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Operative Techniques in

Sports Medicine

Arthroscopic Bankart Reconstruction with Minimal Bone Loss

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Arthroscopic shoulder stabilization is the most commonly used technique to treat shoulder instability; however, recurrence rates have been shown to be high in our literature. Optimizing treating of glenohumeral instability is crucial to improve patient outcomes. This chapter will provide a basic review of the key steps in the evaluation and management of patients with shoulder instability with minimal bone loss.
Oper Tech Sports Med 27:18-24 © 2019 Published by Elsevier Inc.

KEYWORDS **Arthroscopic bankart, shoulder instability, minimal bone loss**

Introduction

The glenohumeral joint is one of the most commonly dislocated joints in the body.[1] Shoulder instability not only impacts short-term pain and disability but also has long-term implications on post-traumatic joint degeneration.[2] Arthroscopic shoulder stabilization has become the most commonly used technique in the treatment of glenohumeral instability.[3] Despite its popularity, recurrent instability or apprehension is worrisome with recurrence rates as high as 42% in long-term follow-up studies.[4,5] Multiple studies have also concluded that significant bone loss severely impacts the success rate with arthroscopic stabilization procedures.[6-8] Furthermore, results of revision arthroscopic Bankart stabilization are disappointing.[9] Hence, optimizing the initial treatment of glenohumeral instability is critical if improved patient outcomes are our goal. This chapter is focused on the arthroscopic treatment of anterior instability with minimal bone loss.

Pathology

Anterior glenohumeral dislocations and subluxations can produce injuries to both the soft-tissue and osseous stabilizing structures of the shoulder joint. These structures include the labrum, the glenohumeral ligaments (HAGL), glenoid, and humeral head. The glenoid labrum functions to increase the depth of the glenoid and resist humeral head translation. The labrum is contiguous with the HAGLs at the insertion site on the glenoid. During anterior glenohumeral instability episodes, the anterior-inferior capsulolabral complex is most commonly avulsed from the glenoid. This detachment has been termed "the essential injury" in anterior instability.[10] Since Bankart's original description, biomechanical studies have demonstrated that injury to the capsule and associated ligaments, in addition to the Bankart lesion are required for glenohumeral instability.[11,12] Bone loss is frequently encountered involving both the humeral head and glenoid in glenohumeral instability episodes, and the degree of bone loss plays a critical role in surgical decision making.[8,13-16]

Evaluation

History and Physical Exam

A thorough history must be obtained when evaluating patients with glenohumeral instability. Key components include age, sex, number of dislocation events, participation in contact sports, and history of prior surgical stabilization procedures. Physical exam of the shoulder begins with inspection of the shoulder girdle for any evidence of muscle atrophy or scapular dyskinesis. A neurologic exam should be performed with attention to the motor and sensory function of the axillary nerve. Active and passive shoulder range of motion should be evaluated while strength against resistance may reveal

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https://doi.org/10.1053/j.otsm.2019.01.004
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associated rotator cuff pathology, especially in older patients.[17,18] The anterior apprehension test is performed best with the patient in the supine position on the exam table. The shoulder is brought into 90° of flexion, abduction, and external rotation while a gentle anteriorly directed force is applied. If a patient reports a sense of instability, not pain, this is considered a positive finding. If pain is the predominant complaint, instability is less well-established with this test. If apprehension occurs at lesser degrees of abduction, significant bone loss must be considered.[19] Finally, patients should be screened for ligamentous laxity using the Beighton score.[20]

