Arthroscopic Anterior Shoulder Stabilization With Percutaneous Assistance and Posteroinferior Capsular Plication

David M. Levy, MD, Borys V. Gvozdyev, MD, Brian M. Schulz, MD, Karen J. Boselli, MD, and Christopher S. Ahmad, MD

Abstract

To study the technique and clinical outcomes of arthroscopic shoulder stabilization with anterior labral repair and percutaneous posteroinferior capsular plication, we retrospectively reviewed 20 cases. Mean (SD) final postoperative follow-up was 3.4 (0.6) years (range, 2.7-5.1 years).

A mean (SD) of 4.9 (0.9) suture anchors (range, 4-7) was used during surgery, with 1.6 (0.7) (range, 1-3) devoted to the posteroinferior plication. There were statistically significant improvements in forward elevation ($P = .016$) and internal rotation ($P = .018$) from before surgery to final postoperative follow-up; external rotation did not change ($P = .336$). Significant improvements ($P < .001$) were also seen in visual analog scale pain ratings, American Shoulder and Elbow Surgeons survey scores, and Simple Shoulder Test scores. Mean (SD) Rowe instability score at final follow-up was 81.1 (28.9). Eighty-five percent of the patients returned to sport at or above preinjury level, and 70% returned to a degree of athletic physical contact at or above preinjury level. Two cases (10%) were categorized as treatment failures (redislocation).

Percutaneously assisted arthroscopic anterior stabilization with posteroinferior capsular plication produces acceptable results, with functional outcomes and redislocation rates comparable to those reported in the literature.

Perhaps the most significant contributor to the rise in arthroscopic shoulder stabilization is an improved understanding of the pathology of anterior glenohumeral instability. Biomechanical studies have shown that a single labral lesion does not in itself cause a shoulder dislocation.[1,2] Rather, anterior dislocations routinely involve a component of capsular stretch. The principle of capsular volume reduction, first described by Neer and Foster[3] with their open inferior capsular shift, has now been incorporated into standard arthroscopic repair. Arthroscopic capsular plication collects excess capsule and sutures it to itself, to the labrum, or both. The same suture anchors used for Bankart repair can be used to imbricate the anterior capsule.

But anterior capsulorrhaphy alone neglects the posterior and inferior capsular redundancy that often accompanies anterior instability.[4] Many surgeons have advocated complete release of the anterior capsulolabral complex followed by a shift of the capsule superoanteriorly.[5,6] More recently, authors have described use of posteroinferior capsular plication to treat posterior capsular stretch injury and supplement the anterior repair.[4,7-9]

All-arthroscopic anterior repair with posteroinferior plication, however, necessitates multiple arthroscopic portals. These portals can be challenging to establish and maintain during surgery, and they add to the surgical morbidity of the rotator interval, the rotator cuff, and the capsule. In addition, these portals may decrease maneuverability and anchor placement accuracy. Therefore, we advocate a technique of percutaneous anchor placement and suture passage. This assistive percutaneous technique reduces capsule morbidity while enhancing the ability to manage intra-articular pathology with more precise anchor placement and suture passage.

Posteroinferior capsular plication and percutaneous suture anchor placement have been described separately, and positive clinical outcomes have been reported for arthroscopic posteroinferior capsular plication.[4,9] No previous studies, however, have evaluated the outcomes of percutaneously assisted arthroscopic stabilization with posteroinferior capsular plication. We therefore conducted a study to describe the surgical technique and clinical outcomes of percutaneous arthroscopic anterior stabilization augmented with posteroinferior capsular plication. We hypothesized that clinical outcomes would

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be comparable to previously published data on arthroscopic shoulder stabilization.

Materials and Methods

Patient Selection

Included in the study were patients with anterior shoulder instability treated by Dr. Ahmad with the aforementioned technique. Patients were excluded if they had a full-thickness rotator cuff tear, multidirectional instability, posterior labral tears, a bony lesion requiring fixation or grafting, or prior history of ipsilateral shoulder surgery. As we sought to evaluate the impact of posteroinferior plication on anterior repair alone, patients who underwent concurrent repair of a superior labral anteroposterior (SLAP) tear were also excluded. In total, 20 patients satisfied these inclusion criteria.

