Chapter 12: Arthroscopic Bony Bankart Repair

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Abstract:

Arthroscopic stabilization has proven an effective technique in the treatment of anterior shoulder instability due to soft tissue labrum/ligamentous (i.e. Bankart) injury. However, this procedure has not proven as reliable in patients with glenoid rim fractures that have either been neglected or unrecognized, and gone on to resorb. Consequently, there has been a growing emphasis on the importance of preserving the glenoid's bony rim anatomy, through recognition of it's involvement, and development of techniques to treat bony Bankart pathology. When small, the avulsed fragment can be integrated into a "single-row" arthroscopic Bankart repair. Larger fragments however, are not as easily reduced or secured using conventional repair techniques. A recently described "double-row" or "bone bridge" technique, in which the bony Bankart lesion is secured via two points at each fixation site along the glenoid, has been shown to be biomechanically superior in restoring glenoid rim integrity, and is the preferred approach for dealing with significant bony Bankart lesions in anterior instability. When properly performed, arthroscopic shoulder stabilization yields predictable outcomes and high patient satisfaction rates in patients with bony Bankart lesions.
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Introduction

Arthroscopic Bony Bankart repair may be indicated in patients with anterior glenohumeral instability in which part of the bony glenoid has been fractured or avulsed along with the anterior-inferior glenohumeral ligament/labrum complex. Seen in both the acute and chronic (recurrent) setting, bony Bankart lesions are relatively common, with a reported incidence ranging from 4-70% (1-4). Failure to restore normal structural integrity to the anterior glenoid has been convincingly shown to increase the risk of recurrent instability following conventional soft tissue arthroscopic repair alone (5- 9). Biomechanical studies have further reinforced the importance of preserving and/or reestablishing the normal architectural vault of the glenoid rim as critical to restoring normal shoulder stability (10). Although the precise tolerance for glenoid bone loss, (via fracture, erosion, or some combination) is not currently known, there seems to be an emerging consensus that anterior or anterior-inferior bone defects approaching or exceeding 20-25% of the glenoid's normal diameter jeopardizes the effectiveness of an arthroscopic soft tissue repair alone.

The most commonly described and performed bony Bankart repair is the single-row technique, in which individually spaced anchors are placed along the rim or onto the face of the glenoid. Such an approach has been shown to be highly effective (7,8, 11-

14), and is particularly appealing when dealing with fairly small fragments[1] or when bone fragment quality is suboptimal (comminuted, crumbling, soft). The bone fragment(s) is/are incorporated into the repair itself using simple sutures to ensnare the bone within the capsuloligamentous complex.

Recent interest in achieving improved fixation has led to the evolution of a double-row procedure, first described by Zhang (15) and further refined and popularized as a "bony Bankart bridge" technique by Millett et al (16, 17). Fixation is achieved by using suture anchors medial to the fragment on the glenoid neck, encircling the bone and adjacent capsulolabral tissue, and docking them into the anterior glenoid using knotless anchors. This ingenious approach offers the biologic advantage of eliminating sutures within the fragment/glenoid interface, and in the lab, has proven biomechanically superior compared to the single row technique, with improved compression and stability to mechanical loading (18). This technique is particularly compelling in cases where the bony Bankart lesion constitutes a fairly large fragment or fragments, spanning a distance of more than 4-5 mm from the medial fracture plane to the glenoid rim. Large fragments can displace due to inadequate fixation using a single-point anchor fixation approach, whereas a double-row anchor construct can both achieve anatomic reduction and enhance fixation stability. However, double-row constructs are more technically challenging, and can increase procedure time and anchor cost (2x as many anchors per bone fixation site). Passing sutures around or through a large fragment can be a tedious and difficult endeavor, so due consideration ought to be given before undertaking the bone fragment repair.

Arthroscopic bone fixation using screws has been described, and is conceptually appealing (19). Several instrument sets are available for this purpose, one of which is the Percutaneous Pinning Set (Arthrex), which includes an array of devices used to target, drill, and fix bony fragments with cannulated variably sized screws. Offset guides, drill sleeves and even flexible wires and drills have enhanced our technical ability to achieve anatomic fixation using this approach. However, despite its' compelling rationale, the reality is that the vast majority of bony Bankart lesions lack the size or sturdiness to permit percutaneous screw fixation. Even if they were large enough, rotational stability is not necessarily assured, requiring secure fixation at the superior and inferior aspect of the fragment, or a second screw above or below the first. From a practical standpoint then, most Bony Bankart lesions will be fixed using either a single or dual-row bridge suture anchor repair technique. How to proceed will be determined by a number of factors, including bone fragment size and quality and the

[1] Small here is defined as a fragment whose medial-lateral dimensions are typically similar or less than the thickness of the labrum through which sutures will be passed, ie 4-5mm. Bone fragments that are larger than this pose a greater challenge to encompass or pass through using various suture-passing devices, and may warrant consideration of a "bridge" or "two row" technique.

ease with which the fragment can be manipulated and viewed for reduction and fixation. For smaller bone fragments, we will proceed with a single-row repair. Fragments greater than 4-5mm from the medial glenoid neck to the rim are repaired with a double-row bone bridge technique. Currently there is no clinical data that proves the superiority of dual row bridge vs. a single row bony Bankart repair, but both single and double-row techniques report a high rate of radiographic incorporation (20, 21) and clinical success (1,11-14,21). However, currently there are no studies comparing the clinical outcome of single vs. double-row bridge repairs.

