31

SYMPOSIUM

Arthroscopic Bankart Repair for Unidirectional Shoulder Instability

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Abstract

A successful arthroscopic Bankart repair for unidirectional shoulder instability requires careful patient selection and, to the extent possible, the restoration of normal anatomy. The patient's goals and anticipated demands are important considerations. A patient who participates in an overhead sport requires not only a stable shoulder but also a full range of shoulder motion. An athlete who engages in a contact or collision sport, however, may tolerate a mild loss of motion provided the shoulder is stable. Compared with an open procedure, an arthroscopic repair provides the opportunity to retain the most normal postoperative range of motion and function. Other considerations include patient age, which often relates to overall tissue laxity, and the number of previous instability episodes, which correlates with the severity of pathology (in particular, capsulolabral strain, glenoid chondromalacia, and bony deficiency of the glenoid or posterior humeral head). The magnitude of bone loss, particularly for the anterior glenoid, can make an arthroscopic repair inadvisable. Accurate portal placement, glenoid preparation, anchor insertion, and suture passage are key components of the arthroscopic technique, but the most important overall goal is the secure restoration of capsulolabral tissue tension. Secondary posteroinferior laxity, partial rotator cuff tears, labral disorders, and articular cartilage pathology may also require treatment.

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The choice of surgical procedure to correct instability is determined in part by the patient's anticipated shoulder demands and functional goals. Patient history (including such factors as age, tissue quality, and previous instability episodes), and clinical and radiographic findings also are important considerations.

Considerations in Decision Making

Patient Goals

Shoulder instability recurs in 7% to 10% of patients after an open or arthroscopic suture anchor repair.[1-4] The choice of surgical procedure to correct instability is determined in part by the patient's goals, including anticipated shoulder demands. Although an open Bankart repair is a reliable method for eliminating clinical instability, range of motion and overall function may be unacceptably compromised in some patients who engage in high-demand activities.[5] In particular, overhead athletes, including throwers, cannot tolerate restrictions in flexion or external rotation. The patient's range of motion usually returns more rapidly and completely after an arthroscopic rather than an open repair, and the patient is more likely to be able to return to competitive throwing.[6] However, overhead athletes have a lower overall rate of functional success (70%) than other athletes (90%) following an arthroscopic repair.[7]

A comparison of 30 open and 30 arthroscopic Bankart repairs found that muscle strength for forward elevation was markedly weaker after open repair for as long as 3 months; the difference, however, was only 5% after 6 months.[6] Muscle strength for external and internal rotation was significantly weaker 6 weeks after open repair but also approached 5% after 6 months. In a biomechanical investigation of arthroscopic anterior repair, a traumatic dislocation

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was created in 12 cadaver specimens, and an arthroscopic suture anchor repair of the Bankart lesion was performed. Glenohumeral translation and rotation were found to approach normal predislocation values.[8]

Arthroscopic Bankart repair remains controversial for athletes who participate in contact and collision sports. Several recent studies have concluded that there is no increased risk of recurrent instability for these athletes after an arthroscopic procedure.[2,7,9] The overall recurrence rate was 10% in 85 patients treated with a suture anchor arthroscopic anterior repair.[7] Two patients had a recurrence in a subset of 18 collision sport athletes (a similar 11% recurrence rate). In a review of contact or collision sport athletes who were younger than 20 years, 2 of 18 patients (11%) had a recurrent dislocation at a minimum 2-year follow-up but did not require further treatment.[9] In another evaluation of suture anchor repairs, the 9.5% recurrence rate for contact sport athletes (2 of 21 patients) was not significantly different from the 6% overall failure rate.[2]

A review of 48 shoulders in 46 collision sport athletes reached a different conclusion. Sixteen of the shoulders were arthroscopically stabilized (4 using Suretacs [Smith and Nephew Endoscopy, Mansfield, MA] and 16 using suture anchors) and 32 underwent open repair. Instability recurred after 25% of the arthroscopic repairs (one using Suretacs and three using suture anchors) compared with 12.5% of the open repairs. The authors concluded that open stabilization is a more reliable method of repairing anterior shoulder instability in contact athletes.[6]

