ARTHROSCOPIC CAPSULAR PLICATION AND CAPSULAR SPLIT/SHIFT TECHNIQUES FOR MULTIDIRECTIONAL INSTABILITY

Joseph C. Tauro, MD
Assistant Clinical Professor of Orthopaedic Surgery
New Jersey Medical School
Newark, New Jersey
Ocean County Sports Medicine Center
Toms River, New Jersey

Jonathan B. Ticker, MD
Assistant Clinical Professor of Orthopaedic Surgery
College of Physicians & Surgeons of Columbia University
New York, New York
Island Orthopaedics & Sports Medicine, PC
Massapequa, New York

Correspondence:

Jonathan B. Ticker, MD
Island Orthopaedics & Sports Medicine, PC
660 Broadway
Massapequa, NY 11758
Tel: 516/798-0111
Fax: 516/798-0152
Email: jticker@shoulders.md

"Arthroscopic Capsular Plication And Capsular Split/Shift Techniques For Multidirectional

Instability In A Nutshell"

History
Young, active patient. Increasing pain, feeling of subluxation or "dead arm" sensation. History may be atraumatic, microtraumic or frank traumatic dislocation.

Physical Exam
Positive instability tests - anteriorly and/or posteriorly with sulcus sign. Generalized hyperlaxity.

Diagnostic Imaging
Negative in many cases. Patients with traumatic dislocation may have a posterior or anterior Hill Sachs lesion on x-ray, and corresponding labral pathology may be seen on MR arthrography.

Indications
Persistent pain, loss of function, subluxation or dislocation despite appropriate rehabilitation.

Contraindications
Voluntary dislocators, poor compliance with prior rehabilitation efforts.

Instrumentation and Sutures
Spectrum® instrument set used for direct insertion of #1 PDS or to pass non-absorbable sutures (i.e., #2 braided suture) using a suture shuttle technique. Careful suture management and secure knot tying is important.

Evaluation Under Anesthesia
Anterior, inferior and posterior instability testing at 0°, 45° and 90° of abduction to further define pathology *(essential).* Sulcus sign that does not reduce when repeated with arm in external rotation suggests incompetent rotator interval.

Portals
Three portals for visualization, capsular advancement and suture management. The posterior portal is slightly more lateral and inferior than standard for posterior plication. The anterior-superior lateral portal is used for suture management during anterior and inferior plication, and for posterior viewing during posterior plication. The anterior-inferior medial is the primary working portal for anterior and inferior plication, for the capsular split and anchor placement and serves for suture management during posterior plication.

Arthroscopic Findings
Excessive laxity/redundancy indicated by deep capsular gutters. Combinations of anterior, inferior and posterior redundancy possible, with attenuated glenohumeral ligaments. Though not typical, partial labral tears or complete labral detachments along with Hill Sachs lesions in cases with traumatic dislocations may be found.

Plication Techniques
Capsule lightly abraded to promote healing. 1.0 - 1.5 cm of capsule is captured, and translated laterally and superiorly. Glenoid labrum is pierced, suture is passed and then tied for a secure

repair. Multiple sutures are used to shift the capsule and selectively reduce capsular volume inferiorly, and anteriorly and posteriorly as indicated.

Capsular Split/Shift
Used when a Bankart lesion is present. A 1.0 cm capsular split beginning at the inferior pole of the glenoid, advanced superiorly, will shift the capsule ~2.0 cm and tighten the axillary pouch. Cut the capsule using a narrow basket punch inserted through the anterior-inferior medial portal.

Interval Closure
Perform when exam suggests or arthroscopic findings confirm excessive superior capsule and enlarged rotator interval. Insert one or two sutures through the superior capsule and into the middle glenohumeral ligament. Tie inside of joint or on bursal side (for more tightening).

Post-operative Management
Sling immobilization for 3+ weeks. IR for primarily anterior repair, neutral rotation for primarily posterior repair. Focus on ROM initially and follow carefully, then add strengthening. Light overhead sports activity at 4 months, and progressed as able at 6 months. Contact sports allowed at 8 months.

KEY: MR-magnetic resonance, ROM-range of motion, IR-internal rotation

I. Case Histories

The following two cases are used as an example for patients with glenohumeral instability who have failed a non-operative physician-supervised treatment regimen and would be indicated for an arthroscopic capsular plication or shift technique. As a general rule, these patients are young, active individuals with generalized hyperlaxity and symptomatic, recurrent glenohumeral instability in the anterior and inferior direction, the posterior and inferior direction, or all three directions [Ticker 1995]. Trauma may or may not be a part of the given history, though microtrauma is often involved in the injury pattern, and these patients should not have a voluntary component. The degree of instability is often subluxation, as well as dislocation, without (case A.B.) and with (case F.M.) imaging evidence of traumatic capsulolabral pathology.