Imaging

All patients with a history of shoulder instability should be initially evaluated with plain radiographs consisting of anteroposterior (AP) internal and external rotation, axillary and outlet views of the shoulder. Plain radiographs should be carefully scrutinized for glenohumeral dislocation, subluxation, or fractures of the glenoid and Hill-Sachs lesions. The Bernageau view is an excellent alternative view to evaluate glenoid bone loss.[21] The Stryker notch view is an additional view that helps better define Hill-Sachs bone loss.[21] There is debate as to whether or not all instability cases require magnetic resonance imaging (MRI) in the initial evaluation. However, if deemed to be appropriate, a MR image with intra-articular contrast facilitates assessment of the labrum and HAGLs while providing preliminary information on bone loss. The MRI may reveal bony Bankart lesions, anterior labroligamentous periosteal sleeve avulsion, humeral avulsions of the HAGL (Fig. 1), and glenoid labral articular disruption (Fig. 2), all of which have an impact on outcome.[22,23]

If significant bone loss is suspected, a 3-Dimensional (3D) computed tomographic (CT) scan with humeral head subtraction and reconstructed images is recommended for precise measurements and preoperative planning. Utilization of a 3D printer to create a 3D model is also a very useful tool in surgical planning (Fig. 3). Methods of glenoid bone loss measurement include the bare spot method, best fit circle technique, and the Pico Method.[7,24,25] Additionally, Hill Sachs lesions can be characterized typically as a percentage of the circumference as well as the depth of the lesion. When

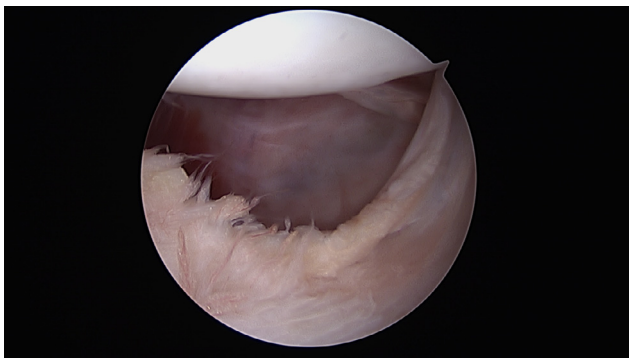

Figure 1 Posterior view of a right shoulder; humeral avulsion of the glenohumeral ligament (HAGL) injury (ARROWS). HH, humeral head; SSc, subscapularis. (Color version of figure is available online.)

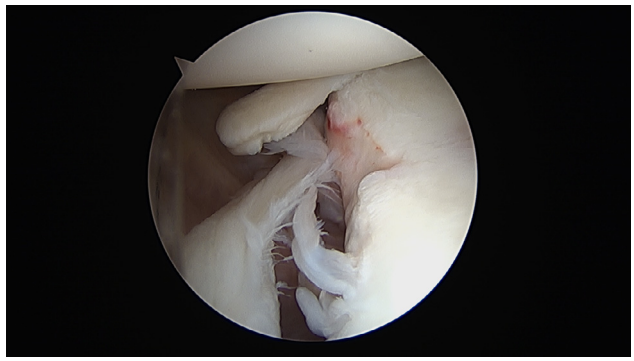

Figure 2 Anterior superior portal view in a right shoulder of a glenolabral articular disruption (GLAD) lesion; HH (humeral head); G (glenoid); Articular defect (large arrows), Osteochondral fragment (*); inferior glenohumeral ligament (IGHL) (small arrows). (Color version of figure is available online.)

encountering significant bone loss, the glenoid track can be measured and the lesions determined to be either "on" or "off" track as "off-track" lesions usually require a bony, not soft tissue, solution.[8,14,26] Identifying shoulder instability patients with minimal bone loss is critical if only soft tissue procedures are to be performed.

Patient Selection

Surgical decision making is based on the patient's history, physical findings imaging, and expectations. Risk factors for failed stabilization including age, gender, contact sport participation, multiple episodes, and associated ligamentous laxity should be reviewed on an individual basis and treatment should be tailored to the patient accordingly. Scoring systems, such as the instability severity index score, have been developed and validated to assist in the selection process when considering arthroscopic, bone block or open shoulder stabilization procedures (Table 1).[15,27]

Primary arthroscopic Bankart reconstruction is typically indicated for patients with anterior glenohumeral instability with minimal bone loss who have failed nonoperative treat-

Figure 3 A 3-Dimensional model based on computerized tomographs. Glenoid bone loss (arrows); inferior displaced bony Bankart lesion (*). (Color version of figure is available online.)

