Technical Note

Transosseous Equivalent Technique for Bony Bankart Repair

Benjamin W. Hoyt, M.D., Jon F. Dickens, M.D., and Kelly G. Kilcoyne, M.D.

Abstract: Bony Bankart lesions of the anterior glenoid arise from traumatic glenohumeral instability events and can predispose persons to recurrent instability if not surgically stabilized. Large osseous fragments, when repaired anatomically, have excellent stability and functional outcomes; however, techniques to achieve this repair are often either tenuous or overcomplicated. In this technique guide, we describe a repair technique based on established biomechanical principles that achieves a reliable, anatomic glenoid articular surface. This technique can be readily applied in most bony Bankart settings using standard anterior labral repair instrumentation and implants.

Introduction

Anterior glenohumeral instability events typically occur via a traumatic mechanism in young, athletic persons, resulting invariably in capsulolabral injury and frequently in glenoid bone loss (GBL).[1,2] This bone loss can occur secondary to erosion or compression, as the humeral head engages the anterior glenoid rim. Substantial anterior GBL greatly increases the risk of failure of arthroscopic capsulolabral repair or increases the necessity of open or reconstructive options.[3,4]

However, in a study using computed tomography (CT) 3D reconstructions, Sugaya et al.[5] demonstrated that fractures (bony Bankart lesion) were present in 50% of shoulders with recurrent anterior instability. 54% of these were medium in size, comprising average 10.6% of the glenoid. When left unrepaired, osseous fragments in bony Bankart lesions will not provide an anterior buttress to humeral head escape and may eventually resorb. Nakagawa et al.[6] observed that when bony Bankart lesions were repaired and achieved union, recurrence rates were significantly lower and were similar to outcomes after capsulolabral repairs for soft tissue-only injuries, while failure of union greatly increased the risk of recurrence (46.9% vs 6.3%). In a separate study, Nakagawa et al.[7] determined that as larger osseous defects (>7.5% GBL) achieve union at a higher rate than smaller ones, large osseous defects counterintuitively had lower recurrence rates after repair (10.5% vs 33.3%).

As failure to anatomically reconstruct the glenoid within 2 mm of native congruence is a risk factor for recurrent instability,[8] it is critical to anatomically reduce and suspend the anterior glenoid rim. The goal of any repair of a bony Bankart is to achieve sufficient compression at the osseous junction to enable bony healing in an anatomic position. Although rigid screw fixation is available to compress the fragment against native glenoid, the osseous lesion is often thin and fragmented, making it less amenable to screw fixation. In many cases, suture anchor fixation is ideal to limit stress concentration.

In this study, we describe our technique for arthroscopic bony Bankart repair using a transosseous equivalent (TOE) construct, similar to those applied for rotator cuff repair.

Each author certifies that his or her institution approved the protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

From the Department of Orthopaedic Surgery, James A Lovell Federal Health Care Center, North Chicago, Illinois, U.S.A. (B.W.H.); Department of Surgery, USU-WRNMMC, Bethesda, Maryland, U.S.A. (B.W.H., J.F.D., K.G.K.); and Department of Orthopaedics, Duke University, Durham, North Carolina, U.S.A. (J.F.D.).

The authors report 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 November 29, 2022; accepted February 11, 2023.

Address correspondence to Kelly G Kilcoyne, M.D., Shoulder & Elbow Surgery, Department of Orthopaedic Surgery & Rehabilitation, Walter Reed National Military Medical Center, Bethesda, MD 20889, U.S.A. E-mail: Kelly.kilcoyne@gmail.com

2212-6287/221583

https://doi.org/10.1016/j.eats.2023.02.024

Surgical Technique

Planning

Prior to surgery for bony Bankart lesions, we obtain plain films and advanced imaging to characterize the amount of GBL, associated labral pathology, and any other intra-articular pathology or osseous (i.e., Hill-Sachs) lesions (Fig 1). CT imaging is helpful to quantify the size and character of the osseous lesion, as particularly small or partially resorbed bony fragments may be addressed similar to soft tissue Bankart tears with bone loss. Magnetic resonance imaging (MRI) is important to identify rotator cuff pathology (particularly in older patients) or other concomitant lesions. In many cases, MRI may be sufficient for visualization of bone loss and operative planning, particularly if three-dimensional reconstructions are available.[9,10] However, advanced imaging with CT may be helpful to determine whether repair is possible versus reconstructive options using bone grafting techniques.

Positioning and Portals

We find that performing bony Bankart repair in an arthroscopic fashion permits anatomic positioning of