A.B. is a 19 year-old right-hand dominant female competitive swimmer who presented with left shoulder pain of one-year duration. At about that time, she increased her swimming regimen in an effort to have faster times during competition. Pain developed in her left shoulder that was not relieved with initial rest, ice and a period of rest. A. B. was unable to resume her swimming without pain that radiated to the lateral aspect of her arm, and she developed a "dead-arm" sensation, though she denied any numbness to her hand. The complaints included pain at night, as well as pain in the overhead position. She reported that there were times when she felt her shoulder shift in and out of the joint. Non-steroidal anti-inflammatory medication with a home exercise program resulted in minimal improvement. The addition of a physician-directed physical therapy program over a four-month period was not successful in eliminating her pain or allowing A.B. to resume her swimming.

F.M. is an 18 year-old right hand dominant competitive skate boarder who presented after having multiple documented right shoulder dislocations and many episodes of subluxation with accompanying "dead-arm" sensation. This patient had also failed many attempts to resolve the problem through a non-operative approach, including a physician-directed physical therapy program.

II. Physical Examination

In both cases, there was no evidence of swelling or atrophy and the skin was intact. A.B. displayed generalized hyperlaxity, which was demonstrated by hyperextension of the elbows and knees and her thumbs touching the volar aspect of her forearm. She had range of motion of 180° of forward flexion, 90° of external rotation and internal rotation to the T4 (the 4th thoracic spinous process). In the supine position at 90° of abduction, her external rotation was to 135° and internal rotation was to 60°. Her instability testing was also performed initially in the supine position. There was a positive anterior relocation sign and only minimal discomfort with the humeral head posteriorly-directed. Anterior drawer testing revealed 1+ translation (humeral head shifts to the glenoid rim) with guarding and posterior drawer testing revealed 2+ translation (humeral head subluxes over the glenoid rim) [Ticker 1998]. In the sitting position, there was a 2+ sulcus sign (2 cm inferior translation). No clicking was noted with instability testing or range of motion. Biceps active tests did not reveal any positive findings. As expected, there was greater tuberosity tenderness and a positive impingement sign. Other pertinent negative findings included no acromioclavicular tenderness, no scapular winging, a normal cervical spine exam and an intact neurovascular exam. F.M.'s physical examination was similar except he had less hyperlaxity but 2+ anterior translation of the humeral head while being more relaxed.

III. Imaging

Radiographs were obtained at the initial examination and include a true anteroposterior (AP) view, an axillary view and a supraspinatus outlet view. One additional view that is often obtained for patients with instability is the Stryker notch view. In A.B.'s case, no abnormalities

were identified on the radiographs. In particular, the glenohumeral joint was normal on the AP and axillary views, including the glenoid rim, and there was no Hill-Sachs lesion found on the Stryker notch view. A closed magnetic resonance imaging study was available for review. Normal labral and capsular anatomy were appreciated. No tendinous, cartilaginous or bony pathology were identified. Additional cross-sectional imaging studies with arthrography were not felt to be necessary. In F.M.'s case, there was a small posterior Hill-Sachs lesion noted on plain x-ray. An MR arthrogram also showed an anterior Bankart lesion.

IV.   Decision Process

The clinical diagnosis in both cases was primary (1°) multi-directional instability with secondary (2°) impingement. In the case of F.M., consideration was given to an additional traumatic component, the anterior labral tear. Non-operative versus operative treatment was reviewed with each patient and parents. Both had failed to improve with a non-operative treatment regimen and surgical intervention was offered. Open and arthroscopic approaches were reviewed pictorially. An arthroscopic capsular shift procedure was selected for its ability to address all components of the instability pattern in a potentially less invasive and more cosmetically pleasing manner. Risk and benefits were reviewed, including, but not limited to, infection, recurrent instability, pain, stiffness, implant failure, functional limitations with regard to sports activity, and neurovascular compromise. Each patient was notified that additional procedures might include a rotator interval closure and/or posterior plication, the requirements for which are often detected on the examination under anesthesia and during the diagnostic portion of the arthroscopy. Furthermore, implants in the form of suture anchors might be utilized to supplement the repair or address any labral pathology that might be encountered. The peri-operative and post-operative courses were described. Each patient chose to proceed with the arthroscopic capsular shift technique. While not present in these cases, contraindications specific to this surgery would include voluntary dislocators, patients with an unacceptable psychological profile and those individuals who were poorly compliant with the pre-operative rehabilitation regimen.