Table 1 Instability Severity Index Score[15]

Prognostic Factors	Points
Age at surgery	
≤20 years old	2
>20 years old	0
Degree of sports participation	
Competitive (preoperative)	2
Recreational or none	0
Type of sport (preoperative)	
Contact or forced overhead	1
Other	0
Shoulder hyperlaxity	
Shoulder hyperlaxity (anterior or inferior)	1
Normal laxity	0
Hill-Sachs on AP x-ray	
Visible in external rotation	2
Not visible in external rotation	0
Glenoid loss of contour on AP x-ray	
Loss of contour	2
No lesion	0
Total (points)	10
>6 points = 70% chance of recurrence after arthroscopic Bankart repair	

ment, have significant risk factors for recurrent instability or are first time dislocators with high-risk recurrence profiles. How much bone loss constitutes a contraindication to soft tissue repair without increasing the risk of failure is not entirely understood, but certainly must be considered with bone loss greater than 10%-15%. It is noteworthy with bone loss exceeding 13.5% (subcritical), although recurrent instability may not occur, functional scores can be very disappointing.[14] Burkhart et al. reported on contact athletes with significant bone loss experiencing a recurrence rate of 89%, whereas those contact athletes without significant bone defects experienced recurrence rates of 6.5%.[16] Historically, glenoid bone augmentation procedures have been recommended for glenoid bone loss exceeding 20%-25%.[28,29] For patients with an engaging Hill-Sachs lesions without significant bone loss recent studies suggest that the addition of an arthroscopic remplissage to the soft tissue repair, may improve outcomes.[30-32]

The importance of decision making when deciding on soft tissue repair for anterior shoulder instability cannot be over emphasized given the consequences of a failed soft tissue stabilization procedure. Although the arthroscopic technique must be meticulous, poor selection will ultimately lead to an unacceptable failure rate.

Arthroscopic Bankart Technique

1) Positioning: The patient is placed in the lateral decubitus position, which is the preferred position for shoulder stabilization procedures.[33] Examination under anesthesia of the involved and uninvolved shoulders should be performed routinely to determine the degree and direction of instability. The examination should confirm the preoperative diagnosis before proceeding. The arm is placed in a dual suspension padded arm holder with 8-10 pounds of force in each direction. The arm is slightly forward flexed, internally rotated, and abducted 20°. The operating room table should be rotated posteriorly such that the glenoid is made parallel to the floor for orientation during anchor placement.
2) Portals: Portal placement is the single most important task for a successful stabilization procedure. A standard posterior portal is made, slightly lateral to the glenohumeral joint line. This portal will eventually become a working portal and must be above the equator. While viewing from the posterior portal, anterior superior (ASP) and anterior inferior portals (AIP) are established using an outside-in technique. The shoulder should be reduced prior to creating the dual anterior portals. The AIP should be created slightly superior and lateral to the superior border of the subscapularis with a spinal needle. The ASP is placed directly behind the biceps tendon at the top of the rotator interval such that the distance should be maximized between these 2 portals to facilitate instrumentation. Typically, an 8.25mm cannula can be placed in the AIP to accommodate the diameter of the suture hooks utilized in the repair. An accessory posterolateral portal is commonly required for anterior inferior shoulder instability and is placed 2-3cm lateral to the standard posterior portal. This portal can be percutaneous and need not utilize a cannula. A spinal needle can be used to localize this portal. (Fig. 4A-D). A comprehensive diagnostic examination, looking from both the anterior and posterior portals is performed in order to evaluate the labral pathology and to assess any associated pathology, such as HAGL, superior labrum from anterior to posterior tear (SLAP), or rotator cuff injuries. Careful probing is mandatory.
3) Bankart Preparation: Once the Bankart lesion has been identified, the arthroscope is placed in the ASP and a posterior working portal is established with an 8.25mm cannula. In most anterior shoulder instability cases, the labrum is injured from the 3-o'clock past the 6-o'clock position (right shoulder) (Fig. 5). While viewing from the ASP, the soft tissue Bankart lesion is liberated from the glenoid neck utilizing angled elevators, shavers and potentially a radiofrequency device. The most critical step in the soft tissue repair is a thorough release of the inferior HAGL such that the ligament can be retensioned appropriately. A helpful guide is to fully visualize the subscapularis muscle fibers after the ligament has been adequately mobilized (Fig. 6).
4) Bankart Repair: After the labrum has been generously mobilized, accurate placement of the anchors must be accomplished. The repair begins with a 6-o'clock anchor placed through an accessory posterolateral portal.[34] Direct suturing of the axillary pouch to the inferior glenoid is a critical step in retensioning the HAGLs as the instability pattern is anterior and inferior.