Patient History

Patient age is believed to affect the probability of failure after an open or arthroscopic anterior stabilization procedure. Patients in their teens generally have greater tissue and collagen elasticity, which may predispose them to a higher likelihood of repair failure. In addition, younger patients are more likely to be attracted to high-risk activities, including so-called extreme sports such as snowboarding and aggressive mountain biking. Few studies have specifically evaluated pediatric patients with shoulder instability. In a review of 32 arthroscopic Bankart repairs in patients age 11 to 18 years, 16 shoulders were repaired after unsuccessful nonsurgical treatment and 16 were repaired after the initial instability episode.[10] At an average 25-month follow-up, three redislocations had occurred in two patients from the first group (18.5%), and two redislocations had occurred in two patients (12.5%) from the second group. The small size of the study, however, does not permit a conclusion as to the optimal treatment of pediatric patients with shoulder instability. The choice of an open or arthroscopic procedure should be based on tissue quality and capsulolabral integrity rather than solely on the patient's age. If traumatic pathology is identified and the patient's soft tissues are reasonably robust, an arthroscopic suture anchor technique can provide a reliable repair.

The number of previous instability episodes also should be considered because capsular strain, labral tearing, and glenoid erosion tend to increase with each occurrence of instability.[11] The severity of the accrued pathology must be evaluated during the diagnostic arthroscopy and helps determine whether an arthroscopic repair is suitable.

Physical Examination

The findings of the physical examination must support the clinical impression of unidirectional shoulder instability. Once the dislocated shoulder is reduced, any deformity usually disappears. There may be diffuse tenderness over the anterior capsular tissues and, less frequently, along the posterior glenohumeral joint line. The patient's range of motion is often restricted following an instability event secondary to pain. In those with chronic instability, acquired anterior capsular laxity may result in an increase in external rotation over their norm. Excessive anterior translation typically appears on the load-and-shift test unless involuntary muscular guarding is present. The magnitude of laxity in the posterior and inferior directions can help determine the need for accessory posterior plication and closure of the rotator interval, respectively. Most patients exhibit apprehension when the shoulder is placed in a position of abduction and external rotation. The relocation test is positive if the apprehension sign is minimized or eliminated when the examiner's hand is placed over the anterior aspect of the proximal humerus and prevents anterior subluxation of the humeral head. With the arm in full adduction and 30° of external rotation, a sulcus sign of more than 1 cm suggests that significant multidirectional laxity is present. In patients with true multidirectional instability, however, clinical symptoms must also be present in more than one direction. Hyperelasticity findings (the ability of the thumb to be passively placed against the forearm, elbow hyperextension, and marked medial/lateral translation of the patellas) suggest that the collagen tissue is pathologic, which is a known risk factor for failure after arthroscopic stabilization.[12]

Imaging

Routine radiographs should be obtained. The AP view may show a fracture of the inferior glenoid margin; a West Point axillary lateral view is more sensitive for anterior and inferior rim fracture fragments; the Stryker notch view identifies the presence and size of a Hill-Sachs defect of the posterior humeral head. A CT scan, especially with three-dimensional reconstruction, is useful for assessing the size of a glenoid rim deficiency or fracture fragment, and a Hill-Sachs lesion of the humerus.

Figure 1 Probe entering a right-shoulder acute Bankart lesion through the posterior portal.

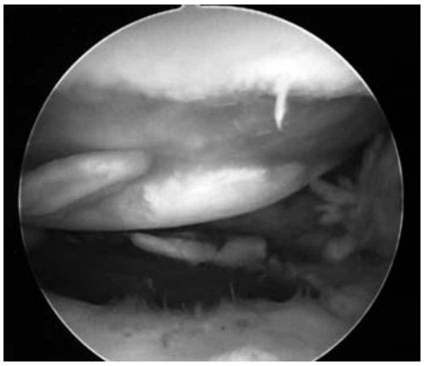

Figure 2 An acute Bankart lesion of the humeral head with chondral damage and loose bodies (posterior portal, right shoulder).