The purpose of this chapter is to draw attention to this anterior instability variant, suggest indications for surgical treatment, and describe techniques by which this sometimes technically challenging problem can be successfully addressed using an arthroscopic approach.

Indications:

Patients with first-time or recurrent anterior instability associated with a glenoid rim fracture fragment that is less than 20-25% of the glenoid diameter.

Controversial Indications:

1. Bony Bankart lesions exceeding 20-25% of glenoid involvement
2. Presence of concomitant "significant"[2] Hill-Sachs lesion or concomitant HAGL[3] (Humeral Avulsion of the Glenohumeral Ligament)
3. Bony Bankart lesion in a contact/collision athlete
4. Failed prior arthroscopic stabilization in the face of poor quality anterior glenoid bone remnant.

Pertinent Physical Findings:

1. Positive apprehension sign with the shoulder in the abducted-externally rotated (i.e. throwing) position.
2. Increased translation on anterior laxity testing, via either "load and shift" test, or "anterior drawer" test when compared to the opposite shoulder. Such testing may be accompanied by patients' subjective perception of instability or an objective palpable clunk during translation.

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[2] An "Insignificant" Hill Sachs lesion is probably one that involves less than 10% depth of involvement of the humeral head, and does not involve the underlying bone, but is more of a chondral lesion than an osteochondral impact zone.

[3] HAGL lesions are uncommon, but can accompany bony Bankart avulsions, and technically may justify an open approach to satisfactorily address both sides of the capsuloligamentous pathology.

3. Some patients with bony pathology of the glenoid may sense or exhibit instability only in the mid-range of motion (rather than at the extremes), such as in 45 degrees of abduction/external rotation.
4. Positive relocation sign.
5. Axillary nerve injury with sensory deficit to the overlying dermatome and/or deltoid weakness.
6. Although generalized ligamentous laxity and the sulcus sign are not specific or commonly present in patients with traumatic unidirectional instability, soft tissue laxity may be present even in this population, and may require plication, in addition to treating the bony lesion.
7. Positive belly press test may reflect a subscapularis injury, which can (uncommonly) occur during a traumatic anterior instability event.

Pertinent Imaging for Pre-op Planning:

1. High quality radiographs are critical for preoperative planning purposes.
2. Standard plain radiograph imaging (True AP in the plane of the glenoid (Grashey view), as well as an Axillary, and Scapular Y view) are obtained in every patient.
3. While it is much easier to see larger glenoid defects on plain films, one can assess for smaller lesions by loss of anterior cortical margin on the true AP or axillary view (Fig. 1).
4. Several radiographic studies have demonstrated improved detection of glenoid bony pathology using modified plain views such as the Bernageau (22) or West Point view (23).
5. However, 60% of bony lesions requiring operative treatment can be missed when radiographs are used alone preoperatively (24).
6. Because of the importance of detecting bony pathology, more sophisticated imaging, such as MRI or CT scan, deserve consideration in patients with significant trauma or a history of multiple post-traumatic recurrences.
7. MRI shows superior soft tissue detail and does not involve ionizing radiation, an advantage over CT imaging, particularly in the younger population with instability (Fig. 2). However, no consistent scanner or sequencing currently demonstrates the ability to assess or measure bone involvement as accurately as CT scanning.
8. CT scan enhances both detection and quantification of bony pathology, both on the glenoid and humeral side. A recent comparison study demonstrated that 3D CT was the most accurate imaging modality in predicting glenoid bone loss (25) (Fig. 3). 3D CT scans, with or without contrast (depending upon acuteness of event), including views with and without digital subtraction of the humeral head, are the current imaging study of choice to asses bone involvement. CT scans permit bilateral glenoid morphology assessment during image acquisition, an advantage over MRI.