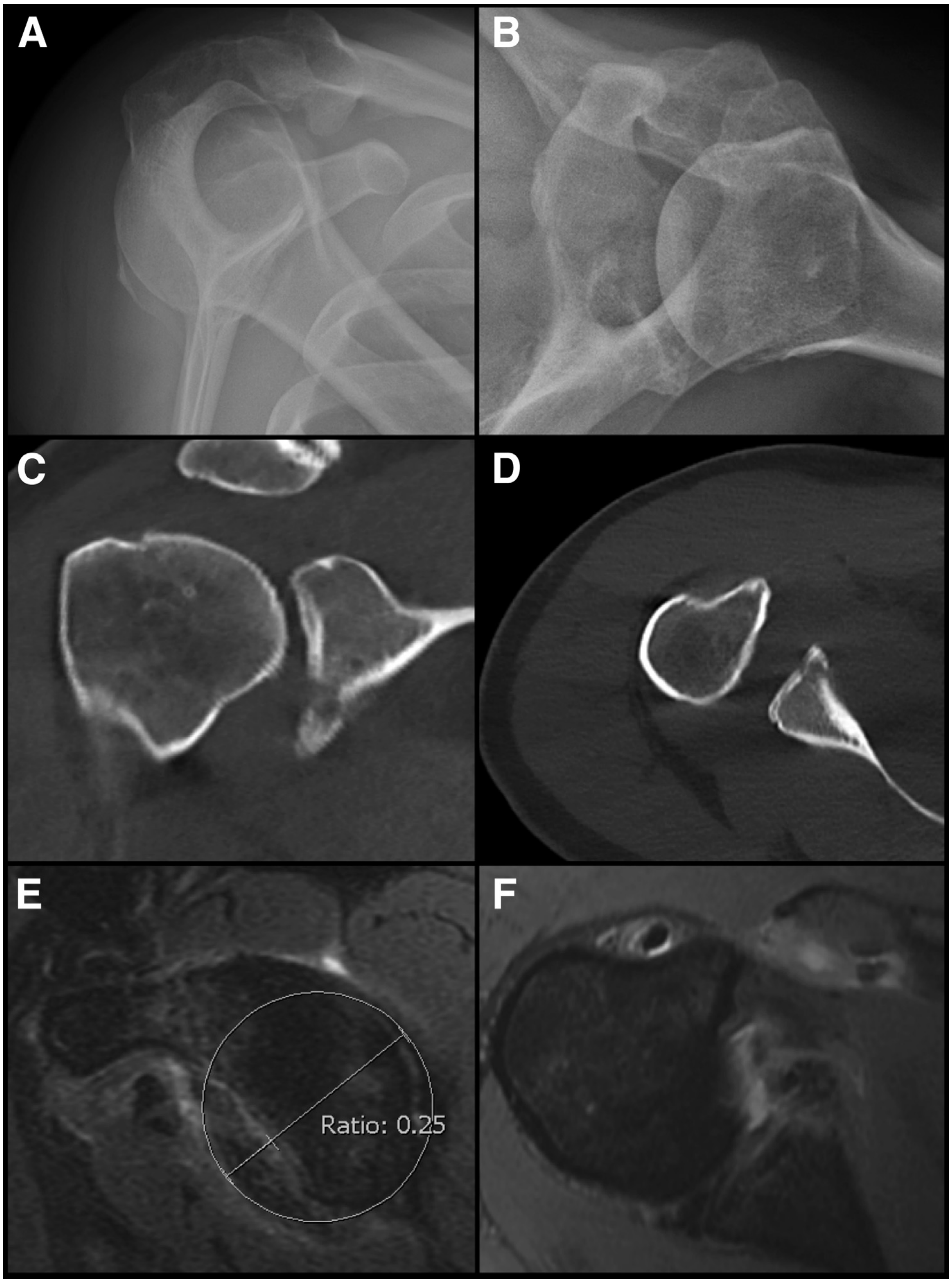

Fig 1. Preoperative imaging of the right shoulder, including plain films scapular Y and axillary views respectively (A and B), computed tomography coronal and axial cross sections respectively (C and D), and magnetic resonance imaging sagittal and axial slices respectively (E and F), which demonstrate a large anterior bony Bankart lesion, which represents 25% of the glenoid width based on the perfect circle method. The perfect circle method is demonstrated in box E, demonstrating the fragment measuring 25% of the total circle diameter.

the osseous fragment and accommodates additional intra-articular work, if needed, while avoiding the necessity of large incisions or split/takedown of the subscapularis. We prefer to perform all arthroscopic procedures for instability in the standard lateral decubitus position with a beanbag due to the relative ease of humeral distraction and placement of inferior anchors,[11] although this technique can be applied without any adjustments in the beach chair position. While positioned laterally prior to draping, an exam under anesthesia is performed. The patient is then prepped and draped, and the extremity is placed on traction in abduction with slight external rotation.

This procedure uses three standard portals, including a posterolateral, mid-glenoid, and anterosuperior (ASP) portal. The standard posterolateral viewing portal is created first ∼2 cm distal and 1 cm medial to the posterolateral corner of the acromion, and a diagnostic arthroscopy is subsequently performed. A midglenoid and ASP portal are then created under direct visualization. The midglenoid portal is placed immediately superior to the border of the subscapularis tendon. For this technique, we position this portal slightly medial to permit access to the medial anterior face of the glenoid. Care should also be taken to ensure the portal position enables access to the inferior glenoid. The ASP portal is made directly anterior off the acromion coming through the superior rotator interval. The ideal trajectory for this technique is directly in line with the fracture bed to ensure appropriate visualization, preparation of fracture bed, and assessment of reduction.