Diagnostic Arthroscopy

A thorough arthroscopic assessment of the instability pathology is imperative. The extent and nature of an acute Bankart lesion are usually apparent (Figure 1). The humeral head must often be displaced posteriorly to detect the inferior extent of capsulolabral detachment from the glenoid. The true capsular margin may be difficult to identify if the labrum has been obliterated. An anterior labroligamentous periosteal sleeve avulsion may be difficult to detect in the chronically unstable shoulder; the most reliable clue to its presence is that the capsulolabral tissue appears to be attached too far medially along the glenoid neck (3 to 4 mm medial to the rim). Chondral damage may also have occurred in a shoulder with chronic instability (Figure 2).

Bone loss can result from a fracture or progressive erosion. Thin glenoid rim fracture fragments often remain securely affixed to the capsule and can be detected only by palpation of the tissues with a hook probe. These small wafer fragments can be repaired or simply excised. Evidence suggests that rim fracture fragments larger than 10% of the glenoid diameter should be preserved. In a review of 42 shoulders with posttraumatic recurrent anterior instability, CT was used to estimate the glenoid defect size, which ranged from 11.4% to 38.6%.[13] The bony rim fragment was incorporated during arthroscopic Bankart repair with 39 of the shoulders rated good or excellent on the University of California Los Angeles Shoulder Scale at an average 39-month follow-up. Two reinjuries were reported. In another study, 21 patients with a bony deficiency of the glenoid, including 11 with a traumatic rim fracture and 10 without an identifiable fragment but with attritional bone loss, had a suture anchor arthroscopic Bankart repair.[14] At a mean 34-month follow-up, 2 of the 21 patients had recurrent subluxation, and 1 had a recurrent dislocation. None of the patients with repair of a rim fracture fragment had an episode of postsurgical instability. In a study of 65 patients (41 with acute instability and 24 with chronic instability) who had undergone an arthroscopic suture anchor repair of a bony Bankart lesion, 2 patients (1 with acute and 1 with chronic instability) experienced a redislocation at a minimum 4-year follow-up.[15] The average Rowe score of the patients with acute instability improved from 59 to 92, and the score of those with chronic instability improved from 43 to 61. Glenoid rim erosion may increase with recurrent episodes of instability. Arthroscopic Bankart repair has an unacceptably high failure rate if there is significant anteroinferior glenoid bone loss. In a retrospective review of 194 consecutive arthroscopic Bankart repairs using suture anchors, two groups of patients were identified based on whether or not significant glenoid or humeral bone loss was present.[16] Glenoid loss was considered significant if the normal pear-shaped configuration of the glenoid had changed to an “inverted pear” shape, in which bone loss resulted in the inferior one half of the glenoid becoming narrower than the superior half. A 67% failure rate following arthroscopic Bankart repair was found in patients with an inverted pear-shaped glenoid or a significant Hill-Sachs lesion, compared with 4% for patients without a significant bony defect. The size of larger glenoid defects can be estimated using the central bare spot as a reference. The normal radius of the glenoid (inferior two thirds) is the distance

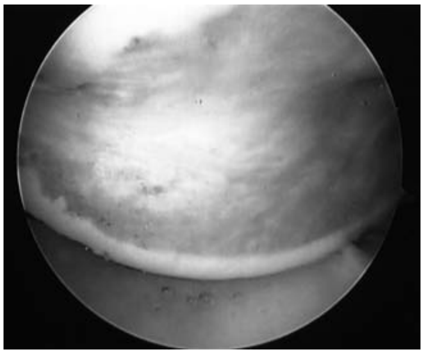

Figure 3 Posterior view of a Hill-Sachs lesion (posterior portal, right shoulder)

from the central bare spot to the intact posterior glenoid rim. The difference of the normal radius and the distance from the bare spot to the remaining anteroinferior glenoid margin can be used to estimate the percentage defect (for example, a defect of one half the length of the radius is approximately 25%).

