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Operative Techniques in

Sports Medicine

The Surgeons' Dilemma: Revision Instability in the Athlete

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Management of the athlete who has failed one or more prior primary shoulder stabilization procedures is a great challenge for the orthopaedic surgeon. With the risk of recurrence of instability being greater in the revision setting, a systematic approach to treat these patients is of great importance. This article will discuss the causes of recurrent shoulder instability, including improper diagnosis, ligamentous laxity, and technical errors and the various treatment options that should be explored. An algorithm for the treatment of athletes with recurrence of instability following a failed primary shoulder stabilization procedure will be presented to help the surgeon in determining the best mode of treatment for their patients.

KEYWORDS revision instability, shoulder, revision bankart, revision latarjet, revision remplissage, bone graft

Anterior shoulder instability is a common shoulder injury, which can be devastating to an athlete's career. In fact, shoulder stabilization procedures have been shown to shorten the expected career of professional American football athletes by more than 1.5 years.[1] Reports have shown the risk of recurrence in young athletes to be as high as 100% with nonoperative treatment.[2-6] Although stabilization procedures successfully reduce the risk of recurrence in athletes, the procedure is not without complications. Failure rates following stabilization procedures range from 6.7%-13.0% in noncollision athletes, 0%-19.4% in contact athletes, and 9.0%-33.3% in collision athletes.[7-10] Even though this may seem like a bleak outcome for the athlete with shoulder instability, we believe, no different than others, when carefully thought through, stabilization procedures in athletes can return the glory days to many athletes with great success.

In the shoulder without any bony defects, arthroscopic and open Bankart procedures have high success rates in the primary repair setting.[9,11-15] Glenoid bone loss and humeral head defects have been substantiated as important factors for success of outcomes in anterior instability procedures but even more important to recognize in the shoulder that has failed primary instability procedures. Unrecognized or ignored bone loss of greater than 25% has been indicated as the predominant risk factor for failed anterior stabilization repairs.[16] This bone loss, often seen as an inverted pear-shaped glenoid described by Burkhart and De Beer,[17] has been associated with high recurrence in athletes.[18,19] In the setting of bone loss greater than 25%, the following procedures are considered as viable options for patients: arthroscopic Bankart with bone incorporation, arthroscopic Bankart with internal fixation of the bone fragment, open Bankart repair with bone augmentation (eg, tibial, iliac crest and other allograft sources), open or arthroscopic Latarjet, and soft tissue plication or capsular shift added to the aforementioned procedures as necessary.

Treatment options for the athlete with a failed instability procedure and subsequent recurrent episodes of instability are a great challenge to orthopaedic surgeons. Little has been written about the topic in the past. Meticulous examination and exploration of underlying causative factors contributing to recurrence is of utmost importance to determine the most appropriate course of treatment to revise athletes and get them back on the playing field. It is important when approaching this population to have a true understanding and appreciation of the associated ligamentous laxity, number and type of prior injuries (eg, subluxation vs dislocation events), number and type of prior procedures, and associated soft tissue or bony