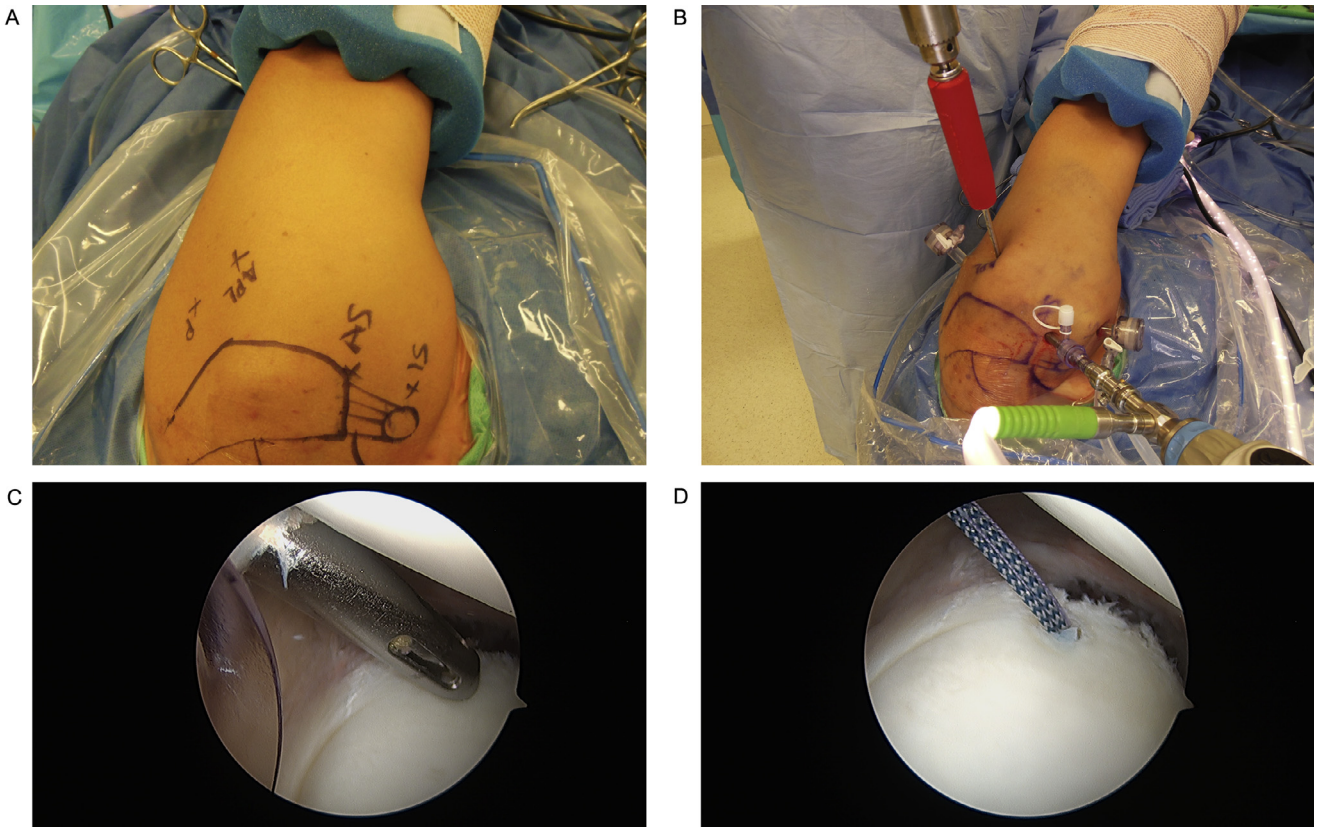

Figure 4 (A) Left shoulder, lateral decubitus position; Posterior portal (P), Accessory posterolateral portal (APL); Anterior superior portal (AS); Inferior portal (IS). (B) Left shoulder, lateral decubitus position; trochar and sleeve through accessory posterolateral portal for the 6-o'clock anchor placement (arrow). (C) Left shoulder, lateral decubitus position, viewing from the anterior superior portal; posterior labrum (PL); glenoid (G); humeral head (HH); drill sleeve (single arrow); 6-o'clock position (circle). (D) Viewing from the anterior superior portal in a left shoulder; 6-o'clock double loaded anchor/suture (arrow). (Color version of figure is available online.)

Utilizing a suture hook from the posterior working portal can facilitate accurate suturing of the inferior capsule utilizing a double loaded 6-o'clock anchor. The curve of the suture hook permits penetration of the labrum while shifting tissue posterior to anterior as well as inferior to superior (Fig. 7). Implanting a double loaded anchor is recommended as load to failure and stress sharing is optimized.