Arthroscopic Bony Bankart and Labral Repair

A detailed description of our surgical technique is provided in Video 1. We begin our bony Bankart and labral repair by first preparing the bone on the intact glenoid side, as well as the fractured fragment (Fig 2). We use a rasp to free up both the labrum at the inferior hinge point of the fracture and bony fragment inferiorly to about the 6 o'clock position. We do not liberate labrum from the glenoid fragment. We rasp both the glenoid fracture bed and the inferior native rim to promote healing of fragment, labrum, and capsule to the glenoid. If substantial fibrous tissue prevents introduction of a rasp, a liberator may be used to create the cleavage plane.

The initial anchor placed is dependent on whether the labral tear extends well beyond the fracture site. In most cases, using an accessory posterolateral portal, we position a suture anchor in the native glenoid (typically

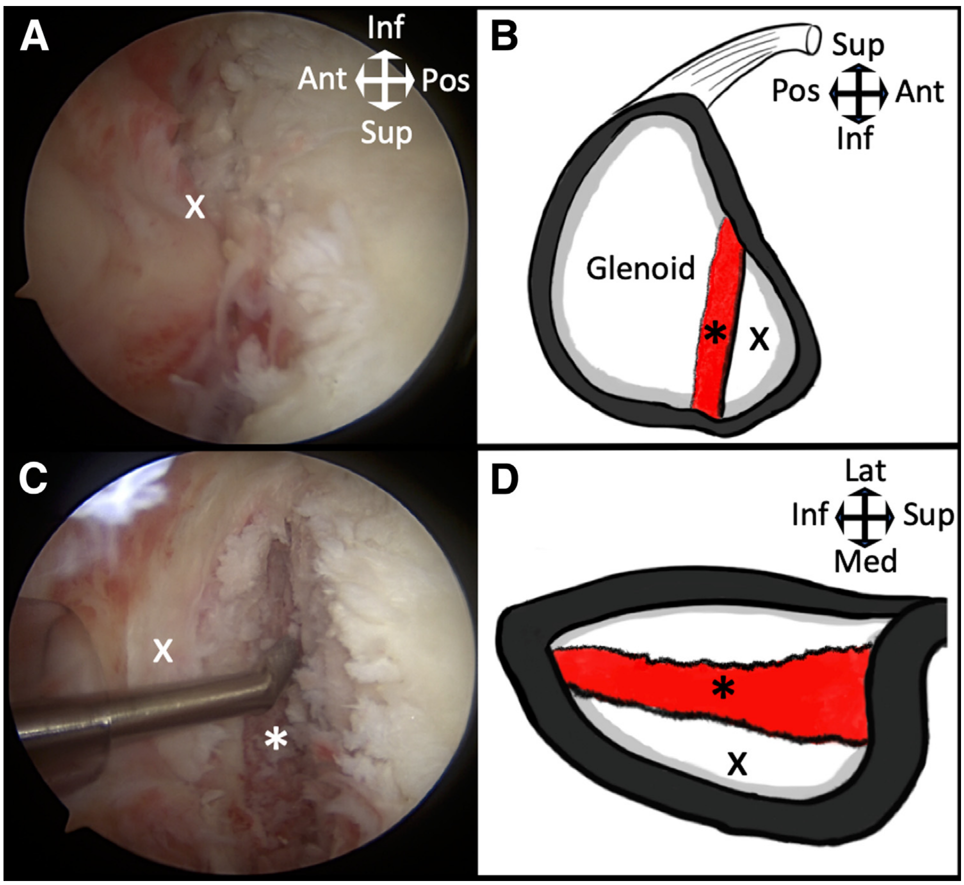

Fig 2. Arthroscopic images and diagrams demonstrating bony Bankart lesion of the right anterior glenoid. (A) In the lateral position, viewing superior to inferior from the anterosuperior portal, the fracture has not yet been mobilized, but it is readily visualized. (B-D) The bony Bankart fragment (x) is mobilized, permitting the fracture bed (*) to be exposed for instrumentation. Box B and D are a saggital and coronal view representations of the arthroscopic image C, taken from the anterosuperior portal. Note that the appropriate position of the anterosuperior portal is in line with the fracture line, which allows excellent visibility of the medial glenoid bone. Ant, anterior; Inf, inferior; Lat, lateral; Med, medial; Pos, posterior; Sup, superior.

Table 1. Pearls and Pitfalls of the Transosseous Equivalent Technique for Bony Bankart Repair

Pearls	Pitfalls
• Pre-position additional labral repair stitches. • Use curved drill guide for medialized position without violating subscapularis. • Shuttle nonworking sutures outside cannula to decrease traffic.	• Avoid fully tightening labral repair stitches. • Ensure articular reduction prior to final tightening TOE stitches.

TOE, transosseous equivalent.

in the 6-7 o'clock position) and pass a repair stitch, which will be tightened at the end of the case. Until this final step of the case, these sutures will be kept in the accessory portal. When tightened too early, this stitch can increase difficulty for subsequent steps.