V.   Surgical Technique

The arthroscopic approach for glenohumeral instability repair allows for more accurate diagnosis of intra-articular pathology and enables to arthroscopic surgeon to address all aspects of the instability using techniques (Figure 1 [Wolf 2002])
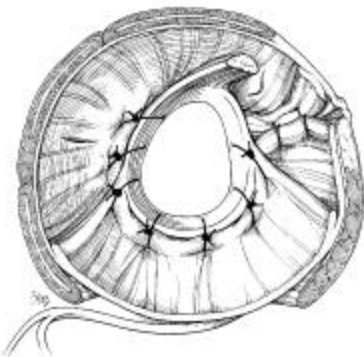
with less morbidity and often an easier recovery. Certain instrumentation and specific skills, both of which can be attained by the surgeon, are essential for a successful outcome.

The operation can be performed under general anesthesia in the lateral decubitus position (JCT) or the beach-chair position under an interscalene block (JBT). When in the lateral decubitus position, a bean bag is used to position the patient declined 20 degrees posteriorly. The arm is placed in a shoulder holder in 10 pounds of traction. The shoulder is abducted 45 degree and forward flexed 15 degrees. When using the beach-chair position, a device, such as the T-MAX Beach Chair Positioner (Tenet Medical Engineering, Calgary, Alberta, Canada), is

advisable to insure patient comfort and surgeon access. With the hips and knees flexed comfortably, the head of the bed is brought to approximately 70° and all down surfaces are padded.

Once anesthesia is administered, positioning is completed and the patient is secured on the operating room table. When muscle relaxation is achieved, an examination under anesthesia (EUA) is performed to confirm the degree and direction of instability. Range of motion is first assessed and compared to the contralateral shoulder, then drawer testing of the shoulder is performed using a technique similar to that described by Altchek and coworkers [Altchek 1991]. This can be performed with anterior, posterior and inferior drawer tests with the shoulder in three positions of abduction (0°, 45°, 90°) and three positions of rotation (neutral or midrange, and maximum internal and external rotation) to yield maximum information about laxity in both the inferior and superior portions of the anterior capsule and the posterior capsule. The anterior and posterior drawers are graded on a 0-3+ scale, where 0 = no increased translation compared with the contralateral side, 1+ = increased translation with the humeral head translating to the glenoid rim, 2+ = actual subluxation of the humeral head over the glenoid rim that reduces after the anterior force is released, and 3+ = frank dislocation of the humeral head. The inferior drawer (sulcus sign) is also graded on a 0-3+ scale with inferior translation perceived as separation between the humeral head and the acromion, such that 0 = = 1cm of inferior translation, 1+ = 1-2cm of inferior translation, 2+ = 2-3 cm, and 3+ = =3 cm inferior translation. Therefore, the magnitude of translation is used to help determine the location and amount of capsular laxity. For example, a 3+ inferior drawer (sulcus sign) with the arm adducted and in neutral rotation which decreases to 0 or 1+ at 90° of abduction and neutral rotation suggests that the superior capsule is excessively lax compared with the inferior capsule. Conversely, a 2+ inferior drawer with the arm in abduction and external rotation suggests a significant component of inferior capsular laxity. A large sulcus sign with the arm adducted and in external rotation may indicate a pathologic rotator interval lesion [Ticker 1998].

Three arthroscopic portals are utilized with these techniques. These include a posterior portal in the soft spot of the infraspinatus, though this portal position can vary based on patient size as well as the planned procedure. It can be helpful, if posterior plication is planned, to place the posterior portal slightly more lateral and inferior than the standard posterior portal to improve the approach to the capsule and glenoid rim. An accessory posterior portal further inferior and lateral is infrequently utilized. An anterior-superior lateral portal is used predominantly for suture management during anterior and inferior placating, and for posterior viewing during posterior plicating. This portal is located just anterior to the anterolateral corner of the acromion. From the glenohumeral perspective, this portal enters the joint just above or just anterior to the biceps tendon, anterior to the supraspinatus, at the lateral aspect of the rotator interval. This leaves enough room for a second portal, anterior-inferior, which is placed lateral to the coracoid process and enters the joint above the subscapularis and lateral to the middle glenohumeral ligament. This portal is the primary working portal for anterior and inferior plicating, and serves for suture management during posterior plicating. Accurate portal placement is important to permit adequate viewing and tissue repair. The anterior portals can be localized with a spinal needle to insure correct placement. Cannulas that screw into place are helpful to maintain their placement.