[35,36] Curved aiming devices and all soft suture anchors are popular alternatives to placement of the 6-o'clock anchor but caution should be used as glenoid bone reaction with significant tunnel expansion has been reported.[37] Furthermore, placement of the anchor on the glenoid face permits better bony purchase and is associated with better functional outcomes as

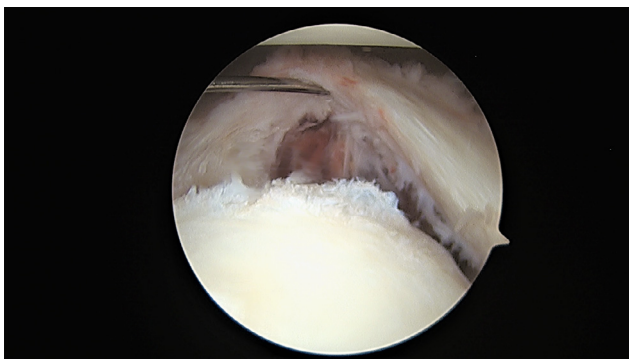

Figure 5 Viewing from the anterior superior portal in a left shoulder, thorough mobilization of the Bankart lesion past the 6-o'clock position; probe from posterior portal (large arrow); inferior capsule (small arrows). (Color version of figure is available online.)

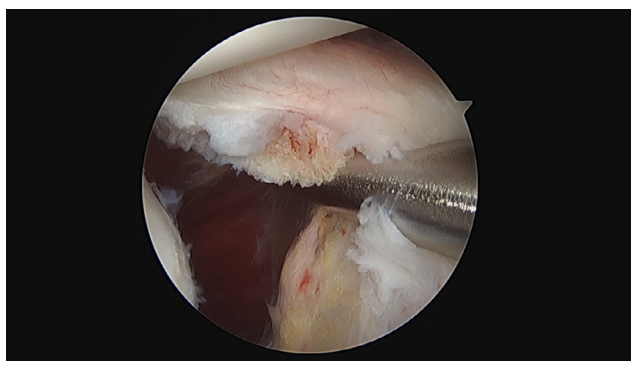

Figure 6 Viewing from the anterior superior portal in a left shoulder of mobilized IGHL (small arrow); humeral head (HH); subscapularis (SSc); glenoid (G). (Color version of figure is available online.)