Equipment to Complete Procedure:

In addition to standard instruments used during shoulder arthroscopy, a number of specific instruments are critical in facilitating proper technique execution. These include:

1. A 70-degree arthroscopic lens, which when positioned in the posterior viewing portal affords a nearly en-face view of the anterior glenoid.
2. Multiple arthroscopic cannulae of various depths (7cm length usually sufficient, but must be considered in context of normal "working length" of hand instruments, such as rasps, shaver blades, drill sleeves, anchors, etc.), widths (starting with 5mm outer diameter and changing to 8.25mm outer diameter), and accommodation for instruments used during tissue manipulation, anchor insertion, suture passage, knot tying, and suture management.
3. Percutaneous instrumentation specifically designed to permit accurate anatomic targeting around the "clock face" of the glenoid, typically at the 5, 6, or 7 o'clock positions. We have found that use of a system that utilizes a "hubless" spinal needle, with accompanying nitinol wire and a series of small diameter metal dilation cannulae (Arthrex, Naples, Fl.) are invaluable (Fig. 4).
4. Suture anchors of various sizes, with requisite drill/punch/tap instruments. We utilize 3.0mm BioComposite SutureTak anchors, which are available single- and double-loaded with #2 Fiberwire. Occasionally we will use smaller 2.4 or 2.0mm implants (Arthrex). We prefer composite Bio-composite (PLLA-based) or composite (PEEK) over metal anchors, to minimize metallic debris, subsequent imaging distortion, loss of bone stock if/when requiring revision anchor placement, and risk of proud or loose metal anchor implants.
5. We also have knotless anchors available, particularly helpful if using the bone bridge technique, relying on 2.9mm BioComposite Pushlock Anchors (Arthrex), which employ metal cannula to permit implant passage.
6. Multiple non-disposable and disposable suture-passing instruments, including those that shuttle suture through and around tissue (Fig. 5). These most commonly include 0, 45, 60 and 90 degree Spectrum hooks (Linvatec) or Suture Lassos (Arthrex). An additional helpful set of suture-passing devices is "Penetrators" (0, 22.5 and 45 degree upsweep tips – Arthrex), which can traverse soft tissue and bone and grasp and retrieve suture). Use of Jaw-designed suture passing instruments such as the Labral Scorpion (Arthrex) or Caspari Suture Punch are particularly effective when passing suture through soft tissue. Use of a "Needle Punch" device (Arthrex), specifically modified with a 30-degree curve to facilitate passing sutures under the humeral head at the 6 o'clock position, can be extremely helpful in tough/thick ligament/labral tissue.
7. Instruments that permit suture passage through bone, such as the Bone Stitcher (Smith and Nephew, Andover MA)
8. A set of cannulated percutaneous screw fixation instruments (Percutaneous Pinning Set - Arthrex) must be available in uncommon cases in which bony fragment fixation is achievable using screws.

9. Open surgical tray should be available for use in cases where structural integrity cannot be restored arthroscopically and requires conversion to an open approach. This should include appropriate retractors, as well as anchors that have suture needles to facilitate passage as possible alternatives to arthroscopic suture devices.

Positioning and Portals:

Arthroscopic bony Bankart repair can be satisfactorily achieved in either the beach chair or lateral decubitus position. The latter is our preferred approach, as we have found that it affords superior visualization of the glenoid and labrum, and does so without requiring much intra-operative shoulder manipulation or assistance. Care is taken to maintain the head and neck in neutral alignment, and carefully pad the dependent extremity and protect bony prominences of the hip, fibular head and lateral malleolus. The torso is maintained in this position using a vacuum-beanbag with support, with 5-pound sand bags positioned in front and back in case of inadvertent beanbag insufflation during the case. Rolling the patient back approximately 15-20 degrees facilitates easier access to the front of the shoulder, and gives the glenoid an orientation that is more parallel to the OR room floor. Failure to ensure the shoulder is rolled back can make anterior access more difficult. Although we do not routinely use an axillary roll, we are careful to ensure the axillary contents are well protected. Once positioned, if any compression or concern exists, an axillary roll is placed. The arm is temporarily suspended by an IV pole for prepping and draping of the extremity, from the shoulder girdle to the fingertips. During the procedure, the shoulder is suspended with a weight which varies from as little as 7, to as much as 12 lbs., based on patient size and tissue laxity. We use an Acufex Shoulder Positioner with the arm placed in approximately 30 degrees of abduction, 20 degrees of forward flexion, and neutral rotation.

Arthroscopic portals include the traditional posterior “soft spot” portal for initial shoulder arthroscopic viewing, placed approximately 2-3 cm inferior to and 2cm medial to the posterolateral acromion. Rather than actually measuring placement, we try to identify the optimal placement for each patient, by palpating the humeral head during anterior and posterior translation. By palpating directly over the anterior and posterior glenohumeral joints, one can discern a predictably accurate trajectory for posterior scope insertion. Anterior portals include “twin” antero-superior (AS) and anterior-anterior (AI) portals (Fig. 6). The AS portal is established first, using an “outside-in” technique. A spinal needle is introduced just inferior and somewhat medial to the anterolateral margin of the acromion. This needle should enter the joint just under cover of the intra-articular long head biceps tendon, and angle inferiorly towards the axillary pouch, roughly parallel to the anterior glenoid. Care should be taken to ensure proper cannula positioning just lateral to the glenoid rim. If the cannula is placed too laterally, instrument passage inferiorly may be challenging because of the sometimes-obstructing humeral head. Upon a nick skin incision with an #11 blade, a straight clamp is used to spread soft tissue in a path parallel to the adjacent needle, followed by