Operative Technique

Each patient underwent conscious sedation with regional interscalene block. Supine examination under anesthesia (EUA) was performed to assess degree and direction of glenohumeral laxity. After EUA, the patient was placed in the lateral decubitus position to allow optimal access to the inferior and posterior glenohumeral joint.[10] The table was tilted in 20° of reverse Trendelenburg and angled slightly posterior to bring the glenoid face parallel to the floor. Ten pounds of traction was applied using a limb positioner (Spider; Smith & Nephew, Memphis, Tennessee).

Figure 1. Location of posteroinferior percutaneous portal 3 cm inferior and 1 cm lateral to posterolateral edge of acromion.

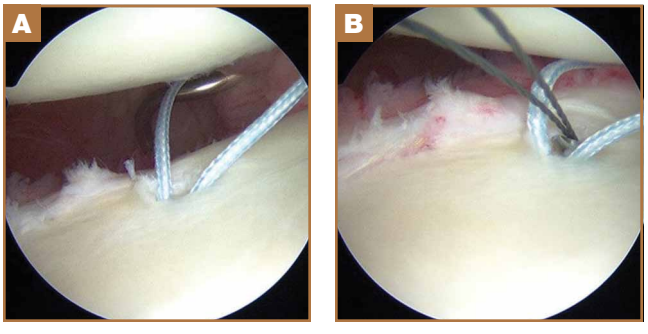

Figure 2. Suture-passing device (A) enters capsule at previous rent made by drill guide and (B) then penetrates capsulolabral complex.

For the sake of convention, all positions described relative to the glenoid clock face refer to a right shoulder. The posterior viewing portal was established first 2 cm inferior to the posterolateral edge of the acromion. A spinal needle was introduced anteriorly through the rotator interval to guide development of the anterior working portal. In both portals, a 7-mm cannula was used to allow easy movement of the arthroscope from front to back.

A complete diagnostic arthroscopy was performed. All areas of torn labral tissue were mobilized with an elevator, and the underlying glenoid bone and neck and capsular surfaces were abraded with a motorized shaver or rasp to enhance healing. The posteroinferior capsular plication sutures were placed first. These sutures were placed before the anterior labroligamentous repair in order to maintain anterior translation of the humeral head and thus prevent obstructed visualization of the posteroinferior glenoid. Our percutaneous posterior portal corresponded to the "7 o'clock portal" described by Seroyer and colleagues[10] 3 cm inferior and 1 cm lateral to the posterolateral edge of the acromion (**Figure 1**). The risk for iatrogenic axillary nerve injury was minimized by using a blunt obturator to introduce an anchor guide (SutureTak; Arthrex, Naples, Florida) through a 2- to 3-mm percutaneous stab incision. The anchor was placed percutaneously on the glenoid face just inside the labrum at the 6 or 7 o'clock position, depending on the region of most capsular laxity.

A suture retriever was inserted through the posterior arthroscopic portal to retrieve 1 suture limb from the anchor. A curved lasso device (SutureLasso SD; Arthrex) was then passed through the percutaneous portal and through the same capsular rent to enter the joint with caution to avoid the axillary nerve. The lasso was passed into the capsule just inferior to the anchor to allow 1 cm of capsular imbrication (**Figures 2A, 2B**). It was then passed through the posteroinferior labrum to create a fold between capsule and labrum in a standard pinch-tuck technique. These sutures were left untied until completion of the more critical anterior repair so as not to constrict the capsule and limit exposure of the anteroinferior recess. Depending on the degree of posterior capsular redundancy, additional anchors were placed percutaneously at 1-hour increments along the posterior glenoid face.