For the TOE technique, we use knotless 1.8-mm all-suture anchors (FiberTak Soft Anchors, Arthrex, Naples, FL). These anchors can be drilled and placed using a straight or curved guide and are available in both single- and double-loaded variations, although only the single-loaded anchors are needed to complete this procedure. The initial TOE anchor may be placed at the inferior margin of the bony Bankart lesion, ∼7 mm offset from the articular surfawce, which can be measured with the arthroscopic probe. This anchor is placed through the mid-glenoid portal. A curved drill guide is advantageous to position the medial anchors and allows placement through the mid-glenoid portal, obviating the need for percutaneous placement through the subscapularis (Table 1). The repair stitch and knotless shuttle sutures are pulled out of the mid-glenoid portal, and then a suture lasso is passed through the anteroinferior capsular tissue, medial to the anterior bone fragment into the fracture site. The sutures are shuttled to bring the sutures through the capsular tissue and bring the labral tissue superior and

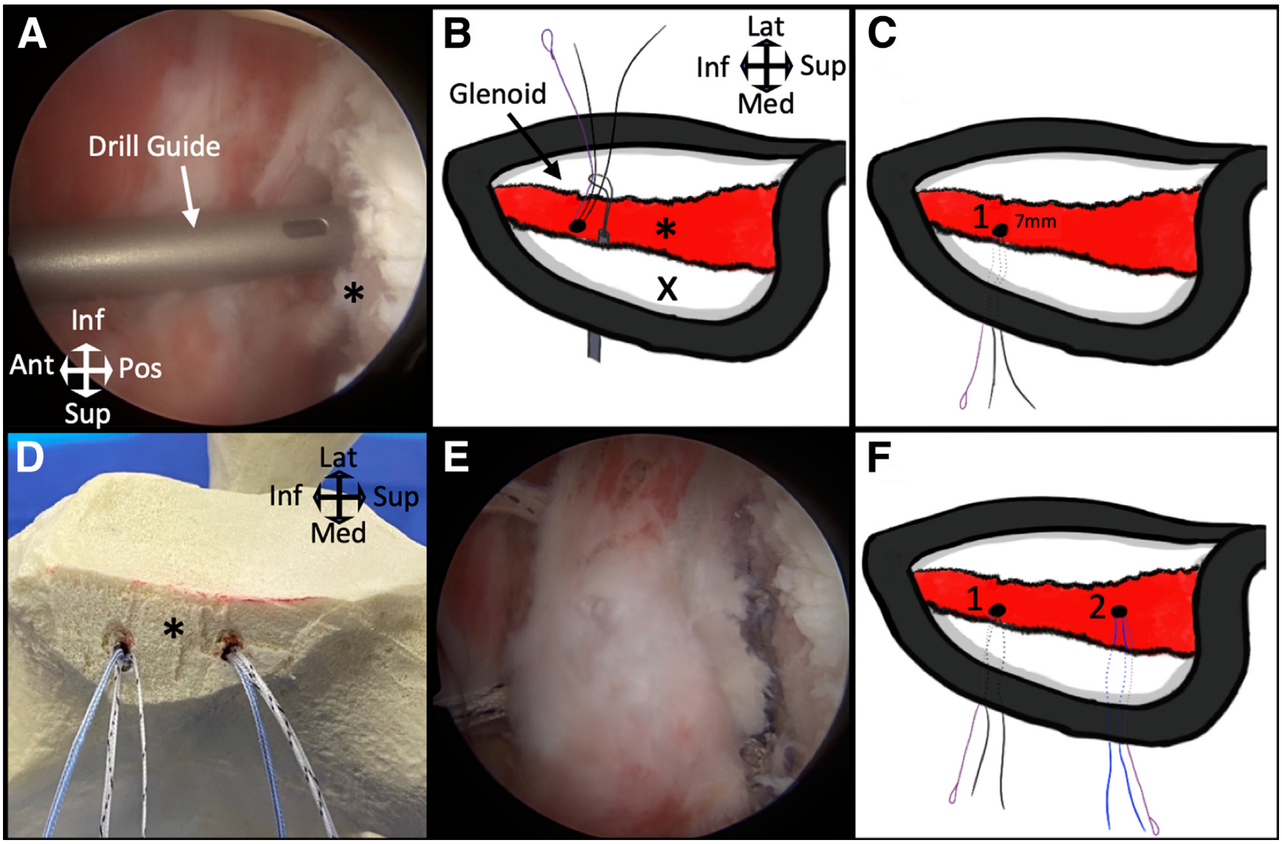

Fig 3. (A) Arthroscopic images, model, and diagrams demonstrating placement of anchors in fracture bed (*) ∼7 mm from the articular surface, as viewed from the anterosuperior portal in the lateral decubitus position. (B and C) After placement of anchors, sutures limbs are retrieved using a suture lasso device medial to the bone fragment (x) and labral tissue and delivered through the midglenoid portal. (D-F) These steps are then repeated for the superior anchor to achieve two medial anchors, and the sutures are stowed outside the cannula for suture management. Boxes B, C, D, and F are coronal view representations of the arthroscopic images A and E, taken from the anterosuperior portal. Inf, inferior; Lat, lateral; Med, medial; Sup, superior.