Hill-Sachs lesions are common after shoulder instability, especially if the episodes are recurrent (Figure 3). Most of these lesions are relatively small and can be ignored without compromising the success of the repair. However, a specific subgroup is associated with a higher failure rate after arthroscopic stabilization.[17,18] In the study cited above regarding glenoid rim deficiency, significant Hill-Sachs lesions were also defined.[16] Three of 21 failures in that study were deemed to have been caused by an "engaging" Hill-Sachs lesion, wherein the posterior humeral defect engaged on the anterior glenoid rim with the arm in a functional position of abduction and external rotation. If the loss is greater than 30% to 35% of the articulating surface of the humeral head, an open osteoarticular allograft or arthroscopically assisted transhumeral impaction grafting may be considered.[17-19]

Translation of the humeral head can be difficult to quantify. However, a qualitative estimation of anterior capsular laxity or strain is useful in determining how much to plicate the capsule with each anchor suture. In addition, the magnitude of posterior laxity helps determine whether or not to augment the repair with several posterior "pinch-tuck" capsular plication sutures. A traumatic midcapsular rent or tear can exist, even in the presence of a separate Bankart lesion. In a prevalence study, 12 of 303 shoulders undergoing stabilization (4%) had a midcapsular tear in addition to a Bankart lesion.[20] Eleven of the 12 tears were repaired arthroscopically, with the average Rowe score of those patients improving from 30.4 to 90.4 at 31-month follow-up. In a review of 21 patients with a midcapsular tear, 7 tears were isolated and 14 were accompanied by a Bankart lesion.[21] More than 90% of the patients had a good or excellent Rowe score after an open or arthroscopic capsular repair along with a Bankart repair when indicated. The average loss of external rotation was 8° for patients with an isolated capsular closure and 16° for those who also had a Bankart procedure.

Humeral avulsion of the glenohumeral ligaments is recognized as a cause of recurrent shoulder instability. The lesion may not be readily apparent and must be carefully sought during diagnostic arthroscopy by examining the anterior and posterior capsular insertions onto the humeral neck. These avulsions can be repaired arthroscopically, although the procedure is technically demanding.[22] Considerably less morbidity is generated with a posterior arthroscopic repair than an open posterior approach. For an anterior avulsion, however, a standard open deltopectoral approach provides ready access to the anterior neck of the humerus with only partial subscapularis detachment.

Any associated lesion (superior or posterior labral lesion, chondral injury, or partial-thickness rotator cuff tear) should be identified and treated.

Technique for a Suture Anchor Arthroscopic Bankart Repair

A successful arthroscopic Bankart repair requires careful patient selection, a thorough understanding of normal and pathologic anatomy, skill in using arthroscopic tools and implants to approximate normal anatomy, and discernment in guiding the postsurgical rehabilitation program. The technique is not inordinately difficult, but mastery requires study and practice. The necessary skills can be honed in dry model and cadaver laboratories. Thorough planning and the ability to mentally rehearse the procedure are invaluable preparations. The operating room staff must be oriented to the sequence of steps and instruments to minimize miscues and optimize efficiency.

Optimal Visualization

A clear arthroscopic view of the intra-articular structures is essential and is improved by using mildly hypotensive anesthesia (approximately 100 mm Hg systolic pressure). Epinephrine can be introduced into the irrigant to help control bleeding (1 mL of 1/1000 epinephrine per 3 L). Although the procedure can be satisfactorily performed using gravity inflow, a pump allows blood pressure spikes to be offset with a temporary increase in inflow pressure. The pump pressure must be carefully monitored to prevent excessive fluid extravasation.

Patient Positioning

The patient's position must allow access to all areas of pathology. In the lateral decubitus position, the pelvis and thorax are supported by a vacuum pack (bean bag) with a 20° posterior tilt of the chest to facilitate access and orient the glenoid approximately parallel to the floor. A 5- to 10-lb weight attached to the arm sleeve permits suspension rather than traction of the arm. Excessive traction may compromise the ability to adequately retension the soft tissues in a superior direction and can cause undue tension on the brachial plexus during a prolonged procedure. A 5- to 10-lb accessory lateral traction can be oriented perpendicular to the humerus to aid in separating the humeral head from the glenoid and provide additional working space. Alternatively, an assistant can manually displace the humeral head posteriorly as the need arises. The standard beach chair position may be preferred because of the normal, upright orientation of the shoulder anatomy. However, the posterior aspect of the shoulder is relatively difficult to access arthroscopically with the patient sitting. For a patient in the beach chair position, a higher systolic blood pressure is necessary to maintain adequate cerebral perfusion; the normal compensatory mechanisms for cerebral blood flow may be compromised with the patient in a sitting position under general anesthesia. Conversion to an open procedure is simplest if the patient is in the beach chair position but also can be accomplished relatively easily from the lateral decubitus position.