After the posteroinferior plication, the arthroscope was repositioned in the posterior cannula for anterior repair. The anteroinferior percutaneous skin site was 4 cm inferior to the anterior arthroscopic portal (**Figure 3**). A spinal needle and blunt obturator were again used to localize this portal and facilitate delivery of the drill guide. We have not had any axillary nerve complications with use of this trans-subscapularis portal and have found similar results in the orthopedic literature.[11]

Figure 3. Anteroinferior percutaneous portal 4 cm inferior to anterior arthroscopic portal.

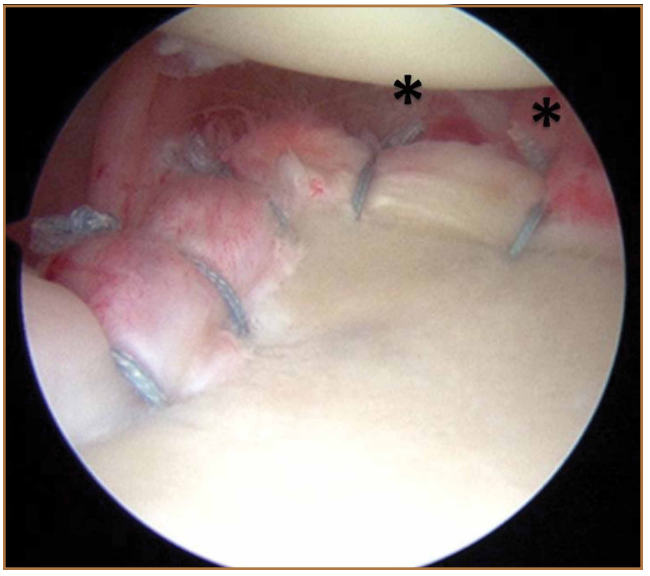

Figure 4. Suture configuration of instability repair with 3 anterior sutures and 2 posteroinferior plication sutures (asterisks).

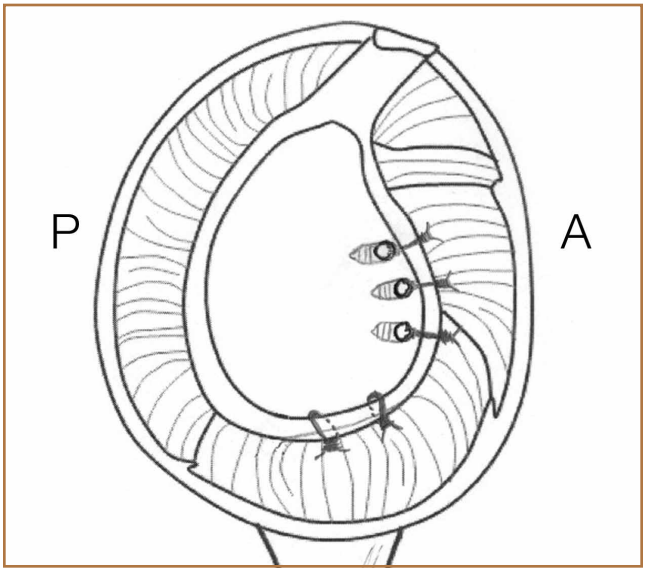

Figure 5. Schematic of posteroinferior capsular plication, in which 3 anchors secure anterior labrum, and 2 posteroinferior plication sutures (anchors not visible) further augment repair. Abbreviations: P, posterior; A, anterior.

Suture anchors were placed percutaneously at the 5, 4, and 3 o'clock positions, as needed. Both labral repair and 1-cm capsular imbrication were achieved with the sutures from these anchors. All tissue passes were made with a lasso inserted through the same percutaneous portal and capsular rent.

All anterior suture limbs were then tied, starting with the 5 o'clock anchor and proceeding superiorly. A probe was used to assess the quality of the anterior repair. The arthroscope was then placed in the anterior cannula, and all posterior plication sutures were tied as simple stitches through the posterior cannula (**Figures 4, 5**). Great care was taken to advance the capsulolabral tissue both superiorly and anteriorly. Knots were kept away from the articular surface to minimize the risk for postoperative cartilage wear.