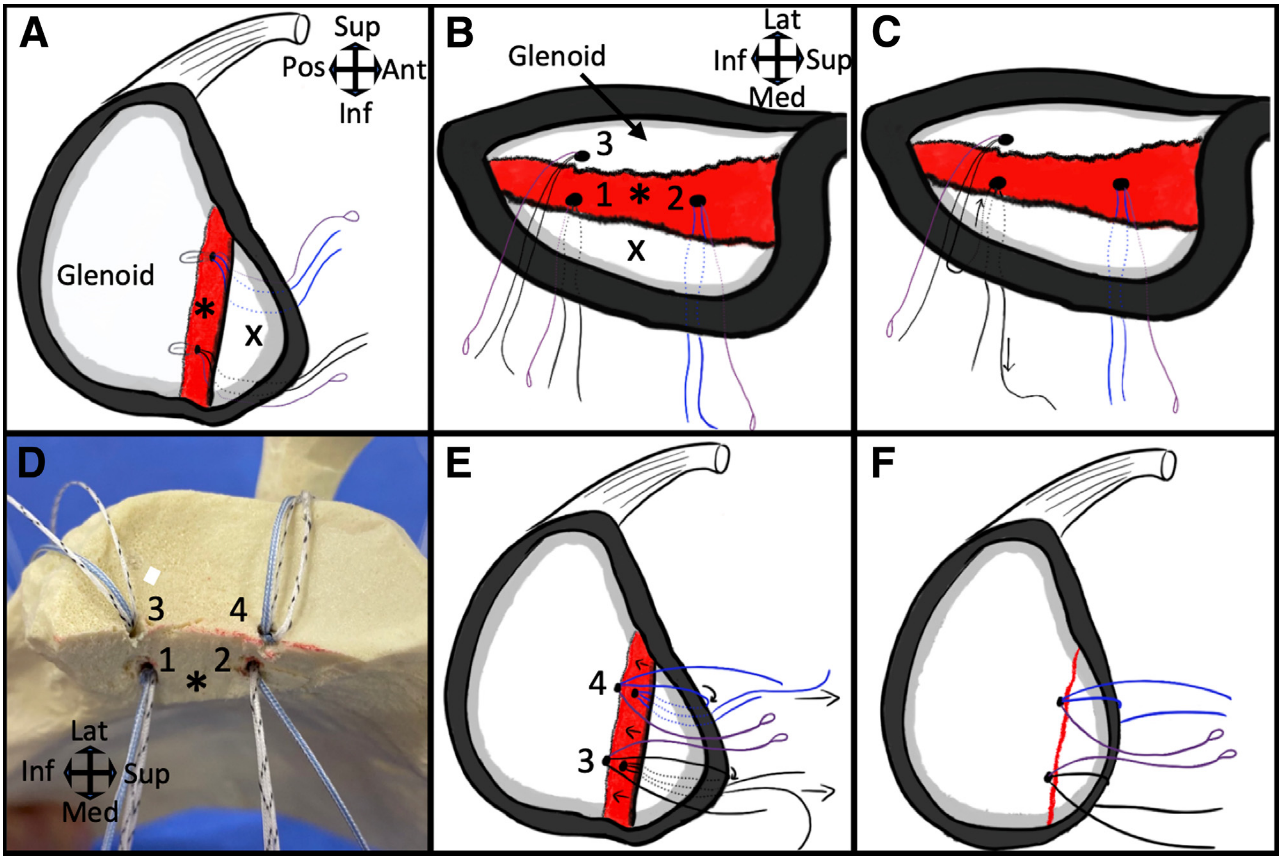

Fig 4. (A) Model and diagrams demonstrating suture limbs from medial anchors placed in fracture bed (*) passed medial to the bony Bankart fragment (x) and through the midglenoid portal. These are stowed outside the cannula for suture management purposes. (B) An inferior articular surface anchor (3) is placed and sutures are passed through the midgenoid portal within the cannula. (C) The suture limbs from the inferior medial anchor (1) are retrieved into the midglenoid portal cannula and are then used to shuttle a lateral suture from anchor (3) for the horizontal stitch. (D) A superior anchor (4) is then placed on the articular surface at the level of anchor (2). (E) The horizontal stitch process is repeated for the superior anchor pair, achieving two stitches for reduction of the bone block against the native glenoid. (F) Tension is pulled under direct visualization to guide reduction of the osseous fragment to the native glenoid. Box B, C, and D are coronal view representations, and box A, E, and F are saggital-view representations of a right glenoid. In box D, the bony Bankart fragment is omitted for better visualization of anchor positions. Ant, anterior; Inf, inferior; Lat, lateral; Med, medial; Pos, posterior; Sup, superior.

medial (Fig 3). A second anchor is positioned at the superior margin of the bony Bankart lesion, also 7 mm offset from the articular surface. The suture limbs are also shuttled medial to the osseous fragment. At this stage, with two repair suture limbs and one passing limb for each anchor, suture management is critical. We find it is easiest to remove and replace the midglenoid cannula to move these sutures external to the cannula or to stow these inactive sutures in an accessory posterolateral percutaneous portal prior to placing the second set of anchors.