The operative extremity is now prepared and draped in the usual sterile fashion. Landmarks are outlined, including the acromion, scapular spine, clavicle and coracoid, and lidocaine with epinephrine is injected into the planned portal sites. A spinal needle with stylet is inserted into the glenohumeral from posterior, directed toward the tip of the coracoid process. Normal saline is injected into the joint to allow for distension, which can diminish the chances

for articular damage when the arthroscope sheath is inserted. The posterior incision is made, and the blunt trocar and sheath are introduced into the joint, with backflow of fluid noted to confirm placement. The arthroscope is introduced and the diagnostic portion of the arthroscopy is begun. The anterior-superior lateral portal is localized with a spinal needle, the skin incision is made and a disposable cannula (at least 5.5mm inner diameter) is introduced into the glenohumeral joint. While this cannula will usually be anterior to the biceps tendon, it can be introduced through the capsule in a direction posterior to the biceps tendon. This helps to avoid cannula placement too inferior or medial in the anterior capsule that would compromise placement of the second anterior cannula. The cannula is then brought anterior to the biceps, if it is not already there, and used for probing labral structures as needed.

A complete diagnostic arthroscopy, as described elsewhere in this text, is performed. Specific arthroscopic findings for this pathology include excessive deep capsular gutters, with an obvious drive-through sign. Attenuated glenohumeral ligaments, especially the inferior glenohumeral ligament, are common. An enlarged rotator interval may be noted, with a large volume anterosuperior to the biceps tendon. Less frequently, a complete labral tear is identified, though careful inspection might reveal small partial tears. Bony pathology is not common. At this point, the decision to place posterior sutures for plication has been determined, based on the pre-operative diagnosis, and influenced by the EUA and the arthroscopic findings. Posterior sutures are placed more often than not, though the number of sutures and, therefore, the amount of capsular plication, varies based on the instability pattern and the pathology identified. Posterior work is performed first, as this is more difficult to complete after the anterior structures have been tightened. If this is planned, which is often the case, the anterior inferior portal is established and a disposable, screw-in cannula (at least 8.25mm inner diameter) is inserted to accommodate larger instruments for capsular repair. At this point, only the inferior capsule is lightly abraded with a shaver as access is easily achieved.

Switching sticks are then used to allow for a posterior working portal and the anterior-superior lateral portal is used for posterior viewing. A disposable, screw-in cannula (at least 8.25mm inner diameter) is inserted posteriorly, and the posterior and remaining inferior capsule are lightly abraded with a shaver. The Spectrum Tissue Repair System (Linvatec, Largo, FL, USA) is the primary instrument that will be utilized for the reconstruction. This device allows the arthroscopic surgeon to pass a monofilament suture through soft tissue. The 45° left and right hooks and the crescent hooks are most often used. While the plication can be achieved with a #1 absorbable monofilament suture (JCT), such as PDS II (polydioxanone, Ethicon Inc., Piscataway, NJ, USA), a #2 braided, non-absorbable polyester or nylon suture (JBT) can also be used. A Shuttle-Relay Suture Passer (Linvatec) or simply a #0 or #1 monofilament suture, such as Prolene (polypropylene, Ethicon) with a half-hitch loop, is used to transport the non-absorbable suture through the capsular tissue. A suture length of at least 30 cm, but preferably 36 cm, facilitates knot tying.

When working posteriorly or anteriorly, the object is to capture a sufficient amount of capsule more inferiorly and translate this tissue laterally and superiorly up to the labrum, which is used as the point of fixation. This creates a pleat of capsular tissue which folds onto itself, which is intended to scar together from the abrasion performed earlier. The capsule is often captured 1.0 - 1.5 cm from the glenoid, but the amount of tissue varies in each patient and with each plication stitch. If the labrum is deficient and cannot be used for fixation (which is uncommon), an anchor can be placed on the glenoid rim and its suture used for the plication at that position in the capsule.