introduction of a blunt 5mm cannula (Smith Nephew Dyonics). The cannula's blue tip can be seen indenting the superior aspect of the rotator interval and with gentle pressure, usually "pops" into the joint. If the tissue is thick and difficult to penetrate, the blunt obturator can be replaced with a sharp one, which will easily puncture the joint capsule. The 5mm cannula is next exchanged for an 8.25mm x 7cm fully-threaded clear Fishbowl cannula (Arthrex), which will facilitate a variety of suture passing instruments.

The AI portal is next established, again using an outside-in technique, and is placed immediately superior to the upper rolled tendon of the subscapularis tendon. Care should be taken to ensure that this portal is established a few centimeters from the AS portal, to avoid instrument "sword fighting" when using both portals. Additionally, the AI portal must be directed from a lateral-to-medial angle, to permit an accurate approach to the glenoid during glenoid drilling and anchor placement. Failure to ensure an accurate "angle of attack" may lead to 1) articular cartilage damage due to sub-articular tunneling of the drill and or anchor, 2) inadequate anchor purchase, or implant/device breakage due to unnecessary torque.
Under direct view, a second 5mm cannula is introduced along the same trajectory as the spinal needle to establish the AI portal. We again replace the smaller cannula with a second 8.25mm x 7cm Fishbowl cannula (Arthrex). Both twin anterior portals have now been established.
Several other additional percutaneous portals are useful during Arthroscopic Bony Bankart repair. The most common is the accessory anterior-inferior 5 o'clock portal (26). Typically this is placed from 1-3 cm inferior to the established AI portal, with a similar lateral-to-medial targeting angle determined with outside-in spine needle placement.
Occasionally an accessory posterior-inferior portal is helpful, particularly in cases of labral pathology that continues beyond the 6 o'clock position. This portal both facilitates anchor placement on the posterior-inferior quadrant of the glenoid, and provides an accessory portal for bony fragment manipulation and suture management. In cases of bony Bankart pathology, particularly when the fragment is large, this portal can make anchor placement and suture management easier.

Step-by-step technique:

Anesthesia and Exam:
Following pre-operative interscalene block anesthesia performed under ultrasound guidance in the holding area, patients are brought to the Operating Room and undergo General Anesthesia. Exam under anesthesia is performed to assess the degree of translation in anterior, inferior and posterior directions and both shoulders are compared.

Positioning:
The patient is then rolled into the lateral decubitus position as described above, caring to ensure they are properly padded and rolled back such that the glenoid is parallel to the floor and the anterior shoulder readily accessible. The arm is prepped in a sterile manner from the chest wall to the fingertips and the shoulder draped. Using a cord and a weight of 7 – 12 lbs. (depending on arm size and joint distension), the arm is suspended using a forearm sleeve carefully wrapped with Coban (3M). We initially place the extremity in 30 degrees abduction and 20-degrees of flexion. Excessive force can actually decrease the ease of manipulation and visualization.

Portal Establishment and Diagnostic Arthroscopy:
Diagnostic evaluation begins with placement of the 30-degree arthroscope in the posterior "soft spot" portal. A dual port cannula is used to facilitate irrigation and clearing of the joint, using inflow through one port and suction through the other. Alternating inflow and suction permits optimal visualization, sometimes helpful following manipulation during the exam under anesthesia, which can stir up some bleeding and debris. Often this initial viewing confirms expected pathology and is followed by establishment of the anterior (AS and AI) portals as described above. Occasionally, in cases of very small bony Bankart lesions, only a single anterior portal within the center of the rotator interval is necessary.
Diagnostic arthroscopy is performed systematically, viewing and palpating from both anterior and posterior portals. Concomitant pathology is identified and addressed at this time. The AS portal is often used as a viewing portal, permitting an en-face view of the glenoid for anchor placement.

Assessment of Bony Bankart (and other associated instability) Pathology
Although pre-operative imaging should already have afforded preliminary evaluation of bone fragment size and position, careful intra-operative assessment is necessary. Visualization with a 70 degree lens from the posterior portal, while palpating and manipulating from the anterior portal(s) allows assessment of bone fragment dimensions, position, mobility, bone quality, degree to which it has healed to the glenoid (and whether by fibrous or bony union). In addition, its' relationship to the labrum/ligament complex (which often contains the avulsed fragment), and the degree, if any, of associated capsular patholaxity (Fig 7) is determined.