After surgery, the shoulder was protected in a sling set at 10° of external rotation for 4 to 6 weeks. Passive and active-assisted range of motion (ROM) exercises were started at 2 to 6 weeks and advanced to full active ROM by 8 to 10 weeks. Progressive strengthening was initiated at 10 weeks, and resistance exercises and sport-specific rehabilitation at 12 to 16 weeks, with a typical return to sport at 5 to 6 months.

Clinical Evaluation

Preoperative demographic and physical examination findings were reviewed retrospectively. Participation in athletics was evaluated according to degree of physical contact, ranging from collision sports (eg, football, hockey, lacrosse) and contact sports (eg, soccer, wrestling, basketball) to noncontact sports (eg, swimming, baseball, volleyball). The preoperative tests used were the anterior apprehension and rotator cuff strength tests. ROM measurements were forward elevation, external rotation with arm at side, and internal rotation based on vertebral levels reached. Clinical data included visual analog scale (VAS) pain ratings, American Shoulder and Elbow Surgeons (ASES) survey scores, and Simple Shoulder Test (SST) scores.

Operative data included EUA and operative findings and techniques. Glenohumeral laxity was quantified, with 1+ representing translation to the glenoid rim; 2+, subluxation with spontaneous reduction; and 3+, dislocation without spontaneous reduction.

Mean (SD) final postoperative follow-up was 3.4 (0.6) years (range, 2.7-5.1 years). Patients repeated the pain VAS, ASES, and SST surveys and the ROM measurements and completed a one-time Rowe instability questionnaire. They were asked about any recurrent dislocations or subluxations, revision surgeries, or changes in athletic performance. Treatment failure was defined as a recurrent dislocation, instability preventing

full return to activity, or revision surgery. Preoperative and postoperative clinical survey results and ROM values were compared using paired *t* tests. $P < .05$ was considered statistically significant.

Results

Demographic Data

All 20 patients were available for final postoperative follow-up. The study population consisted of 15 men and 5 women. Seven patients (35%) presented for instability of the dominant shoulder. Mean (SD) age at time of initial symptoms was 20.2 (7.3) years (range, 15.0-36.4 years). Primary complaints at initial presentation were shoulder dislocation (16 patients; 80%), subluxation (3 patients; 15%), and pain (1 patient; 5%). Sixteen cases (80%) involved athletic injuries, 8 caused by physical contact or falling and 8 caused by loading the arm in an externally rotated abducted position. Collision sports, contact sports, and noncontact sports were the inciting activities in 3 (15%), 6 (30%), and 7 (35%) patients, respectively. The 4 nonathletic cases involved 2 motor vehicle accidents, 1 fight, and 1 case of sleeping in an externally rotated abducted position.

> We advocate use of [this technique] in any patients who are at risk for arthroscopic failure, such as young patients, contact athletes, and patients with significant capsular or ligamentous laxity.

Seven patients (35%) had presented to the emergency department for a reduction. Mean (SD) number of dislocations before surgery was 4.1 (4.9) (range, 0-20). Four patients (20%) reported a history of contralateral shoulder instability, none treated operatively. Eight patients (40%) underwent surgery within 1 year, 4 (20%) between 1 and 2 years, and 8 (40%) more than 2 years after onset of initial symptoms. Mean (SD) age at time of surgery was 25.0 (9.0) years (range, 14.6-42.6 years).

Operative Data

Preoperative physical examinations revealed a positive anterior apprehension test and 5/5 rotator cuff strength in all 20 patients. EUA revealed anterior instability grades of 3+ in 10 patients (50%) and 2+ in the other 10 patients (50%). Diagnostic arthroscopy showed a Hill-Sachs lesion of the humeral head in 14 patients (70%), a minor SLAP tear necessitating débridement in 3 patients (15%), an anterior labroligamentous periosteal sleeve avulsion in 3 patients (15%), and a glenolabral articular disruption in 1 patient (5%). All patients had a labral tear, and all labral tears were anteroinferior. Mean (SD) size of labral tears was 164.2° (64.3°) (range, 90°-300°). Mean (SD) number of suture anchors used per patient was 4.9 (0.9) (range, 4-7), with 1.6 (0.7) (range, 1-3) devoted to the posteroinferior plication.