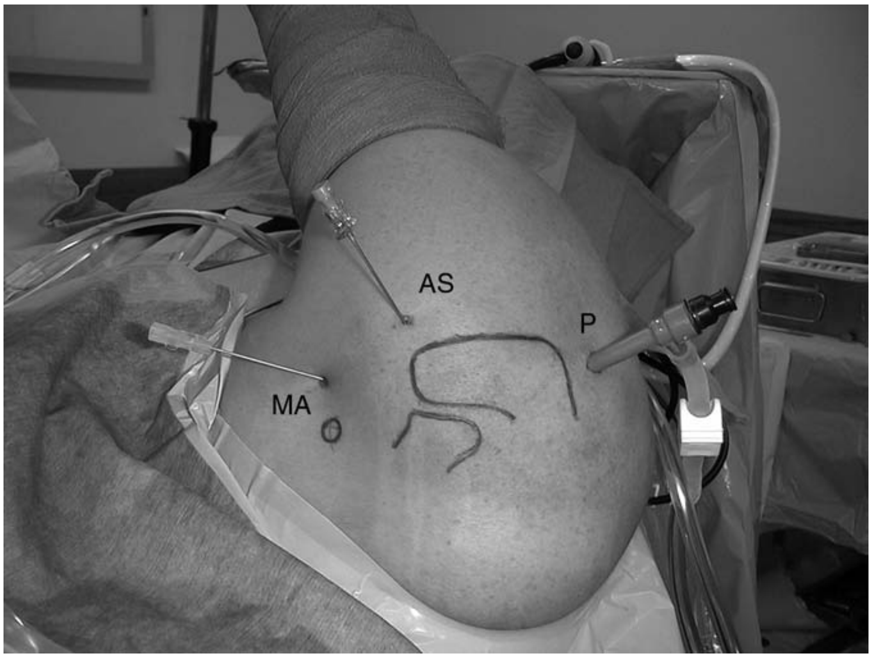

Figure 4 The standard arthroscopic portals. AS = anterosuperior, MA = midanterior, P = posterior.

Portals

Accurate portal placement facilitates identification and treatment of all intra-articular pathology. Poorly placed portals create difficulty in preparing the tissues for repair, placing sutures and anchors, and tying knots. The entry site for the posterior portal is 1.5 cm inferior and 1.0 cm medial to the posterolateral corner of the acromion. The cannula and trocar are directed toward the coracoid tip anteriorly (Figure 4). If drills and anchors may be required for the posterior glenoid, the entry site should be adjusted 1.0 cm farther lateral to provide an acceptable approach to the narrow posterior rim of the anteverted glenoid.

The midanterior portal provides access to the anterior glenoid for instruments. The entry site is located 1.5 cm lateral and 1.5 cm inferior to the coracoid tip. A spinal needle should be used to verify accurate placement; it is initially directed slightly superior, over the superior border of the subscapularis. When the arm is relatively adducted, the subscapularis is fairly lax and can be depressed inferiorly by the incoming needle or cannula and permit ready access to the anteroinferior glenoid. This portal should provide a 30° to 45° approach to the glenoid rim in the transverse plane, which is essential for safe drilling and anchor insertion. An 8.5-mm clear threaded cannula is optimal for this critical working portal.

An anterosuperior portal can be used as a working portal, with viewing from the posterior portal. Alternatively, the anterosuperior portal can be used as the primary viewing portal, and only the arthroscopic sheath needs be inserted. The optimal entry site is 1.0 cm lateral and slightly anterior to the anterolateral corner of the acromion. The proper path is established using a spinal needle that enters immediately anterior to the supraspinatus tendon and through the rotator interval, either anterior or posterior to the biceps tendon.