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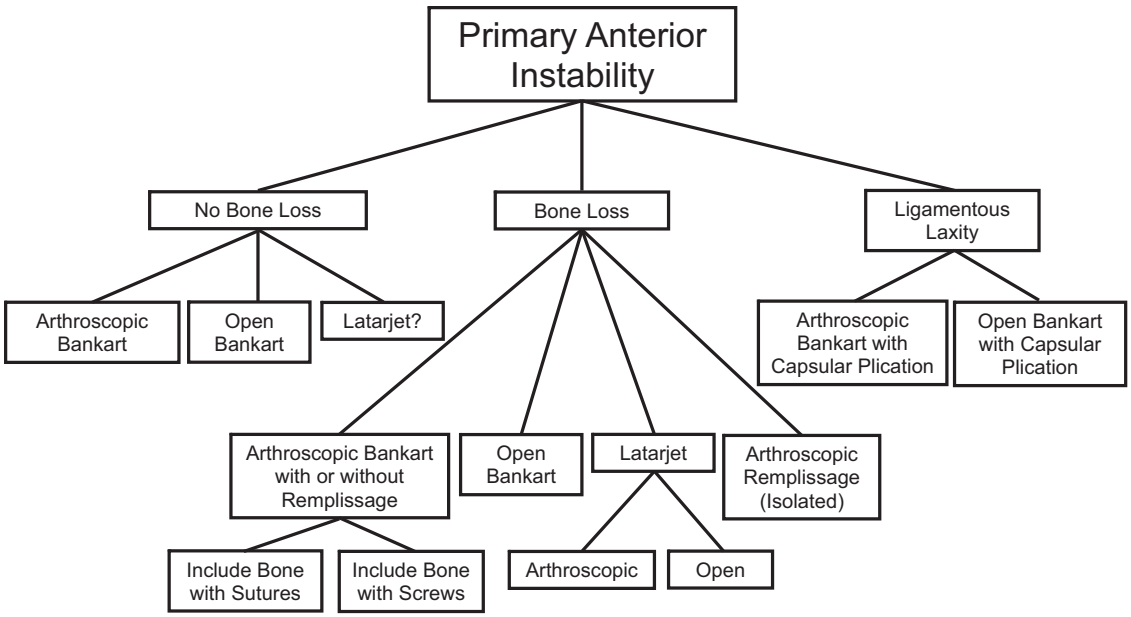

Figure 1 An algorithm for the treatment of primary anterior shoulder instability.

pathology. Our algorithm understands the risks and most appropriate procedure to yield a predictable outcome in the athlete with recurrent instability (Figs. 1 and 2).

This article explores the primary causes of failure for primary repair procedures and evaluates the evidence for treatment options in the athlete that has failed 1 or more previous stabilization procedures and continues to have subluxation or dislocation episodes with our recommendations for success.

Reasons for Failure of Primary Repair

Despite the many successes reported for instability procedures, failures do occur. For the collision or contact athlete, a dislocation episode is likely the defining factor for a failed procedure, whereas, pain, stiffness, and weakness may be perceived as failure in the noncontact or overhead athlete.[20]