Postoperative Data

Mean (SD) VAS pain rating decreased from 4.3 (3.4) before surgery to 0.7 (1.0) at final postoperative follow-up ($P < .001$). Mean (SD) ASES score increased from 60.1 (23.2) to 90.8 (11.1) ($P < .001$), and mean (SD) SST score improved from 7.5 (3.7) to 11.3 (1.2) ($P < .001$). All improvements in VAS pain ratings and ASES and SST scores were statistically significant. Mean (SD) Rowe instability score at final follow-up was 81.1 (28.9).

Functional ROM also improved from before surgery to final follow-up. Mean (SD) forward elevation increased significantly, from 165.3° (21.2°) before surgery to 176.8° (8.0°) at final follow-up ($P = .016$). Mean (SD) external rotation increased from 68.5° (19.0°) to 71.3° (24.9°), but this change was not statistically significant ($P = .336$). Finally, mean (SD) internal rotation improved significantly ($P = .018$), from T8 ± 2.8 levels before surgery to T6 ± 2.8 levels at final follow-up.

When asked to compare preinjury and postoperative athletic activities, 9 patients (45%) reported they were better, 8 (40%) reported they were the same, and 3 (15%) reported they were worse. Before injury, 6 patients participated in collision sports, 7 in contact sports, and 7 in noncontact sports or activities. At final follow-up, 5 patients were participating in collision sports, 3 in contact sports, and 12 in noncontact sports or activities. Thirteen patients (65%) (4 collision, 2 contact, 7 noncontact) maintained the same degree of physical contact in their sports and activities. One collision athlete reduced his activity level to contact sports after surgery; another collision athlete dropped to noncontact sports. Four contact athletes downgraded to noncontact activities. Last, 1 patient actually increased his activity level from contact to collision sports. Of the 6 patients who reduced their degree of physical contact, only 2 did so out of fear of reinjuring the shoulder; the other 4, older teenagers at time of surgery, decided to discontinue participating in high-contact, competitive sports after high school graduation.

Two cases (10%) were categorized as treatment failures because of recurrent dislocation. One patient, a 21-year-old, sustained his initial injury in a motor vehicle accident. At surgery, he was found to have a large Hill-Sachs lesion and nearly 25% bone loss of the anterior glenoid. He later endured 6 or 7 subluxations before dislocating 40 months after the original operation. The other patient was a 14-year-old athlete who first injured himself playing basketball. At surgery, he was found to have a moderate Hill-Sachs lesion and a large inferior recess secondary to severe capsular strain. Thirty months after surgery, he had a recurrent dislocation while making a tackle in football. He later underwent open coracoid transfer.

Discussion

In its nascency, arthroscopic stabilization was marked by higher recurrence rates—often 15% to 20%[12-16] and as high as 49%.[17] In response, numerous improvements were made to

the arthroscopic technique. These methods included use of 2 working portals, use of suture anchors, and repair of tissue to the glenoid articular face as opposed to the glenoid neck.[5,18,19] Recurrence rates decreased dramatically.[20-22] Marquardt and colleagues[20] and Carreira and colleagues[22] reported 7.5% and 10% recurrence rates, respectively, almost 4 years after arthroscopic repair. In the present study, we found a similar, 10% recurrence rate after 3.4 years using percutaneous assistance and posteroinferior capsular plication.