When working posteriorly, in the case of A. B. in a left shoulder, the right-angled hooks are best for capturing the capsule inferiorly (Figure 2)
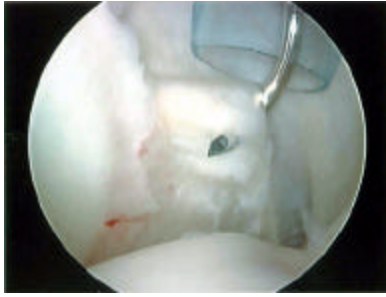
and manipulating its tip to pass through the labrum (Figure 3).
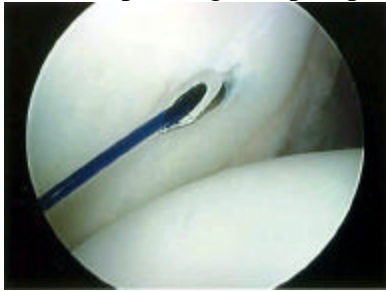
If viewing is difficult when working on the most inferior stitch, lateral or slight inferior translation of the humeral head, either with a positioning device or manually, can facilitate exposure. After passing through the capsule and labrum, the monofilament suture is advanced into the joint. If this suture is intended as the repair suture, such as with a PDS suture, most of it can be fed into the joint. The hook is removed from the labrum and capsule and then withdrawn back out the posterior cannula. The suture end that currently exits the posterior cannula will serve as the post limb for suture repair and can be marked with a clamp. The end of the suture in the joint is now retrieved through the posterior cannula. Alternatively, the suture end within the joint can be retrieved through the anterior cannula and clamped at its end while the hook is withdrawn. After the suture is completely removed from the hook posteriorly, a suture retriever is used to grasp the anterior limb and deliver it posteriorly (Figure 4).
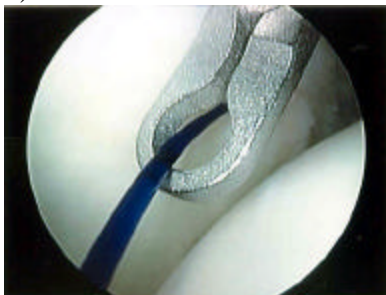
This extra step serves to help manage the sutures and can avoid suture tangling. (Furthermore, as will be described below, this suture, which passes from posteriorly through the capsule and labrum out the anterior cannula, can be used to shuttle a braided, non-absorbable suture for the repair.) A secure knot of the arthroscopist's choice [McMillan 2003] that initially slides, such as the modified Roeder knot [Field 2000] or SMC knot [Kim 2000] with alternating half hitches, is placed, firmly fixing the capsule up to the labrum (Figure 5).
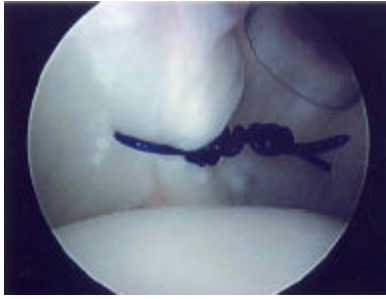
Additional posterior sutures (up to 2 more) are placed as required, based on the surgeon's decision and the instability pattern. A crescent hook can be used for the more superior plication stitch, if desired.

Once the posterior plication is complete, switching sticks are used to place the arthroscope posteriorly and the disposable cannula back into the anterior-superior lateral portal to assist with the repair for suture management, but the anterior-inferior medial portal is the primary portal used for the repair. Two options are available to reduce the capsular volume anterior inferiorly. The capsule can be addressed as described above for the posterior capsule, where the tissue is plicated (JBT). The second option is shifting the capsule using the capsular split/shift technique. This approach is recommended when there is also a Bankart lesion, as in the case of F.M. described below.

If plication is planned, light abrasion of the anterior and inferior capsule is completed. A well-developed inferior glenohumeral ligament, the primary anterior stabilizer [Ticker 1996], is typically not identified. For a left shoulder, a left-angled hook is gently introduced through the anterior inferior medial cannula, manipulated inferiorly into the axillary pouch past the 6 O'clock position to capture the capsule, translate it to the labrum toward the 7 O'clock position and pierce the labrum (Figure 6) to advance a monofilament suture.