Glenoid Preparation

A full-radius synovial resector is used to débride the articular glenoid margins, removing ragged or unstable articular cartilage (Figure 5). To

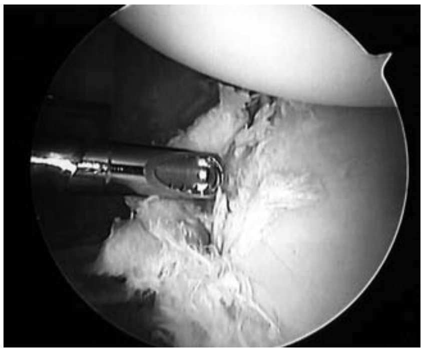

Figure 5 Shaver débridement of chondral and labral damage (anterosuperior portal, right shoulder).

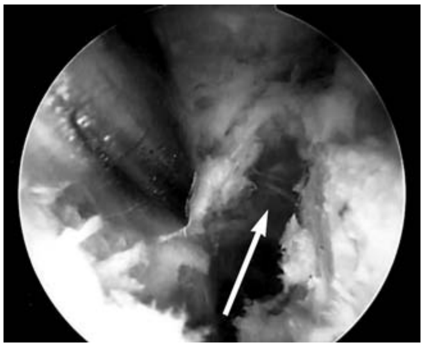

Figure 6 Exposed subscapularis muscle deep to the capsule *(arrow)* (anterosuperior portal, right shoulder).

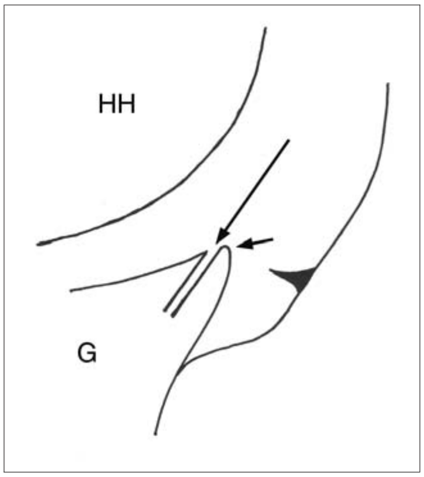

Figure 7 Orientation of the glenoid drill hole in the transverse plane *(long arrow)*; intact bone lateral to the drill hole *(short arrow)* (anterosuperior portal, left shoulder). G = glenoid, HH = humeral head.

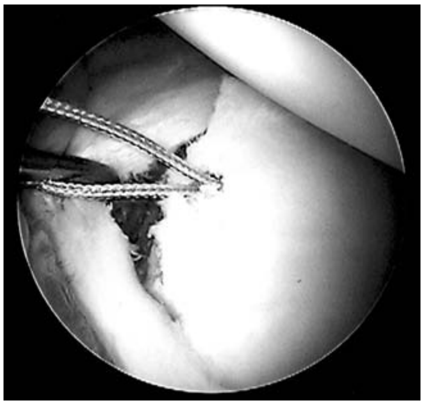

Figure 8 Suture anchor placed 2 to 3 mm onto the face of the glenoid, with intact anterior bone margin (anterosuperior portal, right shoulder).

prevent inadvertent damage to the sometimes fragile adjacent capsulolabral tissue, suction on the shaver should be turned off. The repair must restore normal capsulolabral tissue tension to prevent future glenohumeral instability. Adequate retensioning requires mobilization of the capsular tissue, which may have scarred medially along the glenoid neck. A liberator elevator is introduced through the midanterior portal and used to free the scarred capsular tissue from bone. When the release is complete, subscapularis muscle tissue should be visible medial to the capsule (Figure 6). Adequate mobilization allows the capsule to be advanced both superiorly and laterally onto the glenoid rim. An aggressive shaver or a 4.0-mm burr run in reverse is used to lightly excoriate the anterior neck of the glenoid to provide a bed for tissue healing.