Anteroinferior capsular strain is a well-known consequence of shoulder dislocation,[1,2] and the classic treatment has been the open capsular shift.[3-6] In this procedure, the anteroinferior capsule is incised and shifted superiorly to pull it taut and diminish redundant folds. The advent of arthroscopy, however, has allowed better visualization of the axillary pouch and posterior capsule, and, in turn, there is now increased recognition of posterior capsular strain in anterior instability.[4,9] Westerheide and colleagues[4] were the first to describe the technique of arthroscopic posteroinferior plication. They used a pinch-tuck technique to imbricate the capsule, as opposed to incising and shifting it. They reported a 7% recurrence rate and 90% return to athletic activities. In a randomized trial of 40 patients, Castagna and colleagues[9] found excellent outcomes and no recurrences in the group randomized to posteroinferior plication. Interestingly, the authors noted a decrease in forward flexion in the plication group; others have suggested that posterior plication may also reduce internal rotation.[23] However, we found no such ROM deficits in our study cohort; in fact, we found statistically significant improvements in both forward flexion and internal rotation.

One of the most technically challenging aspects of labral repair with capsular plication is the need for more suture anchors. Prior studies have shown that recurrent instability is reduced when more suture anchors are placed.[24,25] Boileau and colleagues[24] recommended using at least 4 anchors for shoulder stabilization. In our study, mean number of suture anchors was 4.9 (minimum, 4). Accurate placement of so many anchors usually requires a series of arthroscopic portals; these portals can be difficult to maintain, and they damage local soft tissues. However, percutaneous anchor placement and suture passage increase the surgeon's maneuverability by circumventing the need to work through a rigid portal. Furthermore, percutaneous suture passage can be done through a single capsular incision, which decreases iatrogenic damage to the already pathologic capsule.

For 17 patients (85%), postoperative activity level was at least as good as preinjury level—a finding comparable to that of earlier studies.[4,20] Two of the 3 patients whose activity level decreased represented the only study failures. At time of index operation, both patients had moderate or large Hill-Sachs lesions, and 1 had a large area of anteroinferior glenoid bone loss. Large osseous defects are significantly associated with recurrent shoulder instability.[21,24,26] Burkhart and colleagues suggested that patients with an inverted-pear glenoid (25%-27% bone loss)[27] should not be candidates for arthroscopic repair.[26] They reported a 4% recurrence rate among patients without bone defects, compared with a 67% rate in patients with significant bone loss. Therefore, we believe the recurrences in our 2 study failures are in large part attributable to the patients' original bony lesions.

Use of arthroscopic instability repair in contact athletes has been controversial. Our study group included 13 collision and contact athletes, and we saw 1 recurrence among them (7.7%). Seventy percent of all patients maintained participation in activities with the same or higher degree of physical contact as before surgery. Some authors have argued that collision athletes present a clear indication for open surgery[28,29]; others have disagreed. Larrain and colleagues[30] found a recurrence rate of only 8.3% among arthroscopically treated rugby players after a mean of 5.9 years. Mazzocca and colleagues[31] reported an 11% recurrence rate among collision and contact athletes 37 months after arthroscopic stabilization and concluded that contact athletics should not be a contraindication for arthroscopy. We agree with this recommendation, given our own findings in this high-demand population.

This study had its limitations. First, it was a retrospective case series with no control group. The goal of the study was not to promote one technique over another, but to confirm favorable outcomes with a novel arthroscopic technique. In addition, the method we used to compare changes in athletic performance was subjective; each patient judged whether his or her performance was better, the same, or worse. Objective quantification of athletic performance is difficult and affected by factors other than injury status, such as athletic interest or recent high school graduation. Therefore, we believe that a subjective evaluation of changes in athletic performance is equally reliable as any objective, quantitative measures.

Conclusion

Percutaneously assisted arthroscopic anterior labral repair with posteroinferior capsular plication has been shown to be an effective treatment for anterior shoulder instability. The rates of recurrent dislocation and return to preinjury activity level were comparable to previously published data on arthroscopic shoulder stabilization. We advocate use of percutaneously assisted arthroscopic stabilization with posteroinferior capsular plication in any patients who are at risk for arthroscopic failure, such as young patients, contact athletes, and patients with significant capsular or ligamentous laxity.

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This paper will be judged for the Resident Writer's Award.