Third and fourth anchors are then drilled directly lateral to the first and second anchors, respectively, through the articular surface at the rim to create a box configuration (Fig 4). The inferior lateral anchor (anchor three) can be placed first, and sutures are passed as described in subsequent steps for the horizontal limb to decrease suture traffic prior to drilling and placing the superior lateral (anchor four) anchor. The inferior articular anchor shuttle suture is loaded with the suture tail from the corresponding medial initial anchors, and the limb is passed through the knotless mechanism, while maintaining the fragment's position relative to the articular surface to achieve a horizontal stitch. The process is then repeated with the superior suture tail after placing the superior lateral anchor (anchor four), using these sutures to secure the superior portion of the bone fragment against the glenoid in a horizontal stitch orientation. Sutures are pretensioned slightly to elevate and reduce the bony fragment to the level of the articular surface.

The remaining sutures are then passed into the opposite corner anchor (i.e., inferior fracture anchor number one shuttle suture loaded with suture tail from superior articular anchor number four) to create a traversing stitch (Fig 5). This is performed again for

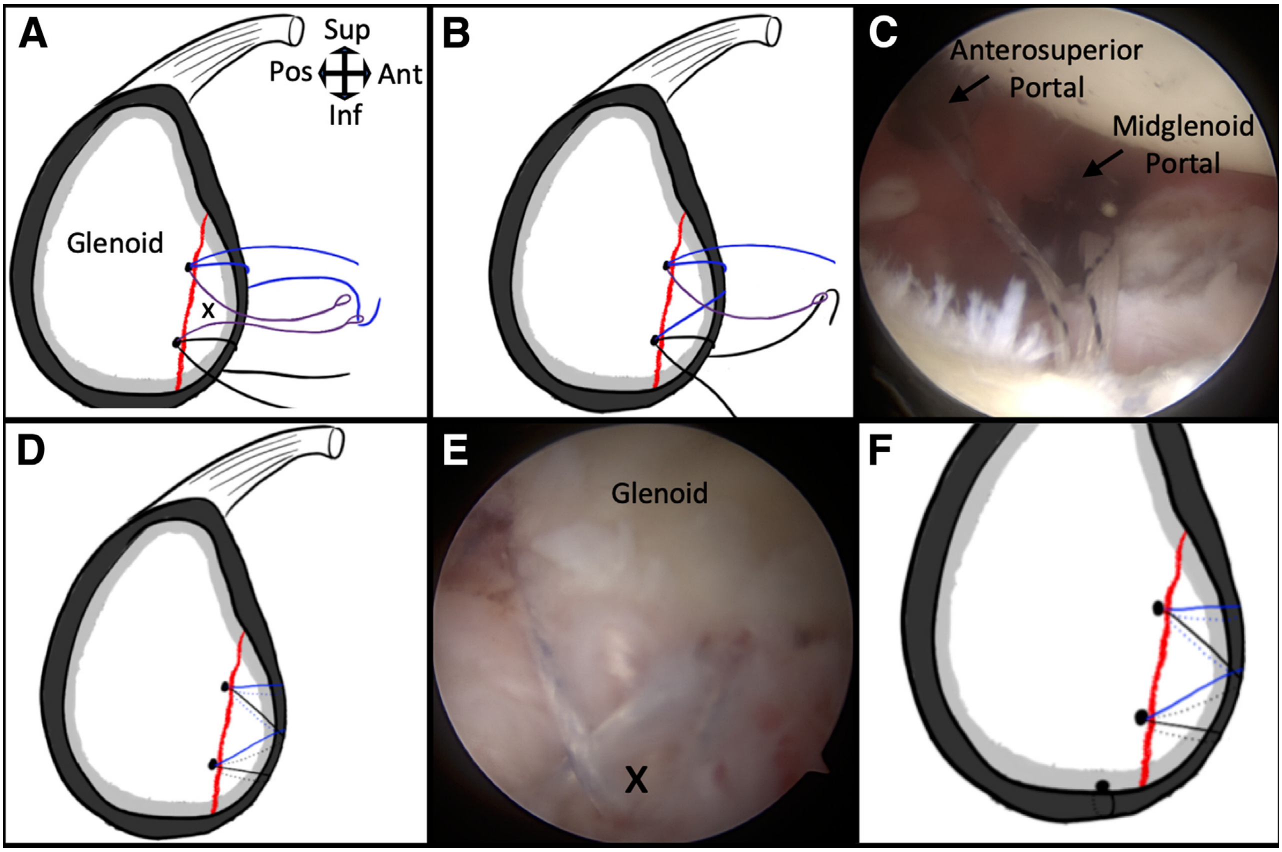

Fig 5. (A and B) Arthroscopic images and diagrams demonstrating passage and reduction of the remaining sutures into shuttle sutures of the opposite anchor. (C) The suture tails are pulled and tensioned through the midglenoid portal, as viewed here from the posterior viewing portal in a laterally positioned patient. (D and E) After reduction of the paired suture limbs, the construct achieves a transosseous equivalent box configuration with osseous Bankart fragment (x) compressed to the native glenoid. Image E is taken in a laterally positioned patient from the midgglenoid portal. (F) The 6 o'clock anchor with passed suture limbs, if one was placed at the beginning of the case, is then tightened to achieve a soft tissue buttress and capsular shift. Boxes A, B, D, and E are saggital view representations of a right glenoid. Ant, anterior; Inf, inferior; Pos, posterior; Sup, superior.

the other pair (anchors two and three). Repair stitches and the inferior labral repair stitch, if used, are then final tensioned appropriately. The result is a large, even distribution of force across the fracture fragment and labrum.