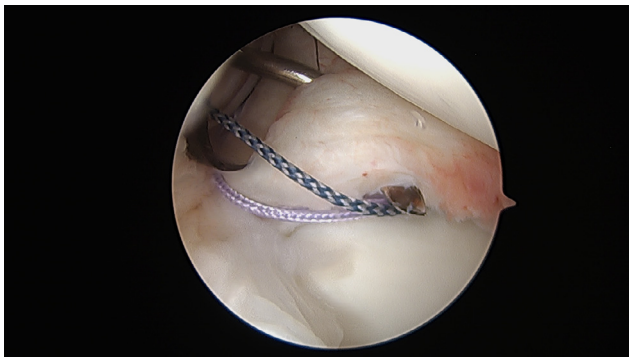

Figure 7 Viewing from the anterior superior portal in a left shoulder; direct suturing of inferior capsule with suture hook from posterior portal for the 6-o'clock anchor; tip of suture hook at 6-o'clock position (arrow). (Color version of figure is available online.)

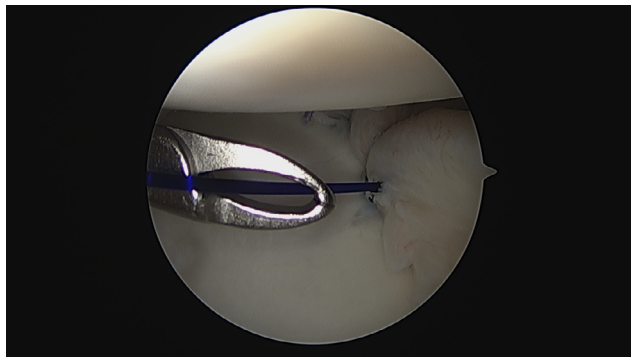

Figure 9 Viewing from the anterior superior portal in a left shoulder of absorbable suture shuttle to facilitate retrograde suture passage; humeral head (HH); glenoid (G); inferior glenohumeral ligament (IGHL). (Color version of figure is available online.)

glenoid labral height is restored (Fig. 8).[38] A minimum of 3 double loaded anchors should be used and prior studies have resulted in higher recurrence rates when fewer anchors are utilized.[39]

Once the double loaded anchor is placed, in sequence the sutures are separated through anterior and posterior cannulas. A 45° suture hook loaded with absorbable suture or a retrograde passing device is then passed through the labrum inferior to the placed anchor such that the ligament is shifted inferior to superior while closing the medial to lateral defect. The absorbable suture is used as a suture shuttle and the permanent suture is loaded and then shuttled through the labrum out the appropriate portal (Fig. 9). For the most inferior 6-o'clock anchor, tying from the posterior portal is recommended. For the remaining sutures along the anterior inferior aspect of the glenoid, tying from the AIP is most appropriate.

The suture configuration may play a role in healing, risk of recurrence and return to sports. We prefer alternating mattress and simple sutures such that compression against the labral footprint is optimized while the simple suture stabilizes the labral edge (Fig. 10A and B).[40,41]

After the 6-o'clock anchor (right shoulder), the second anchor is placed at the 4:30 position while the third anchor is placed at the 3-o'clock location for a total of 6 sutures. When tying the simple sutures, the knot must pass down the limb that has been passed through the labrum such that the suture material is away from the articular margin and serves to elevate the labral edge. As an alternative, a suture first knotless technique can be performed with the same concepts noted above. A suture or suture tape is passed through the labrum and a drill hole made in the glenoid face superior to the suture and/or tape placement with shifting of the labral tissue as the knotless anchor is inserted into the glenoid (Fig. 11A and B). At the completion of the Bankart repair, the humeral head should be well centered and resistant to attempts to dislocate the shoulder (Fig. 12A and B).