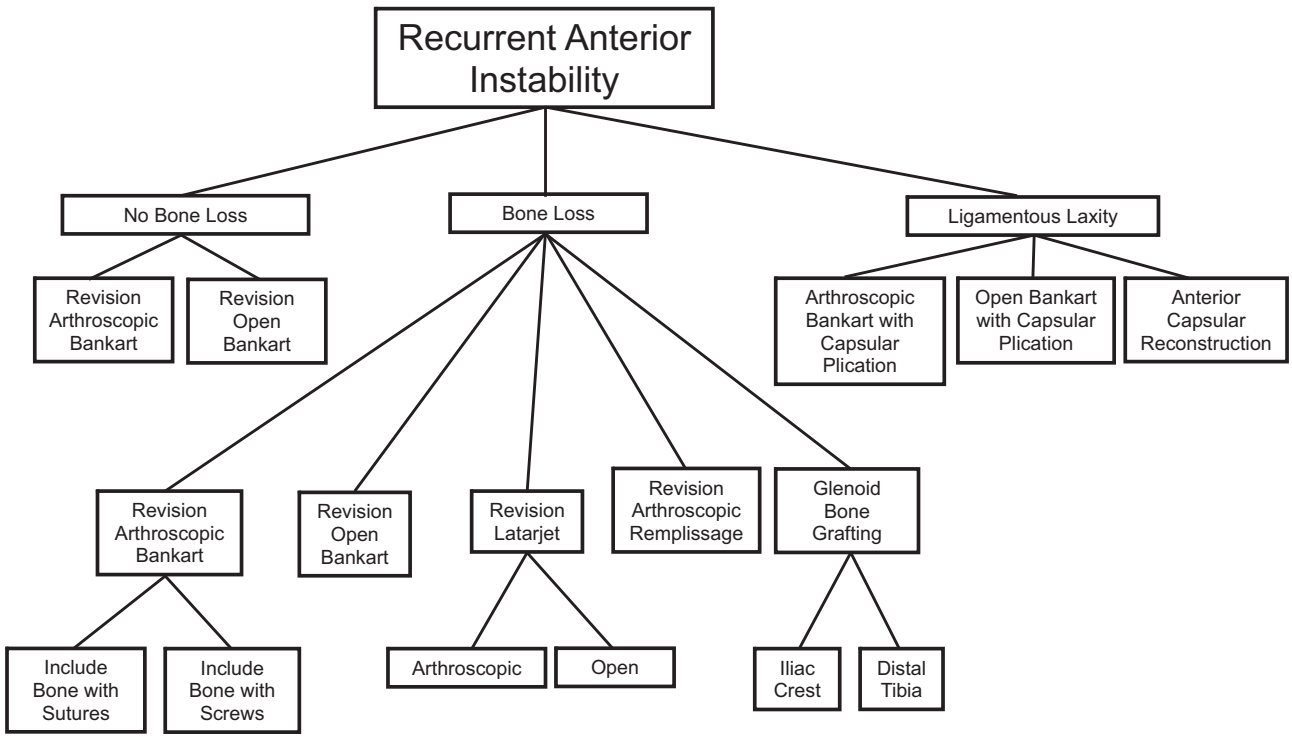

Figure 2 An algorithm for the treatment of anterior shoulder instability in patients who have failed a primary shoulder stabilization procedure.

Reasons for failure of primary repair in the unstable shoulder include misdiagnosis, underestimated capsular laxity, technical errors, early return to sport, and a subsequent traumatic event.

Misdiagnosis

Diagnosis and identification of the etiology for failure are key to a successful outcome. A thorough history and preoperative physical examination are imperative to rule out all issues, as well as the presence of any possible posterior or multidirectional instability.[21] The Bankart repair without soft tissue imbrication or a capsular shift is not indicated for patients without a history of a traumatic event and whose findings of physical examination demonstrate hyperligamentous laxity with a large sulcus sign. Many athletes are noted to have some glenohumeral arthrosis as well as even some rotator cuff tendinopathy on magnetic resonance (MR) images often because of the instability present and multiple subluxations or dislocation events. These athletes with a correct diagnosis can have an alternate procedure with better success upon revision.

We always recommend the amount of bone loss associated with a Bankart lesion be rigorously evaluated with a 3-dimensional computed tomography scan to obtain a better appreciation of the orientation of both humeral head and glenoid defects.[22,23] Subtraction of the humeral head more accurately quantifies the amount of glenoid bone loss.[24] Many methods have been described to help the surgeon.

Underestimated Ligamentous Laxity

Ligamentous laxity has been implicated to play a role in the recurrence of instability as stated earlier.[16] Anterior capsule hyperlaxity indicated by excessive external rotation with the arm at the side, $>90^{\circ}$, has been indicated to be a risk factor for postoperative recurrence.[16,25,26] Patella subluxation and elbow hyperextension are also seen as clues in these athletes. Typically the athlete demonstrates these findings bilaterally, suggestive of a congenitally lax anterior capsule. Laxity of the inferior glenohumeral ligament is a common mode of failure following arthroscopic Bankart repair.[16] A greater than 20° difference compared with the contralateral shoulder on the hyperabduction test is a clear indicator of inferior glenohumeral ligament laxity.

Technical Errors

Technical errors include improper fixation and adequate mobilization techniques. Inadequate number of fixation points can lead to higher rates of recurrence.[16] Boileau et al studied the outcomes of 91 patients, 79 athletes, following arthroscopic Bankart repair, demonstrating a 15% recurrence rate. Patients with 3 or fewer anchors had a higher recurrence rate. These results suggest that a minimum of 4 anchors must be placed on the glenoid rim to minimize the risk of recurrence in this population. We have always used 4-6 anchors for all athletes with instability following the rule of hand surgeons and tendon repair: an increase in the number of core sutures increases the strength of the repair. Kim et al[27] demonstrated higher failure rates in patients with an improper anatomical repair (eg, labrum anchored too medially on the glenoid).

Mobilization of the labrum is also a key component to a successful repair. Poor mobilization of the Bankart lesion does not allow the surgeon to sufficiently shift the capsule superiorly and laterally to attain adequate stability and fixation. This complication is seen all too often.

