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Review Article

# Anterior Shoulder Instability

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**Abstract**

Glenohumeral instability represents a broad array of pathology. Excellent patient history and directed physical examination is critical in distinguishing glenohumeral instability from other shoulder pathologies, and further distinguishing between unidirectional and multidirectional instability patterns. Advanced imaging, computed tomography or MRI may be necessary to adequately evaluate for associated glenohumeral pathology. Treatment algorithms have traditionally included a period of non-operative management in all patients, however young athletic patients may often benefit from early operative treatment. Various open and arthroscopic techniques exist to address unidirectional anterior shoulder instability. An individualized treatment approach, based upon the patient's injury pattern and expectations, will likely lead to the most successful outcome.

In this review there are not figures and outcomes.

**Keywords:** Shoulder dislocation; Glenohumeral instability; Bankart lesion; ALPSA; HAGL; Latarjet; Labrum

## Introduction

The bony architecture of the glenohumeral joint is often likened to that of a golf ball and tee. This geometry provides a functional benefit by allowing for a large arc of motion, but also confers an inherent instability that can result in traumatic anterior shoulder dislocation. In fact, the incidence of traumatic shoulder instability has been reported to be 1.7% in the general population [1,2]. By far the most common type of glenohumeral instability is anterior dislocation, accounting for over 90% of all shoulder dislocations. Rates are increased in men, contact athletes, and enlisted persons [3].

The glenohumeral joint relies on a complex network of static and dynamic structures that that aid in stabilizing the joint. Compromise of these structures leads to dislocation and often, recurrent instability. Structures providing static stability to the glenohumeral joint include the congruency of the humeral head and glenoid, the glenoid labrum, glenohumeral ligaments surrounding the joint, and negative intra-articular pressure [4]. Dynamic stabilizers are primarily muscular and include the rotator cuff, which provides a compressive stabilizing effect, the tendon of the long head of the biceps, and muscles that stabilize the scapula.

The labrum and ligamentous structures are critical for glenohumeral stability. Only one fourth of the humeral head is in contact with the glenoid at any point during range of motion of the shoulder [5]. The labrum functions to deepen the glenoid cavity, increase humeral contact, prevent humeral head rollback, and serves as an attachment site for ligamentous structures [6,7]. The ligaments responsible for glenohumeral stability include the Superior Glenohumeral Ligament (SGHL), the Middle Glenohumeral Ligament (MGHL) and the Inferior Glenohumeral Ligament (IGHL). The most important of the three is the IGHL, which is the primary restraint to anterior subluxation of the humeral head when the shoulder is abducted to 90° and externally rotated. The SGHL is the primary restraint to inferior and posterior subluxation of the humeral head when the shoulder adducted or neutral [8,9]. The MGHL resists anterior subluxation in the mid-range of shoulder abduction.

The most common mechanism of injury causing an anterior dislocation is a fall onto an outstretched arm with the shoulder abducted and externally rotated. In this position, the IGHL is the primary restraint to anterior translation of the humeral head. Injury to this ligament and the anteroinferior labrum, termed a Bankart lesion, can occur and has been reported in as high as 90% of traumatic anterior shoulder dislocations [10]. Recurrent episodes of instability further stretch and elongate this ligamentous structure.

## Diagnosis

### History

Glenohumeral instability can be categorized by the direction of instability, the chronicity, and the etiology. Understanding the pathophysiology and etiology related to the patient's glenohumeral instability may aid in determining their risk of recurrence and ultimately guide management. A thorough history and physical examination are thus essential. Age, activity level, sports participation, and hand dominance should be noted. The examiner should inquire about instability in the other joints, especially the contralateral shoulder. If a traumatic event is related to the patient's symptoms, the position of the arm and amount of energy involved during the event should be noted. If the patient cannot remember the position of the arm during the event, knowing the position of the arm that reproduces symptoms is also useful.