In addition to gauging the dimensions of the bony Bankart fragment, evaluation of the magnitude of glenoid deficiency is important at this step. It is most easily determined viewing with a 30 degree lens from the AS portal, using a calibrated probe from the posterior portal to measure the amount of anterior glenoid bone loss relative to the "bare spot" technique as described by Burkhart et al (27).

The posterolateral humeral head is inspected for evidence and extent of a Hill-Sachs lesion. The arm is often removed from traction and manipulated into an abducted and

externally rotated “throwing” position, observing the degree to which the humeral head defect “engages” the glenoid. The ease of engagement may influence the decision to proceed with an arthroscopic bony Bankart repair and/or consider any adjunctive/alternative approaches, such as remplissage, humeral head bone grafting, open surgery, or a Bristow-Laterjet procedure.

Mobilize Fragment:

Thorough soft tissue and bone fragment mobilization is critical for anatomic reduction of the bony Bankart, as well as allowing restoration of normal capsular tension. While viewing with a 70-degree lens from the posterior portal, a liberator rasp (Smith Nephew) or other instrument (shaver or radiofrequency device) is brought in from the AS portal. This in-line approach permits mobilization of the bony bankart lesion from the glenoid in the plane of the fracture. Further mobilization of the labrum from the glenoid rim can be exploited for the length of the soft tissue bankart above and/or inferior to the bony bankart lesion itself. The AI portal permits access to lesions extending inferiorly beyond the 5 o’clock position (right shoulder). Satisfactory mobilization is confirmed when the fragment and labral complex are easily translated superiorly and laterally, with visualization of the underlying subscapularis muscle.

Tissue Preparation

Thorough tissue preparation is essential to ensure biologic healing of the repaired lesion. With rare exception, most bony Bankart lesions are essentially non-unions, and require debridement of interposed soft tissue and some method to try to generate a healing response. This is performed using a curved shaving blade, burr, and /or curette, addressing both the glenoid and bony fragment / labral faces of the fracture plane. Avoid overly aggressive bony-Bankart debridement, which can inadvertently remove bone.

Plan Repair:

At this point, one should have a reasonably clear perspective about how to best approach the observed pathology. The order of the repair includes 1) Securing the inferior-most extent of the anterior bony Bankart lesion (usually at the 5 – 6 o’clock position for a right shoulder), 2) fixing the bony Bankart lesion itself, and 3) completing the construct with a final anchor at the superior-most extent of the Bankart lesion (usually at 2:30/3:00 o’clock for a right shoulder).

Reduction of Bony Bankart lesion

A traction suture is placed through the upper portion of the AIGHL just above the bony Bankart. This is best passed using the Labral Scorpion (Arthrex), Needle-punch (Arthrex) or Caspari (Linvatec) suture passing instrument via the AS portal. Tensioning the traction sutures through the AS portal facilitates superior translation of the inferiorly and medially displaced fragment, aiding in reduction and determining the optimal placement of sutures. Arthroscopic tissue graspers from the MA portal further facilitate

manipulation and reduction of the Bankart lesion. Occasionally, we have found a percutaneous spinal needle helpful as a "joy stick" to manipulate the fragment.

First Anchor Placement

The first fixation point is the keystone of the repair. It serves to anchor the initial construct in an anatomically reduced position for the remainder of the case. It will also serve as perhaps the most important site of fixation through stress protection at the junction of normal and pathologic tissue (Fig. 8). Although a knotless system can effectively achieve fixation at this point, our preference is to use conventional suture anchors, which are more "forgiving" in terms of glenoid rim targeting.

Repair begins at the inferior-most extent of the detachment. The first anchor is placed at the inferior-most aspect of the tear, inferior to the bony Bankart fragment. We prefer a double-loaded 3.0 BioComposite SutureTak (Arthrex) anchor placed through the AI or or 5 o'clock percutaneous portal, usually at the 5:30 – 6:00 o'clock position (right shoulder). Ideally the anchor's double-loaded sutures emerge from the rim at the lesion's axilla. When drilling the anchor insertion site, make sure to have an appropriate "angle of attack from lateral to medial, to avoid undermining the articular cartilage (which occurs if one is too parallel to the joint). Also, be careful to avoid too vertical an approach, which can lead to inadvertent penetration of the inferior glenoid rim and extra-osseous anchor placement. A self-seating "fish mouth" type drill sleeve (Arthrex) can be used to gently lever the humeral head out of the way while directly targeting the glenoid rim. Care is taken to avoid applying too much leverage to the drill sleeve. An assistant can help by laterally translating the humeral head for better visualization and access. The anchor should be open and ready for insertion so that drill sleeve position and in-line anchor insertion is maintained. The anchor must be firmly seated such that its eyelet is below the articular cartilage, and tensioned to ensure it is secure within the bone.