If this monofilament suture, such Prolene, is serving to transport a braided suture or if a Shuttle-Relay is used, it is advanced into the joint. A suture grasper is brought from the anterior-superior lateral portal and the suture is withdrawn into this cannula (Figure 7).
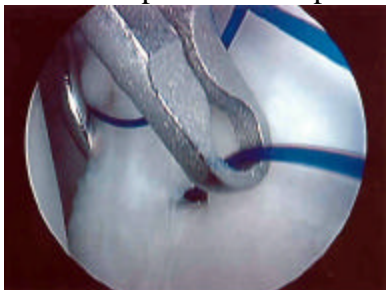
While this end is held securely, the hook is removed from the capsule and out the anterior-inferior medial cannula. A half-hitch loop is created 6-8 cm from the end of the monofilament suture and 6-8 cm of the end of the braided suture is placed into the loop, which is then tightened. If the Shuttle Relay is used, the wire loop at its mid-point is used to hold the end of the braided suture. The other end of the monofilament suture, or Shuttle Relay, exiting the
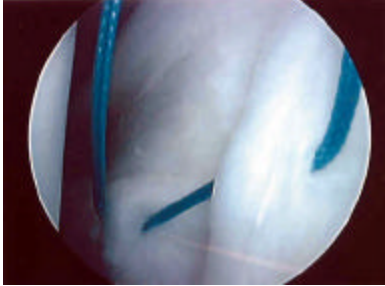
anterior-inferior medial cannula is pulled, drawing the suture loop with braided suture from the anterior-superior lateral cannula into the joint (Figure 8),

through the labrum and capsule (Figure 9),

and out the anterior-inferior medial cannula (Figure 10).

This end of the braided suture, which is on the capsule side, is used for the post limb and placed in the end of a single lumen knot pusher for secure knot tying (Figure 11).


If the Shuttle-Relay is used, once the braided suture passes through the labrum and capsule, it is no longer necessary to firmly pull it out of the cannula. If the Shuttle-Relay is pulled too aggressively at this point, the plastic coating will tear, lengthening the loop, and the braided suture will be more difficult to remove from the loop.

Additional sutures are placed, advancing the capsule superiorly and plicating the capsule to the labrum (Figure 12).
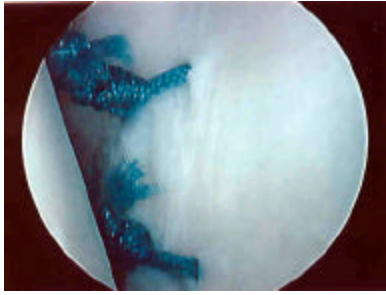
A minimum of three sutures are placed anteriorly, each advancing more tissue superiorly and laterally to the labrum. A crescent hook can be used for the more superior plication stitch, if desired. The surgeon must be cautioned against accepting a thin "bite" of capsule or labrum as this will compromise the suture fixation and repair. In addition, the middle glenohumeral ligament or the subscapularis should not be incorporated in this aspect of the repair to avoid incorrect tightening of the capsular tissue.

    If there is an associated Bankart lesion as in the case of F.M., then the capsular split/shift technique can be employed. The first step is to completely dissect the capsule off the glenoid neck if there is an ALPSA lesion and/or off of the underlying subscapularis muscle if there is a Bankart lesion. The capsular split/shift procedure also advances the capsule superiorly. In the setting of a Bankart lesion, this shift re-tensions the capsule with minimal external rotation loss (Warren ref) and addresses the axillary pouch laxity that is associated with multidirectional instability. The inferior capsular split is made with a narrow angled basket punch inserted from the anterior-inferior medial portal (Figure 13).
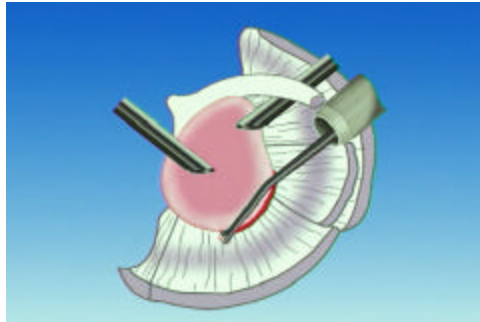

