implications for distal tibial allograft glenoid reconstruction. *Am J Sports Med* 2018;46:2990-2995.
10. Sanchez A, Ferrari MB, Akamefula RA, Frank RM, Sanchez G, Provencher MT. Anatomical glenoid reconstruction using fresh osteochondral distal tibia allograft after failed Latarjet procedure. *Arthrosc Tech* 2017;6(2):e477-e482.
11. Wong IH, King JP, Boyd G, Mitchell M, Coady C. Radiographic analysis of glenoid size and shape after arthroscopic coracoid autograft versus distal tibial allograft in the treatment of anterior shoulder instability. *Am J Sports Med* 2018;46:2717-2724.
12. Beaulieu-Jones BR, Peebles LA, Golijanin P, et al. Characterization of posterior glenoid bone loss morphology in patients with posterior shoulder instability. *Arthroscopy* 2019;35:2777-2784.