First Anchor Suture Passage

Viewing from posteriorly, a limb of one of the inferior anchor sutures is then passed through either the AS or AI portal, through the ligament/labrum complex inferior to the bony Bankart fragment. This first suture is passed slightly inferior to the corresponding anchor point on the glenoid, such that when tied, permits sufficient superior translation re-tension the AIGHL complex, as is conventionally performed in a conventional soft tissue Bankart repair. A number of suture passing instruments can be used for this first suture passage, though we find that the Labral Scorpion (Arthrex) or Needle Punch (Arthrex) are particularly effective in achieving a robust capsular bite. Occasionally, this first suture can be passed from the posterior scope portal while viewing from the AS portal. The passed and unpassed first suture limb pair is retrieved through the AI cannula, and the first limb of the next suture pair similarly passed . This next limb is placed 3-4mm distant from the site of the first suture passage, to ensure adequate tissue capture. We are now prepared to tie these two simple sutures. Sometimes, the construct will be modified, and one of the suture pairs passed twice, to achieve a hybrid

construct, with one simple and one mattress configuration. Tying the second pair of sutures will establish and maintain fragment reduction for the remainder of the case (Figure 9). However, tying the sutures at this point can make subsequent anchor placement and suture passage challenging, especially if the bone fragment is large and or the shoulder tight. Therefore, sutures are clamped and kept loose outside the cannula at this time, and tied only after the bone bridge construct anchors have been inserted and their sutures passed.

Bone fragment repair

The technique by which the bone fragment itself is fixed is determined by its' size and quality. Fragments whose depth (medial to lateral dimension) is less than 3-4mm can be fairly easily incorporated into a single row repair as performed in a typical soft tissue Bankart procedure. Bone fragment(s) exceeding 4-5mm in depth however, may not be adequately secured with a single point of glenoid fixation, and are better served with a double-row "bridge" construct.

Single Row Construct (Fig. 10)

Viewing from the posterior portal with a 70-degree lens, a single-loaded 2.4 or 3.0 BioSuturetac anchor (Arthrex) is seated at the glenoid rim 3-4mm superior to the previously placed (sutures not tied) inferior-most anchor. A Curved or 90-degree angle Spectrum Hook (Linvatec) through the AS portal is then used to shuttle a # 1 PDS monofilament (Johnson and Johnson) underneath the bone fragment and labrum. This monofilament is retrieved and used as a suture shuttle to retrograde pass one of the suture limbs of the anchor, with the other limb brought out on top of the labrum. The suture pair is retrieved and clamped outside the AI portal, and the remaining suture anchors inserted at 4-5mm intervals proximally along the length of the bony Bankart lesion, usually 2-3 additional anchors. A single limb of each anchor is passed encircling the labrum with small bone fragment, and its paired limb brought out over the labrum/bone fragment. None of these sutures are tied until all bony bankart/labral anchors and sutures have been seated and passed. All pairs are now tied in simple suture configurations, beginning inferiorly and proceeding up the glenoid. While suture tying, attention is placed on keeping the knot off the articular face.

Double-Row "Bridge" Construct (Fig. 11)

Bony Bankart fragments exceeding 3-4mm in height (measured from medial to lateral) are secureD to the glenoid using a bone bridge double-row technique. Rather than single points of fixation along the glenoid rim, each attachment is secured with two points of fixation, one placed just medial to the bone fragment on the glenoid neck, and the other at the anterior glenoid rim.

Medial Anchor Placement:

Viewing with a 30-degree lens from the AS portal, the first 3.0 single-loaded Biosuturetac Anchor (Arthrex) is inserted through the AI portal or accessory anterior-

inferior (5 o'clock) portal into the medial glenoid. Anchor placement should be about 2-3mm superior to the inferior aspect of the bone fragment, and should be just medial to the origin of the glenoid fracture fragment (Fig. 12). Accurate medial anchor placement is critical to achieve anatomic bone fragment reduction. If the medial anchor is placed *too* medially, the buttress effect of this medial point is lost, permitting medial fragment displacement and malunion. If the medial anchor is placed too far laterally (towards the rim), the fragment will be translated laterally when securing the lateral row sutures. The anchor sleeve enters lateral to the fragment, essentially displacing the fragment medially while drilling and inserting the anchors.

Suture Passage

Each of the first medial anchors' two suture limbs are then passed around the bone fragment (Fig. 13A and B) and shuttled outside the portal and clamped. Suture passage around the bone block is arguably the most demanding part of this procedure, and can be achieved in a variety of ways. Our preference is the use of a Spectrum crescent straight or curved hook (Linvatec) delivered through the AI portal, which affords a direct shot deep to the bone block, emerging medially at the bony Bankart lesion/glenoid interface. PDS suture is scrolled through the suture-passing instrument, grasped from the posterior (or accessory AI 5 o'clock) portal, and used to shuttle one limb from the medial anchor around the bone fragment. This step is repeated, penetrating the soft tissue/labrum medial to the bone block, and 3-4mm superior to the first suture pass (thereby achieving tissue capture between the suture passes, and better construct fixation). Alternatively, one can use a Penetrator (0, 22.5 and 45 degrees, Arthrex) or Ideal Suture Grasper (DePuy Mitek) though the MA portal to grasp and retrieve the suture limbs. An alternative strategy to achieve suture passage is to drill and place the anchors through the soft tissue medial to the fragment, in situ, which prevents having to separately pass the suture limbs.