    The capsule is divided from the inferior pole of the glenoid caudally into the axillary pouch. Care is taken to ensure that only capsular tissue is cut. Previous cadaveric dissection has shown that the axillary nerve is safe as long the split does not extend closer than 1.0 cm from the capsular insertion on the humeral head (Tauro 1). The completed capsular division is diagrammed in Figure 14, with point A at the intact posterior capsular attachment, point B representing the caudal extent of the split and point C at the anterior origin of the split.
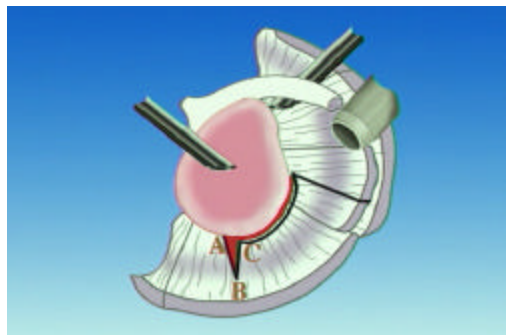
The length of the split should be one half the desired capsular advancement. The usual split is 1.0 cm long. Superior tensioning of the capsule opens the split, bringing the caudal end of a 1.0 cm split (point B) 1.0 cm superiorly and anteriorly up the glenoid rim. The anterior corner of the capsule where the split originally began (point C) advances 2.0 cm up the glenoid rim. The capsule is then repaired back to the articular margin of the glenoid neck using three or four sutures secured to the glenoid rim using suture anchors. The suture material used and the tools used to insert the suture are up to the preference and experience of the surgeon, but correct placement of sutures and anchors is critical to shifting the capsule.
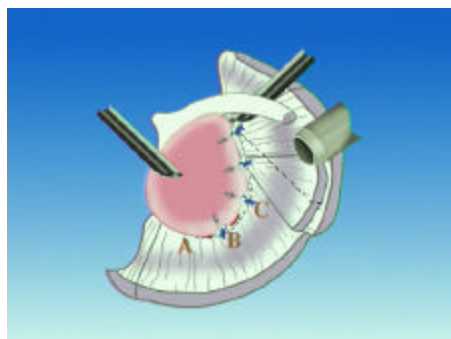
The repair is diagrammed in Figure 15. The first suture should be placed just anterior to point B, with care being taken to capture only capsule with the stitch. The first anchor should be placed on the articular margin of the glenoid 1.0 cm superior to the origin of the split. When in the lateral decubitus position, traction on the shoulder is reduced to 5 pounds and the humeral head is reduced manually in the glenoid prior to tying the first suture. The second suture is placed at point C and the second anchor is inserted 1.0 cm superior to the first anchor. This will insure that point C on the capsule is secured to the glenoid rim at the desired position (Figure 16).
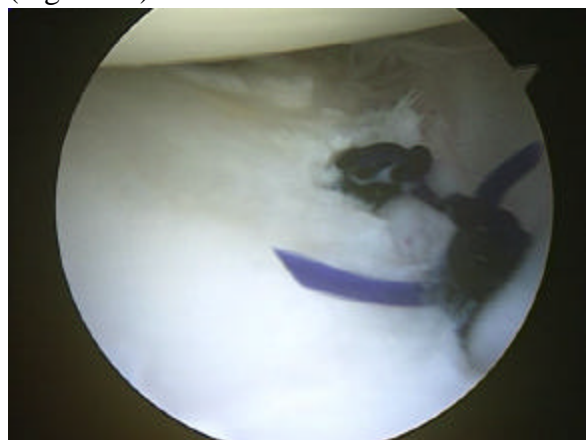
One or 2 additional suture/anchor pairs are then used to complete the repair of the capsule to the glenoid rim.

The final step of the techniques described above, if required based on the examination under anesthesia and the arthroscopic findings, is rotator interval closure. This is well described in another chapter. The rotator interval closure can be performed using the same instruments used for the plication noted above to approximate the superior capsule, including the superior glenohumeral ligament, and the middle glenohumeral ligament. Two sutures are often used, though the more lateral stitch is often tied in a blind fashion with this inside technique and requires a closed end suture cutter.

With the repair complete, the joint is irrigated and suctioned. The portals are closed, using deep braided absorbable sutures as necessary, and a sterile dressing is applied. Cryocompression can be employed, such as the Cryocuff (Aircast, Inc., Summit, NJ, USA), and

a sling is applied. If this is primarily an anterior inferior procedure, a sling placing the forearm across the abdomen is sufficient. If the procedure is equally or primarily a posterior procedure, the sling must assure that the arm is supported and placed toward a neutral position of rotation, using a small pillow attachment such as with the UltraSling or UltraSling II (dj Orthopedics, Vista, CA, USA).