One should inquire about the presence and quantity of previous shoulder subluxations or dislocations. Information regarding all treatment prior to presentation should be ascertained, including any period of immobilization or physical therapy, and previous operative interventions. The characteristics of associated pain should be noted, however, the location of pain is not a specific indicator of glenohumeral instability. A distinction should be made between




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episodes of subluxation, or partial separation of the humeral head from the glenoid, and dislocation. The examiner should inquire about any associated symptoms including neurologic deficits and functional limitations. The baseline functional status of the individual should also be determined and include the patient's mental capacity, neurologic or seizure disorders, collagen disorders or congenital problems. In patients with recurrent instability, it should be noted whether the patient can voluntarily dislocate their shoulder as studies have shown poor outcomes in patients with psychiatric problems who exhibit attention-seeking behavior [11,12]. Age of the patient at the first dislocation is a very important prognostic indicator. Studies have shown that patients with shoulder dislocations younger than 20 years old have a 90% rate of recurrence, while patients older than 40 years have only a 10% recurrence rate but are more prone to rotator cuff injuries [13]. Patients that compete in high level and contact sports are also at an increased risk of recurrence if treated nonoperatively [14].

## Physical exam

In patients with glenohumeral instability, both shoulders should always be examined using the normal shoulder as a reference. Atrophy of the rotator cuff, deltoid or periscapular muscles, previous skin incisions and asymmetry should be noted. Point tenderness is identified by palpation at the anterior and posterior glenohumeral joint, Acromioclavicular (AC) joint, and sternoclavicular joint. Active and passive range of motion of the affected shoulder is compared to the contralateral shoulder. A thorough neurovascular examination should also be completed to evaluate motor strength, and sensation of the axillary, median, radial and ulnar nerves and pulses in the radial and ulnar arteries. If a closed reduction is performed, documentation of a pre-reduction and post-reduction examination is necessary. Recurrence and post-operative failure rates have been associated with pre-existing joint laxity [15]. Therefore, signs of generalized ligamentous laxity including evaluation of elbow hyperextension, metacarpophalangeal hyperextension, and the thumb-to-forearm test should also be noted.

An additional assessment of glenohumeral joint laxity should include the "sulcus" and "load and shift" tests. The sulcus test is used to assess the integrity of the rotator interval, which is formed by the superior glenohumeral ligament and the coracohumeral ligament. It is performed by pulling inferiorly on the humerus with the arm in zero degrees of abduction. If the humeral head subluxates inferiorly, a depression will form between the humeral head and the acromion. The sulcus test is graded, with 1+ representing subluxation up to 1 cm, 2+ representing subluxation 1-2 cm, and 3+ representing subluxation greater than 2 cm. The sulcus test is then repeated in external rotation. If the sulcus sign disappears in external rotation, the rotator interval is deemed competent.

The anterior load and shift test is typically performed with the patient supine. A small compressive load is applied to the humeral head to center it within the glenoid fossa. An anterior force is then applied to translate the humeral head anteriorly (while stabilizing the scapula). This can be performed with the arm in neutral, 45°, and 90° of abduction to assess the laxity of the SGHL, MGHL, and IGHL respectively. The test is graded with 1+ representing translation to glenoid rim, 2+ if the humeral head translates over the glenoid rim with spontaneous reduction, and 3+ if it dislocates without spontaneous reduction.

The apprehension test is useful to evaluate patients with anterior instability. The test is performed with the shoulder abducted to 90° and the elbow flexed to 90°. Progressive external rotation is applied to the shoulder along with a slight anteriorly directed force. Pain alone is not specific for anterior instability as this test may produce pain in patients with impingement. A positive result is indicated when the patient experiences a sense of impending instability which is relieved by changing the direction of the applied force from anterior to posterior, which is called the relocation sign. The apprehension test helps in diagnosis, but it may also aid in determining the risk of recurrence following a traumatic anterior shoulder dislocation. Safran et al. used the apprehension test to assess the risk of recurrent dislocation in 51 males (ages 17-27) 6 weeks following their initial anterior shoulder dislocation. At 24 month follow-up, a recurrent dislocation had occurred in 36.8% and 71.4% of those with a negative and positive 6-week apprehension sign respectively. They concluded that, while not a definitive predictive tool for recurrent dislocation, the apprehension test may categorize patients into high and low risk groups after their initial shoulder dislocation [16].