Early Return to Sport as a Complication

The athlete must be carefully managed following primary repair of anterior shoulder instability, considering the sport-specific demands of each athlete. In the early postoperative period, external rotation range of motion is limited to avoid stress of the repair and allow for appropriate healing. In the late phases of the rehabilitation before return to sporting activities, proprioceptive, strengthening, and plyometric exercises in provocative and sport-specific positions should be incorporated into the patients' rehabilitation program. Patients involved in noncontact sports are allowed to return to most sports at 3 months. Contact athletes (ie, basketball, wrestling, football, and hockey) are not allowed to return to sport until 4-5 months. The last exception, baseball pitchers, must wait 9-12 months before throwing on the mound at full speed, although a true secondary dislocation in this type of athlete is rare, laxity does occur, which is devastating for the athlete.

Traumatic Setting

Despite meticulous surgical technique, successful repair, and compliance with rehabilitation to restore functional strength and range of motion required for return to sport, return to the provocative sporting activities inevitably exposes the athlete to situations that might compromise the primary repair. Not surprisingly, new trauma induced by sporting activities is a predominant cause of recurrence. In 2004, Tauber et al[28] explored the nature of failure following a primary stabilization procedure. Overall, 59% of patients underwent a revision stabilization procedure owing to a second, postoperative traumatic sporting incident. Patients who participate in collision, contact, and noncontact sports, including snowboarding, skiing, soccer, cycling, rock climbing, basketball, ice skating, judo, and tennis, are at risk. Trauma appears to be the primary mode of failure for open Bankart repair accounting for 100% of recurrences in several studies.[29-31] In our series of basketball and hockey athletes, a traumatic event was the only cause for failure when repairing instability.

Treatment Options After Failed Primary Repair

The success of revision surgery decreases with each subsequent revision attempt.[32] Despite the success of resolving instability in this challenging group of patients, patient's subjective reports of function as perceived laxity may be worse following revision surgery.[33] Recurrent instability rates following revision surgery range from 0%-21.7%. Therefore, it is imperative that before proceeding with revision surgery, a thorough evaluation to determine the exact nature of the instability must be

undertaken. A frank discussion with the athlete, parents, and coaches should be undertaken to explore the nature of recurrences, determine the prognosis, and set realistic expectations for a reasonable outcome for the patient's athletic career. Even more important than with a primary procedure, a systematic and thorough history and physical examination, as well as critical imaging modalities, should be utilized. MR imaging must be used to identify soft tissue lesions and assess capsular laxity in the athlete with recurrent instability.[34] A 3-dimensional computed tomography scan is predictably more accurate than an MR image in identifying and quantifying bone loss and must be ordered.[35,36] Old operative notes must be read and any previous arthroscopic pictures should be reviewed. A diagnostic arthroscopy should also be undertaken at the time of surgery to evaluate prior stabilization procedures, evaluate possible concomitant lesions that may have been previously missed, and appreciate the condition of the labrum, capsule, and surrounding tissues before proceeding with any open procedure.

Open Revision Bankart Repair

Open revision Bankart repair is an option for the athlete that has failed a primary procedure.[37-40] Rowe[37] first described open revision stabilization following a failed previous open stabilization demonstrating only a 5% recurrence rate in 38 patients 2-13 years postoperatively. Clearly upon review of the literature, there was an unreported loss of external rotation and a failure to return to sport, yet the shoulder was now stable. Cho et al[38] evaluated 26 shoulders that failed arthroscopic Bankart procedure for traumatic anterior shoulder instability. All patients underwent a traditional open revision Bankart procedure. Recurrence of the open Bankart revision surgery was 11.5%. These patients had an engaging Hill-Sachs lesion and associated hyperlaxity (2+ or greater laxity on the sulcus sign, commonly seen but often underdiagnosed in athletes). Although 88.5% of patients reported a good or excellent outcome, postoperative shoulder flexion and external rotation range of motion were significantly less than preoperative range of motion. An average of 9° was lost in flexion and an average of 10° was lost in external rotation.