VI. Post-operative Management

The patient is discharged on the day of surgery. The arm is maintained in a sling for 3 weeks, except when the patient showers or dresses, though this time frame can be longer. The sutures are removed 5-7 days following surgery, and radiographs are obtained at that time if anchors are placed. Range-of-motion to the elbow, wrist, and hand is encouraged immediately. Isometric strengthening is started for the biceps and triceps, external and internal rotators and all three portions of the deltoid. Restricted range of motion exercises may be started after the first week, with limitations based on the patient and the direction repair. The patient may use the arm for feeding and dressing after the second week. The sling is removed at three weeks and range of motion is assessed by the surgeon. If the patient appears to have greater range of motion than anticipated, immobilization is considered for an additional week or more. In most cases, therapy begins and active-assisted range of motion is instituted, at times without any limitations, but this is dependent upon the individual patient. At six weeks, active strengthening is initiated and range of motion is maximized. If motion greater than expected is appreciated on exam, stretching is deferred and re-evaluated in 2-3 weeks. At 4 months postoperatively, the patient is permitted to begin tossing a ball or hitting ground strokes in tennis. A sport-specific reconditioning program is added as the patient progresses. At six months, the patient is permitted to begin throwing with more force or swinging a racket overhead. Contact sports are avoided until eight months postoperatively.

VII. Results

The results for arthroscopic plication techniques have been reported as between 79% - 89 % successful [Abrams 2003, Snyder 1997, Weber 2000, Wolf 1998]. These reports include anterior-inferior and posterior-inferior instability patterns, involving subluxations and dislocations. These outcomes certainly are within the range reported for open instability repairs [Altchek 1991, Neer 1980, Warner 1995]. The results of the capsular split/shift procedure with a minimum of two-year follow-up have been previously published. The overall recurrence rate for the modern suture anchor version of this repair was 6.9% [Tauro 2000]. The results at a minimum of five year follow-up have been presented more recently [Tauro 2002]. This group had a redislocation rate of 7.2%. 90% of athletic patients returned to their sport but only 74% recovered to their pre-injury level of competition.

VIII. Complications

In general, complications that have been reported with any arthroscopic procedure may present. Specific to the arthroscopic glenohumeral instability surgery described above, failures and complication may include recurrence of instability, loss of motion and neurovascular injury [Lazarus 1999]. These issues are clearly reviewed in detail by Shaffer and Tibone [Shaffer 1999]. An accurate diagnosis, cautious indication of the procedure, precise attention to the details of the technique to address the pathology and a diligent supervised rehabilitation help to avoid these problems. In the capsular split/shift group of patients, there have been no axillary nerve injuries or other neurologic complications. However, all recurrences were caused by significant trauma, and approximately one third of the patients with a recurrence had a significant Hill Sachs lesion; so it is believed that this lesion is, in part, related to recurrence. Arthroscopic bone grafting (using allograft osteo-articular bone plugs) is now being performed in patients with large Hill Sachs lesions in an effort to further reduce recurrences.

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<u>Figure Legend</u>

Figure 1:   Schematic diagram of the completed plication technique, in this case for multidirectional glenohumeral instability that is primarily posterior and inferior, with closure of the rotator interval [from Wolf].

Figure 2:   The tip of the angled hook pierces the capsule lateral and inferior to the glenoid rim.

Figure 3:   The angled hook with the capsule is translated superiorly to the glenoid rim, shifting the capsular tissue, and the tip pierces the labrum, creating the plication, or fold, in the capsule, with the suture then advanced into the joint.

Figure 4:   The suture is retrieved from the anterior-inferior medial portal to bring this limb out the posterior portal for knot tying.

Figure 5:   The knot secures the plication in this region of capsule.

Figure 6:   The hook tip, with a fold of inferior capsule, is passed through the anterior labrum.

Figure 7:   The suture retriever is brought from the anterior-superior lateral portal to retrieve the suture. Retrieving the suture directly at the hook tip decreases likelihood that the suture will entangle.

Figure 8:   The braided suture, secured in the tightened loop of Prolene, is brought into the joint from the anterior-superior medial cannula by pulling on the other end of the Prolene suture at the anterior-inferior medial cannula.

Figure 9:   The shuttle construct is passed through the labrum and capsule.

Figure 10: The braided suture is in position, with the fold of capsule evident.

Figure 11: A sliding knot is placed and locked, as the initial step in knot-tying.

Figure 12: The plication is completed with additional sutures. Each knot is secured by locking the knot and tying alternating half-hitches, with switching the post.

Figure 13: An angled basket punch is inserted through the low anterior portal to perform the split

Figure 14: The completed capsular split. Point"B" is the caudal end of the split

Figure 15: The capsule has now been shifted superiorly and repaired. For a 1cm split, point "B" advances along the glenoid neck 1.0 cm and point "C" advances 2.0 cm.

Figure 16: Arthroscopic view, from the anterior-superior lateral portal of the split/shift repair on the anterior glenoid rim.