Finally, having addressed the bony Bankart lesion, attention is turned to the other structures of the joint and capsulolabrum. The upper extremity may be placed in a position of instability to identify any engaging humeral head lesions (i.e., Hill-Sachs lesion) that should be addressed concurrently with Remplissage. If any capsulolabral laxity persists, additional anchors may be positioned into the intact glenoid to shift the labrum.

Rehabilitation

Postoperatively, rehabilitation is similar to that of labral repair with 6 weeks of shoulder immobilization in abduction sling and Codman's exercises. Passive motion is advanced at 6 weeks, and rotator cuff strengthening progresses around 8 weeks. Return to sporting activities is achieved at 6 months.

Table 2. Advantages and Disadvantages of the Transosseous Equivalent Technique for Bony Bankart Repair

Advantages	Disadvantages
• Large, high-pressure contact area • Excellent load sharing between anchors leading to better tension matching and compressive force titration • Avoids rigid/metal implants • Minimal bone loss from implants	• Necessitates careful suture management • Cannot reverse suture tension to adjust bone block position

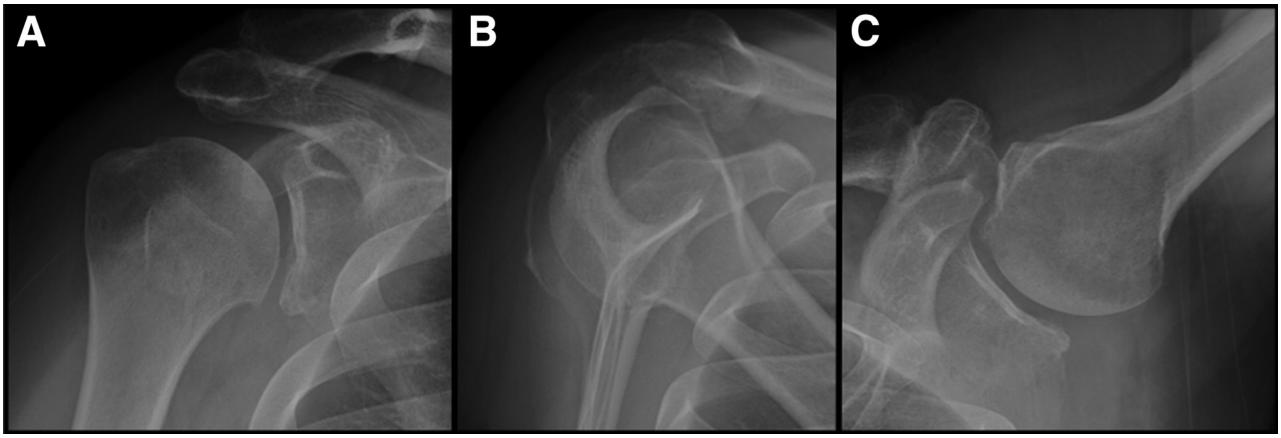

Fig 6. Plain films obtained 3 months postoperatively after transosseous equivalent bony Bankart repair, including true AP (A), scapular Y (B), and axillary views (C) of the right shoulder demonstrate excellent restoration of glenoid osseous architecture and centering of humeral head. No large disruption of osseous architecture is visualized.

Discussion

There are multiple major challenges to addressing bony Bankart fragments, including the tendency for small fragments to fail to heal to the native glenoid and/or resorb.[6] This may limit repair options, as resorption decreases the integrity of any fixation within the fragment itself. Additionally, many techniques for addressing bony Bankart lesions necessitate an open approach or additional or alternative portals beyond those typically used for anterior instability surgery.[12,13] The technique described in this article uses standard arthroscopic portals, familiar implants, and suture constructs, and does not depend on the integrity or size of the osseous fragment. Additionally, this technique provides a laterally directed force on the osseous fragment to prevent subsidence, is readily tensioned to titrate lateral translation and the compressive force, and distributes forces across the majority of the Bankart lesion without excessive suture management or a large number of suture anchors.

There are several theoretical advantages to TOE type constructs over a typical double-row construct for rotator cuff repair and can reasonably be inferred to ours as leveraging an advantage over the double-row technique for bony Bankart lesions described by Millett and Braun.[14] These include a larger pressure contact area, higher contact pressure, and better load sharing between anchors, leading to better tension matching and compressive force titration and, potentially, higher load to failure.[15-18] Biomechanically, TOE constructs are superior to both screws and other suture anchor constructs at preventing fragment displacement and similar loads to failure to traditional screws.[19] One disadvantage is that despite fewer sutures than other described approaches, careful suture management is still necessary. Additionally, once tension is applied through the sutures, it is difficult to adjust graft position as the sutures cannot be untensioned (Table 2). Although there are no data at this point to suggest outcomes are substantially improved compared to other approaches for bony Bankart lesions, this modification is fast, relatively simple compared to a standard labral repair or bony Bankart repair, and necessitates no changes in equipment and minimal adjustments to approach.