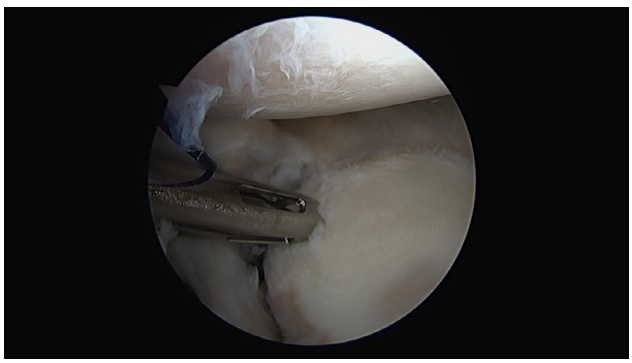

Figure 8 Viewing from the anterior superior portal view in a right shoulder, anchor placement at the edge of the anterior glenoid; humeral head (HH), glenoid (G), inferior glenohumeral ligament (small arrows); drill sleeve (*). (Color version of figure is available online.)

Postoperative Management

The patient is placed into a shoulder immobilizer. Pain control and swelling are optimized while early scapular setting exercises are introduced. For younger, male athletes, immobilization may exceed 4 or 5 weeks while the routine use of an immobilizer is 3 to 4 weeks. After 2 weeks, gentle Codman exercises are introduced with progressive forward elevation, external rotation, and combined abduction and external rotation emphasized for the first 3 months. The goal is to slowly establish a functional range of motion that should be achieved approximately 10 to 12 weeks following surgery. Strengthening is permitted at 8-10 weeks while return to full activities is generally allowed at 5-6 months. The elite level throwing athlete and the contact athlete may deviate from this protocol based on their special circumstances.

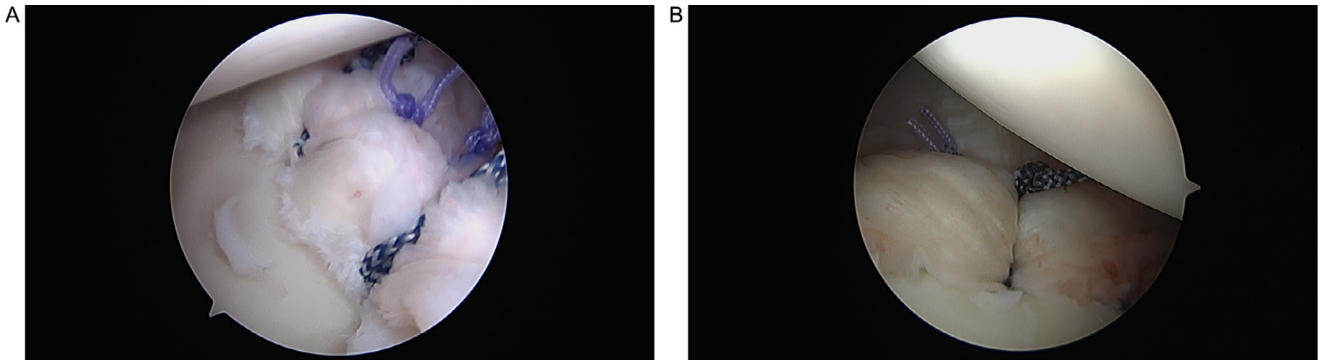

Figure 10 (A) Viewing from the anterior superior portal in a left shoulder, solid suture (small arrow) represents mattress configuration; multicolored sutures (large arrow) reflect alternating simple suture pattern, humeral head (HH), glenoid (G), inferior glenohumeral ligament (IGHL). (B) Viewing from the anterior superior portal in a left shoulder; completed alternating suture pattern with a 6-o'clock anchor; 6-o'clock anchor (*), simple stitch (large arrow), mattress stitch (small arrows). (Color version of figure is available online.)