Open Bankart revision surgery can successfully return both collision and contact athletes back to sport following a failed primary procedure.[41] Overall, 87% of patients were able to return to preinjury sporting activity, including high school and college football, basketball, swimming, baseball, softball, and volleyball, following open revision Bankart procedure.[41] Loss of range of motion and limitation in overhead activities were provided as reasons for failure to return to sport. Our own series shows an average of 10° loss of shoulder external rotation if performed open. We have shown success in regaining stability with even 20% bone loss using this procedure.

Factors contributing to the a negative outcome in open Bankart revision surgery have been reported as mentioned earlier: glenohumeral arthrosis, age greater than 30 years, 2 or more previous instability procedures, a bony Bankart (>25% bone loss) or Hill-Sachs lesion (>40% bone loss circumference), and the diagnosis of multidirectional instability.[38,39]

Arthroscopic Revision Surgery

Modern techniques have improved the success of arthroscopic stabilization procedures making this a viable revision procedure in the case of recurrent instability, especially when no bony procedures are required. Success rates have been reported as high as 90%.[27,42-44]

Kim et al[27] performed the arthroscopic revision Bankart repair in patients who failed either a previous open or arthroscopic Bankart procedure. Arthroscopic revision surgery included repair of the anterior labrum using suture anchors and nonabsorbable sutures, capsular plication, and proximal shift of the inferior capsule with or without closure of the rotator interval in all patients. Seventy-eight percent of patients returned to greater than 90% of their preinjury level of activity. Five patients (22%) experienced recurrence following the revision surgery. Participation in contact sports (eg, rugby, judo, soccer, and basketball) was shown to be moderately correlated with recurrence. Seven patients in this cohort participated in contact sports, 4(57%) of which demonstrated recurrence following revision surgery. Six patients participated in overhead sports and none had further instability episodes. Similar results were presented by Millar and Murrell[42] in a study comparing the results of primary arthroscopic stabilization and arthroscopic revision stabilization. They found similar functional outcomes between groups as measured by questionnaire, pain, range of motion, and strength. Two patients (20%) in the revision group failed at 8 and 60 months postsurgery in an overhead traumatic episode.

Franceschi et al[43] reported on 10 patients, 9 athletes (ie, 1 collision athlete, 7 contact athletes, and 1 noncontact athlete), with a 68-month follow-up after arthroscopic revision Bankart procedure after a failed primary open procedure. Only 1 patient had an instability episode following the revision. Detailed information was not available for this patient, but they were reported to be noncompliant with their postoperative rehabilitation. Patients demonstrated excellent external and internal shoulder range of motion following surgery, while restoration of preoperative forward elevation was achieved, the postoperative mean was 157°.

Revision arthroscopic Bankart repair is more complicated as a result of prior stabilization procedures making this a highly technical procedure that should be attempted only by the skilled surgeon. Hardware, altered anatomy, glenoid bone loss, capsular attenuation, and scar tissue are factors contributing to the technical demands of the revision arthroscopic Bankart.[20] Restoration of the anteroinferior labral bumper can be difficult even with appropriate extensive mobilization of the capsulolabral tissue.[20,45] Reasons for failure of an arthroscopic Bankart procedure include, most commonly, the anchors not being placed on the bumper, improper arthroscopic knot tying, overtightening, and failure to identify bone loss. We have demonstrated success with revision arthroscopic Bankart

in athletes with failed prior stabilization surgeries. We have demonstrated a low recurrence rate of 4% in contact and noncontact athletes with a 95% return to sports. Recurrence occurred after 10 months in 1 hockey player who dislocated his shoulder in his sleep after playing a hockey game the same day with a traumatic event he chose to ignore. He also had 14% glenoid bone loss and 20% nonengaging Hill-Sachs lesion. This patient underwent revision arthroscopic Bankart with 4 anchors and rotator interval closure. He successfully started playing at 7 months and has not experienced any further episodes of instability 48 months later.