A thin rim fracture fragment (1 to 2 mm wide) can be repaired or excised. If the fragment is removed with a burr, the reverse setting should be used to protect the underlying periosteum and thus enhance the integrity of the repair. Reduction and repair should be performed for a fragment larger than 10% of the glenoid diameter. The fragment can be encircled with anchor sutures, or alternatively, sutures can be passed through the fragment by predrilling with a small Kirschner wire. It is often necessary to introduce the Kirschner wire from the posterior portal to safely approach the separate anterior bone segment. Great care must be exercised to avoid inadvertent wire penetration into the soft tissues anterior to the capsule. Overreducing the rim fragment and creating articular incongruity should be avoided.

Anchor Placement

Anchor holes should be drilled 2 to 3 mm onto the articular surface of the glenoid (Figures 7 and 8). The anterior wall of the drill hole must have sufficient integrity to prevent the strong repair sutures from cutting out anteriorly and medially during the healing period, rendering the repair ineffective. The drill bit should approach the glenoid at approximately 45° in the transverse plane. If the approach angle is too shallow, there is a risk that the bit will skive onto the articular cartilage or that the anchor hole will be located too medial along the glenoid neck. Anchors should be evenly spaced between the 5-o'clock and 2-o'clock positions on the glenoid. After an anchor is implanted, its security should be tested by firmly pulling on the suture strands. Higher rates of repair failure have been reported when fewer than three or four anchors are used.[12] Whether made of metal or absorbable material, loose or prominent anchors may cause significant articular cartilage damage. Nonmetallic, nonresorbable anchors made of polyether ether ketone material have been introduced to avoid the cavitary bone cysts sometimes associated with resorbable anchors.

Reports on the use of knotless anchors are conflicting. In one study, experienced users documented excellent results at a minimum 2-year follow-up; knotless anchors failed in only 5 of 72 patients (6.9%), all of whom were younger than age 22 years.[23] After a similar follow-up period, another retrospective review reported failure of 5 of 21 knotless anchor repairs (23.8%) compared with 3 of 61 repairs using knot-tying anchors (4.9%).[24]

Capsulolabral Retensioning

Restoration of normal anatomy during the repair is essential, to the extent possible. A review of 24 patients who underwent revision surgery after an unsuccessful open anterior repair reported a persistent or recurrent Bankart lesion in 16, with capsular redundancy in 4.[25] Viewing is from the anterosuperior portal. A serrated drill guide provides a more secure purchase on the glenoid face than a fishmouth style tip. After drilling a hole in the appropriate orientation, an anchor is inserted through the midanterior portal and the sutures are retrieved out the posterior cannula. A clamp is used to identify the limb that exits the anchor inferiorly so that when this suture is shuttled back through the tissue, a 180° twist of the suture at the anchor eyelet is avoided. Glenohumeral reduction should be maintained during suture placement, and arm traction should not be permitted to cause inferior subluxation of the humeral head. If the capsulolabral tissue is markedly displaced inferiorly, it may be necessary to pass a suture through the capsule and apply superior traction to appropriately tension the capsule while introducing the repair sutures (Figure 9).

The goal is to introduce the inferior limb of the anchor suture approximately 1.0 cm inferior and 1.0 cm lateral to the anchor exit point from the glenoid rim. This placement will permit superior advancement as well as mediolateral plication of the capsule when the suture is tied. A curved, cannulated suture hook is passed down the midanterior portal, through the capsule, and then up beneath any remnant of the labrum. Once the hook has been placed through the tissue, it is brought superiorly with moderate tension to check for proper placement; if the hook can be displaced superior to the anchor site, the capsular tissues will not be appropriately tensioned when the suture is tied, and the hook must be replaced farther inferior. When the hook is correctly placed, a monofilament shuttle suture is delivered and

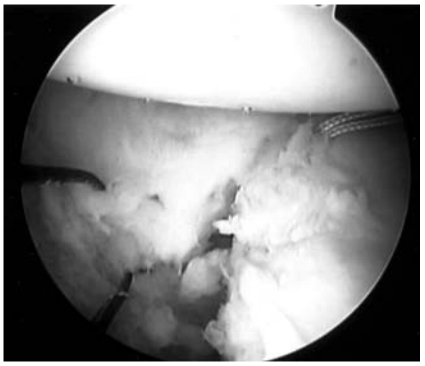

Figure 9 Monofilament traction suture used to retension the capsule superiorly (anterosuperior portal, right shoulder).