Before proceeding with lateral anchor placement to complete the "bridge", additional medial row anchors are first placed. This allows adjustment of anchor position placement to ensure an anatomic reduction of the fragment, and also affords easier suture passage around the fragment. Usually a total of 2 or 3 medial row anchors are required, depending upon the length (superior-inferior dimension) of the fragment.

Lateral Anchor Placement and Suture Fixation

Next, the bone bridge is secured by inserting lateral anchors that correspond to each of the previously placed medial row anchors. Although conventional suture anchors can be used (tying their sutures to the corresponding medial row anchor sutures that have already been passed), our preference is to use knotless anchors for our lateral row. This facilitates achieving a clean, low profile, simple, yet strong, compressive fixation system, which can be fine-tuned during insertion.

When using a knotless system, accurate implant targeting is critical. We have found that the 5mm metal cannula sleeve system used with the 2.9mm Biocomposite Pushlock

(Arthrex) anchor to be ideally suited for this purpose. With the cannula positioned in the accessory inferior (5 o'clock) portal, a pilot drill hole is made at the anterior bony bankart/glenoid interface for the most inferior bony bankart knotless anchor. By pre-"painting" the drill bit with methylene blue, the hole margins are stained to ensure easy identification for subsequent anchor insertion. Next, the suture pair of the first (most inferiorly placed) medial anchor is retrieved and threaded through the 2.7 Biopushlock anchor (Arthrex). While reducing and maintaining reduction of the bony bankart lesion, either through previously placed traction suture, probe or grasper from the AS portal, applying gentle superior translation with the traction stitch (previously placed in the AS portal), the first knotless anchor is seated onto the glenoid rim at a point directly lateral to the corresponding medially placed anchor pair (Fig. 14) The first knotless anchor is gently seated and impacted into place.

These steps of drilling the next knotless anchor insertion site, retrieving the medial suture pair, threading the knotless anchor, and inserting the lateral anchor to tension the next step of the construct, are repeated for each medial anchor.

Complete the procedure:

Upon completion of the bony Bankart repair, any labral detachment superior to the bony Bankart lesion is repaired using suture anchors. Because this repair is usually performed at the mid or superior aspect of the anterior glenoid, anchor placement and suture passage are usually achieved fairly easily using either the AS or MA portals. Labral repair anchors are placed at 3-5mm intervals until the construct is complete.

Alternatives to the bone bridge construct:

1. Suture passage *through* the bone block:

There are several devices, which permit trans-osseous suture passage *across the fragment itself,* rather than around the fragment. This can prove challenging because of the difficulties sometimes encountered in penetrating a hard and sizable bone fragment, as well as the more common problem of iatrogenically comminuting the fragment into multiple "crumbs". If one does elect to drill across bone and pass a suture or use some bone-penetrating instrument, the hole in the fragment must be anatomically aligned with the placement of the anchor sutures. Failure to do so will cause fragment displacement and result in a non-anatomic repair. For these reasons, trans-osseous fixation is a less desirable manner of securing the bony Bankart lesion.

2. Screw fixation through the bone block:

Arthroscopic repair of a bony Bankart using screw fixation is conceptually appealing, and with today's instrumentation, technically achievable. However, the technique requires 1) the ideal bone fragment that is robust enough to tolerate drilling without becoming fragmented, 2) perfect anatomic reduction so that when fixed the bony Bankart will not be mal-reduced, and 3) an ideal target angle for percutaneous screw placement across

the fragment into good glenoid subchondral bone. In cases with large bony Bankarts, we have the instrumentation available (Bone Bankart Repair System – Arthrex), but have not found the technique easy or satisfying.

Post-op Protocol:

Patients wear a shoulder sling with abduction pillow for three weeks. Skin sutures are removed in the office at 3-7 days post-operatively. Patients are allowed to come out of the sling twice daily for active elbow flexion/extension exercises, and instructed in scapular and rotator cuff strengthening exercises. Formal physical therapy starts at the 3-week mark, working to restore active and assistive range of motion, with gentle strengthening of the cuff and scapular muscles advanced as tolerated. Combined abduction and external rotation is avoided until week 12. Patients are allowed to return to sport at 4-6 months.