Conclusions

While many techniques have been described to address bony Bankart lesions, the ideal approach should leverage existing technology/devices and familiar portals, should not add unnecessary time or resource costs, and must achieve the operative goal of restoring the bony glenoid buttress. This arthroscopic variation of a well-known technique is simple and readily applied in any arthroscopic shoulder surgery practice. Healing (or failure) may be evaluated on plain radiographs primarily with axillary views, which should demonstrate union by 12 weeks (Fig 6).

Acknowledgments

All of the authors are employees of the US Government. This work was prepared as part of their official duties. Title 17 U.S.C.§105 provides that “Copyright protection under this title is not available for any work of the United States Government.” Title 17 U.S.C. §101 defined a US Government work as a work prepared by a military service member or employees of the US Government as part of that person’s official duties.

The contents of this publication are the sole responsibility of the author(s) and do not necessarily reflect the views, opinions, or policies of Uniformed Services University of the Health Sciences (USUHS), the Department of Defense (DoD), the Departments of the Army, Navy, or Air Force. Mention of trade names,

commercial products, or organizations does not imply endorsement by the U.S. Government.

References

1. Dickens JF, Slaven SE, Cameron KL, et al. Prospective evaluation of glenoid bone loss after first-time and recurrent anterior glenohumeral instability events. *Am J Sports Med* 2019;47:1082-1089.
2. Owens BD, Dawson L, Burks R, Cameron KL. Incidence of shoulder dislocation in the United States military. *J Bone Jt Surg* 2009;91:791-796.
3. Burkhart SS, Beer JFD. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs Significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. *Arthrosc J Arthrosc Relat Surg* 2000;16:677-694.
4. Tauber M, Resch H, Forstner R, Raffl M, Schauer J. Reasons for failure after surgical repair of anterior shoulder instability. *J Shoulder Elb Surg* 2004;13:279-285.
5. Sugaya H, Moriishi J, Dohi M, Kon Y, Tsuchiya A. Glenoid rim morphology in recurrent anterior glenohumeral instability. *J Bone Jt Surg Am* 2003;85:878-884.
6. Nakagawa S, Ozaki R, Take Y, Mae T, Hayashida K. Bone fragment union and remodeling after arthroscopic bony Bankart repair for traumatic anterior shoulder instability with a glenoid defect. *Am J Sports Med* 2015;43:1438-1447.
7. Nakagawa S, Hirose T, Uchida R, et al. A glenoid defect of 13.5% or larger is not always critical in male competitive rugby and American football players undergoing arthroscopic bony Bankart repair: Contribution of resultant large bone fragment. *Arthrosc J Arthrosc Relat Surg* 2022;38:673-681.
8. Silberberg Muino JM, Fulvi AN. Arthroscopic repair of acute bony Bankart lesions: An analysis of risk factors for instability recurrence. *Int J Orthop* 2020;7:1382-1389.
9. Lee RKL, Griffith JF, Tong MMP, Sharma N, Yung P. Glenoid bone loss: Assessment with MR imaging. *Radiology* 2013;267:496-502.
10. Lansdown DA, Cvetanovich GL, Verma NN, et al. Automated 3-dimensional magnetic resonance imaging allows for accurate evaluation of glenoid bone loss compared with 3-dimensional computed tomography. *Arthrosc J Arthrosc Relat Surg* 2019;35:734-740.
11. Baron JE, Duchman KR, Hettrich CM, et al. Beach chair versus lateral decubitus position: Differences in suture anchor position and number during arthroscopic anterior shoulder stabilization. *Am J Sports Med* 2021;49:2020-2026.
12. Kim KC, Rhee KJ, Shin HD. Arthroscopic three-point double-row repair for acute bony Bankart lesions. *Knee Surg Sports Traumatol Arthrosc* 2009;17:102-106.
13. Ganokroj P, Keyurapan E. Arthroscopic bony Bankart repair using a double-row double-pulley technique. *Arthrosc Tech* 2018;8:e31-e36.
14. Millett PJ, Braun S. The "bony Bankart bridge" procedure: A new arthroscopic technique for reduction and internal fixation of a bony Bankart lesion. *Arthrosc J Arthrosc Relat Surg* 2009;25:102-105.
15. Park MC, Cadet ER, Levine WN, Bigliani LU, Ahmad CS. Tendon-to-bone pressure distributions at a repaired rotator cuff footprint using transosseous suture and suture anchor fixation techniques. *Am J Sports Med* 2005;33:1154-1159.
16. Park MC, ElAttrache NS, Tibone JE, Ahmad CS, Jun BJ, Lee TQ. Part I: Footprint contact characteristics for a transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique. *J Shoulder Elb Surg* 2007;16:461-468.
17. Park MC, Idjadi JA, Attrache NSE, Tibone JE, McGarry MH, Lee TQ. The effect of dynamic external rotation comparing 2 footprint-restoring rotator cuff repair techniques. *Am J Sports Med* 2008;36:893-900.
18. Park MC, Tibone JE, ElAttrache NS, Ahmad CS, Jun BJ, Lee TQ. Part II: Biomechanical assessment for a footprint-restoring transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique. *J Shoulder Elb Surg* 2007;16:469-476.
19. Lin C, Hong C, Jou I, Lin C, Su F, Su W. Suture anchor versus screw fixation for greater tuberosity fractures of the humerus—A biomechanical study. *J Orthopaed Res* 2012;30:423-428.