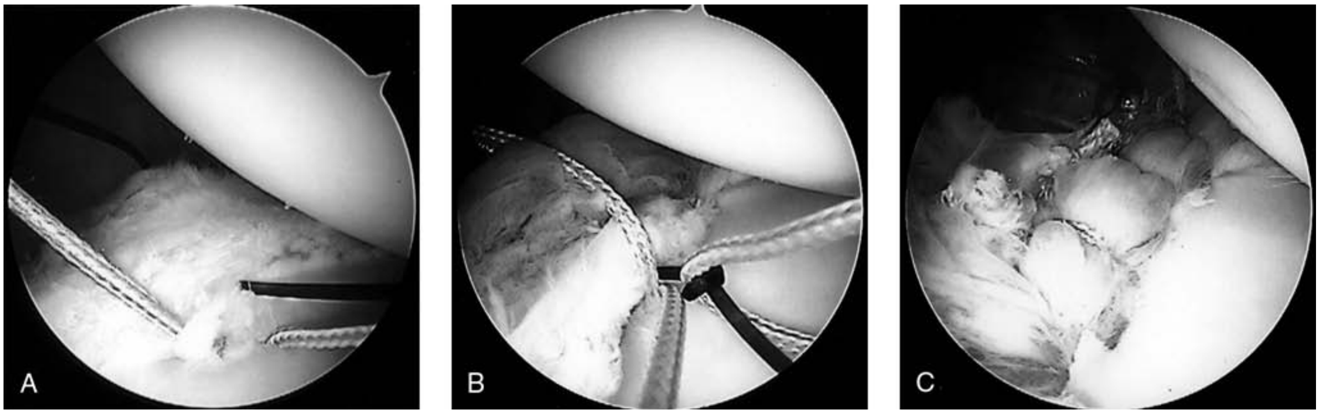

Figure 10 **A,** Monofilament shuttle suture passing through the capsule inferior and lateral to the glenoid anchor site. **B,** Monofilament suture shuttling the inferior limb of the anchor suture through capsulolabral tissue. **C,** The completed Bankart repair, with secure reattachment of capsulolabral tissue to the glenoid rim (All views are from the anterosuperior portal, right shoulder.)

retrieved out the posterior cannula, using a loop grasper (Figure 10, *A*). Using a simple overhand throw, this posterior limb of monofilament suture is tied around the tail of the inferior anchor suture limb (previously identified with a clamp), which is then shuttled from posterior to anterior through the capsule (Figure 10, *B*). This limb, which passes through the tissue, becomes the post for a sliding knot that is delivered laterally away from the glenoid as it is introduced. Sliding knots are backed up with three or four half hitches. These steps are repeated for each anchor and suture pair (Figure 10, *C*).

Test Repair

The repair should be palpated with a nerve hook to ensure that the sutures are tight, the capsulolabral tissue is securely fixed to the glenoid rim, and appropriate tension has been restored. The arm is then removed from suspension and shoulder stability and acceptable range of motion is confirmed. Absorbable subcutaneous sutures and adhesive strips complete the portal closures.

Summary

For an appropriately selected patient, arthroscopic Bankart repair can effectively restore capsulolabral tension and functional shoulder stability while optimizing postsurgical range of motion. The patient's anticipated demands and the surgeon's familiarity and experience with arthroscopic techniques may affect the choice of an open or arthroscopic stabilization procedure. Although youth is not an absolute contraindication to an arthroscopic anterior repair, if significant tissue laxity is present in a pediatric patient, the shoulder should be stabilized using an open procedure. If many instability episodes have led to marked capsular attenuation or significant bony loss, an open repair also is advisable. A CT scan is particularly valuable in assessing the extent of anterior glenoid bone loss and magnitude of posterolateral humeral head impression defects. An arthroscopic Bankart repair requires adequate mobilization of the capsulolabral tissue, careful glenoid preparation, secure anchor placement, and accurate suture delivery. These steps, when properly performed and followed by appropriate rehabilitation, will lead to a successful arthroscopic shoulder stabilization.

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