Potential Complications

The most common complication of this procedure is failure to achieve anatomic reduction and secure fixation, with the potential for recurrent instability, and non- or mal-union of the bony Bankart lesion. Other intraoperative risks include iatrogenic fragment comminution during suture passing or instrument penetration, inadequate fixation (single-row fixation with large fragment), and chondral damage during anchor drilling or insertion.

Top 5 Technical Pearls

Evaluate for bony pathology in patients with anterior shoulder instability. Obtain appropriate radiographic imaging (MRI/CT) to detect and assess glenoid involvement.
Incorporation, rather than removal, of bony Bankart fragment(s) has been shown to increase the success rate in arthroscopic stabilization.
Attention to thorough tissue mobilization and debridement are requisite to achieving an anatomic reduction and biologic healing.
The key to repair begins at the inferior-most aspect of the bony Bankart lesion, where secure fixation at the axilla of the lesion ensures anatomic alignment during the remainder of the repair.
Single row construct is adequate in many cases with small bone fragments, but double-row “bridge” technique affords enhanced compression and fixation in cases with fragments greater than 4-5mm in medial-lateral height.

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Figures/Illustrations:

Figure 1
This axillary view demonstrates a slightly displaced bony Bankart lesion (arrows).

Figure 2
This axial MRI slice demonstrates the bony Bankart lesion (arrow head).

Figure 3
3D CT imagine with humeral head digitial subtraction allows precise determination of fragment size and location.

Figure 4
Percutaneous Set for Anchor Insertion includes a long hubless spinal needle for targeting the glenoid, a cannulated obturator that dilates over the spinal needle, and

a cannulated drill sleeve that passes over the obturtator to establish a percutaneous portal.

Figure 5
Two commonly used suture passing instruments, a “penetrator” (Arthrex) and a Caspari Suture Punch (Biomet)

Figure 6
This view shows a right shoulder in the lateral decubitus position, with the arthroscope in the posterior portal and the twin anterior portals, A clear 8.25mm cannula is shown in the Anterior Superior (AS) portal and a blue 5mm cannula in the Anterior Inferior (AI) portal.

Figure 7
This arthroscopic view of a right shoulder, patient in the lateral decubitus position, 30 degree lens from the AS portal, demonstrates the bony Bankart fragment avulsed from the glenoid rim. The most inferior aspect of the labral detachment is seen just inferior to the 5:30 o’clock position, with the axilla of the lesion marked “A”.

Figure 8
Arthroscopic viewing from AS portal with 30 degree lens shows a spinal needle percutaneously directed at the axilla (A) of the labral detachment, just inferior to the 5 o’clock position. This is the most important anchor in securing anatomic reduction and fixation.

Figure 9
This arthroscopic view of a right shoulder, lateral decubitus position, shows the appearance following tying of the initial “keystone” anchor sutures at the axilla of the Bankart lesion, inferior to the bone fragment. A double-loaded suture anchor permitted simple suture capture of good capsulolabral tissue at two different sites at approximately the 5:30 o’clock position. This arthroscopic photo demonstrates fixation following suture passage for the bony bankart repair. Tying these sutures *before* repairing the bony Bankart may compromise the ability to manipulate the bone fragment and cause undue stress on these important two first sutures, so we clamp and delay final knot tying until the bony bankart sutures have been passed.

Figure 10
This on-face view of the glenoid demonstrates a single row fixation technique in which arthroscopic suture or knotless anchors are used to secure the bony Bankart lesion by encircling it within the avulsed capsulolabral tissue. In this illustration, bony Bankart fixation has been achieved with a double-loaded suture anchor inferiorly, and three single loaded anchors proximally using simple configuration sutures.

Figure 11

A double-row bony Bankart repair shows an A) on-face view, in which double-loaded suture anchors capture the labral detachment superior and inferior to the bone fragment, and knotless anchors secure the bone fragment laterally. In B) an axial view demonstrates the double-row "bone bridge" construct.

Figure 12
Viewing from the AS portal, a drill sleeve engages the medial glenoid neck just medial to the inferior aspect of the fracture fragment.

Figure 13
In this arthroscopic view, A) a retriever grasps a limb of the blue monofilament suture passed around the bone fragment (arrowhead) and one of the anchor sutures limbs (Anchor Suture Limb #1). In B), after shuttling ASL#1 underneath and around the bone fragment, the other suture limb (ASL#2) is ready to be passed.

Figure 14
Following passage of the arthroscopic sutures around the captured bone block, they are threaded through a knotless anchor and seated directly at the interface between the bony Bankart fragment and the articular margin of the glenoid rim.

Figure 15
In A), arthroscopic view following bone bridge technique with two sets of double-row anchor bridges. Sites of compression are seen by indentation of soft tissue under bridging sutures (arrowheads). 3D CT scan with digital subtraction of humeral head, 6 months following bone bridge double-row repair technique of a large bony Bankart.