Revision Latarjet Procedure

The Latarjet procedure has also been described in the setting of recurrent instability following previous instability repair procedures. A Swiss study by Schmid et al[46] demonstrated the success of the arthroscopic Latarjet procedure in patients that had failed 1, 2, or 3+ prior stabilization procedures other than a Latarjet and had a glenoid rim lesion. At 38 months, no shoulder had dislocated or needed additional procedures proving that glenohumeral stability can be restored following a prior failed stabilization procedure. In patients that had preoperative pain, this was not substantially alleviated by surgery and contributed to patient dissatisfaction following surgery. Patients with preoperative pain were 20 times more likely to have postoperative pain.

No different than in the primary stabilization procedure, the size of the bony defect should play a role in determining the best revision procedure in managing athletes with recurrent instability. Bonnevialle et al[47] demonstrated the success of both selective capsular repair and the Latarjet procedure in patients that failed a primary selective capsular repair procedure with a 0% recurrence rate at 40 months. Of 11 patients, 9 resumed their preoperative sporting activities. A patient in the Latarjet group had a fibrous nonunion of the coracoid transfer but did not go on to any further surgery.

The Latarjet procedure offers advantages over Bankart repair for some in the revision setting. Anteroinferior glenoid deficiency is common in athletes with recurrent instability. Placing the coracoid as a bony bumper in the Latarjet procedure addresses this deficiency and restores the articular surface of the glenoid.[20] The coracoid graft should be flush with the glenoid rim at or below the glenoid equator.[48] However, we do not know any athlete that has return to sport following a revision Latarjet procedure.

Revision Remplissage

As previously mentioned, arthroscopic remplissage of an engaging Hill-Sachs lesion is less successful in the revision setting. In a 2014 retrospective study, recurrence rate was 36% in patients that had previously failed a stabilization procedure as an isolated procedure.[49] A cadaveric study investigated the effects of the Remplissage procedure on range of motion in shoulders with Hill-Sachs lesions.[50] Significant reductions in external rotation both in adduction and abduction were reported making the remplissage procedure a less favorable option for throwing or overhead athletes. This procedure has been utilized by us for large bony defects greater than 40% of the humeral head and greater than 25% loss of bone in the glenoid in the shoulder that has dislocated multiple times.

Glenoid Bone Grafting

Glenoid bone grafting can also be considered in the athlete with recurrent instability in the revision setting. Warner et al[51] demonstrated the success of using a tricortical iliac crest bone graft in the revision setting for bone loss. In total, 4 collision athletes sustained injury during hockey, and 2 noncontact athletes sustained their injury during a fall in tennis. All patients successfully returned to sporting activities on an average of 33 months after surgery without recurrence following the procedure. Others have reported less favorable return to sport outcomes following an iliac crest glenoid bone grafting procedure with a 12% recurrence rate and only 68% return to sport.[52]

Provencher et al[53] proposed the use of a fresh osteochondral distal tibial allograft in the management of glenoid bone loss. The use of this graft when appropriately placed restores glenohumeral contact pressures.[54,55] Although a complex open surgical procedure, results are yet to be reported by multiple groups.

Capsular Reconstruction

Anterior capsular reconstruction with an Achilles graft may also be indicated in the revision setting when there is severe capsular deficiency owing to previous thermal damage. The capsular reconstruction attempts to recreate the labrum and capsular ligaments. Although success has been shown with this procedure (eg, 64% patient satisfaction), recurrent instability rates remain high (eg, 25% demonstrated recurrent instability).[56] This patient represents for us a salvage procedure with a very technically challenging problem.

Summary

Many treatment options are available for the athlete with a failed primary shoulder stabilization procedure. Arthroscopic techniques have substantially evolved contributing to the success of arthroscopic stabilization procedures in both primary and revision surgeries. We believe that arthroscopic Bankart repair, as well as addressing associated capsular laxity for athletes with recurrent anterior instability even with mild bone loss, yields excellent outcomes with low recurrence and returns athletes to their competitive sports in the absence of large bony defects. The arthroscopic Bankart-Bristow-Latarjet procedure, popularized in Europe by Dr Boileau, is a favorable option for those athletes who have severe bone loss and requires meticulous technique and may be the gold standard for many of us in the future, as we learn how to overcome some of the complications and problems fraught with this procedure whether open or arthroscopic.

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