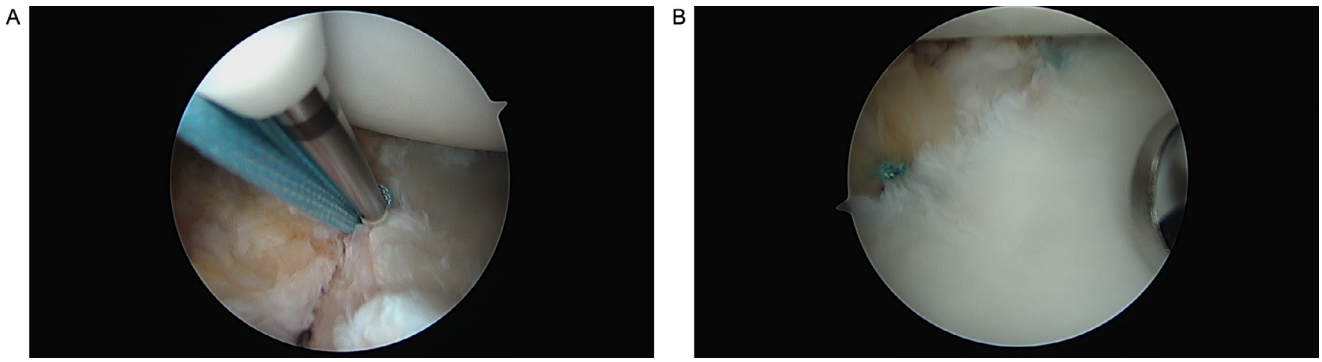

Figure 11 (A) Viewing from the anterior superior portal in a right shoulder showing knotless suture-first repair; suture tape (T) has been passed through the inferior glenohumeral ligament (IGHL) followed by loading into anchor which is in turn secured in glenoid drill hole (small arrow), inserter (I), humeral head (HH), glenoid (G). (B) Viewing from the anterior superior portal in a right shoulder following knotless repair technique where suture tails are minimized (small arrows); humeral head (HH), glenoid (G); inferior glenohumeral ligament (IGHL). (Color version of figure is available online.)

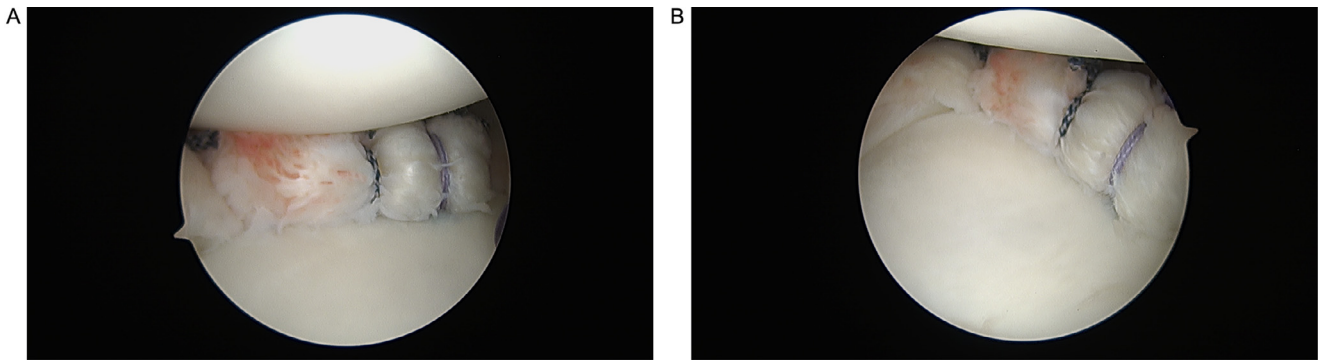

Figure 12 (A) Viewing from the anterior superior portal in a left shoulder, completed repair with reconstructed anterior inferior labrum; glenoid (G), humeral head (HH), inferior glenohumeral ligament (IGHL), 6-o' clock anchor (*). (B) Viewing from the anterior superior portal in a left shoulder; anterior inferior labrum repair (arrow), 9-o'clock position in left shoulder (*), inferior glenohumeral ligament (IGHL). (Color version of figure is available online.)

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