## Radiologic studies

The initial radiologic studies in patients with glenohumeral instability are plain radiographs with Anteroposterior (AP) and axillary lateral views. If the patient cannot tolerate an axillary lateral view in the acute setting due to pain, a Velpeau view may be obtained with them in a semi-reclined, seated position. Further views that may be useful include AP views with the shoulder internally rotated, a West Point view, a Didiee view, and a Stryker notch view. With anterior shoulder dislocations the posterolateral aspect of the humeral head can be impacted against the glenoid rim causing an impaction fracture to the posterior aspect of the humeral head known as a Hill-Sachs lesion. If this bony concavity engages the anterior glenoid with the arm in 90° and external rotation it is term an "Engaging Hill Sachs Lesion", and confers a higher risk of failure following an arthroscopic stabilization procedure [17]. Hill-Sachs lesions are best viewed on AP radiographs in internal rotation and Stryker notch views. The Stryker notch view is obtained with the patient in the supine position and the arm forward flexed to 100° with the x-ray beam centered over the coracoid and tilted 10° cephalad [18]. An apical oblique view taken with the patient seated and rotated 45° and the beam directed 45° caudally is also useful for evaluating posterior humeral head defects [19].

Traumatic dislocations can fracture the glenoid rim. An avulsion fracture of the anteroinferior glenoid at the insertion of the IGHL is referred to as a bony Bankart lesion. Recurrent instability can cause erosive or attritional loss of the glenoid rim causing progressive instability. Loss of 20% of the glenoid rim has been shown to cause significant recurrent instability and usually requires surgical correction of the bony deficiency [20]. This deficiency may be seen on the axillary view and may be suggested by a break in the sclerotic line encircling the glenoid rim on the AP view of the shoulder. If further investigation is needed one can also consider Didiee and West Point views. The Didiee view is obtained with the patient prone and the hand is placed on the ipsilateral iliac crest with the x-ray

beam directed laterally at 45° to the floor [18]. The West Point view is obtained with the patient prone, with the shoulder abducted to 90° and the elbow bent with the arm hanging off the table. The x-ray beam is directed 25° medial and 25° caudal [21].

Other imaging modalities including Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are useful in clinical situations where the diagnosis is unclear. CT may be useful to demonstrate and quantify bony abnormalities including glenoid bone loss or fractures, glenoid version and humeral head abnormalities. Adding contrast and performing a CT arthrogram of the shoulder can also provide some insight into the status of the labrum, rotator cuff and ligamentous complex. MRI is extremely useful, and the preferred method to evaluate these soft tissues, however, it does not provide as clear a picture of the associated bony injuries. In the acute setting, the hemarthrosis resulting from the dislocation serves as an intra-articular contrast medium. In the more chronic setting, gadolinium-enhanced MRI is a useful modality to investigate for soft tissue pathology such as labral tears and capsular damage.

In addition to the commonly discussed Bankart lesion (avulsion or tear of the anteroinferior glenoid labrum), an Anterior Periostial Sleeve Avulsion (ALPSA) or a Humeral Avulsion of Glenohumeral Ligament (HAGL) can occur with an anterior shoulder dislocation. These are associated with higher recurrence rates and if gone unnoticed can lead to higher post-surgical failure rates [22,23]. HAGL and ALPSA lesions are best seen using advanced imaging techniques such as MRI and MR arthrogram.

## Treatment

### Nonoperative management

Throughout history several maneuvers have been described to successfully reduce the anteriorly dislocated shoulder [24]. Intravenous Analgesia with or without Sedation (IVAS) and Intra-Articular Lidocaine (IAL) injection provide similar pain relief and patient satisfaction during the reduction maneuver [25]. A Cochrane review found no difference between IVAS and IAL with regard to immediate success rate of reduction. IAL was associated with fewer adverse events and a shorter recovery time [26].

Once reduced, the affected arm should be placed in a sling and the patient should be prescribed a brief (1-3 week) period of relative rest. During this time the initial focus is on pain control and restoring range of motion. The provocative position of abduction and external rotation should be avoided, as to limit the risk of early recurrence. Physical therapy can be helpful, initially focusing on these previously stated goals, and then advancing to rotator cuff and periscapular muscle strengthening in an effort to maximize the dynamic stabilizers of the glenohumeral joint.

Traditionally, the shoulder has been immobilized in a sling in a position of adduction and internal rotation. When immobilized in this position, studies have shown that there is no clinically significant advantage for immobilization longer than a 1-week period [27,28]. In a classic study by Hoveulis et al., 112 patients used simple sling immobilization for 3-4 weeks following their initial anterior shoulder dislocation, while 104 patients began to use the shoulder as early and as freely as possible. At the two-year follow-up, both groups showed an equal rate of recurrent shoulder instability [29].

In 2003, Itoi et al proposed immobilizing the shoulder in an externally rotated position, following the initial dislocation event, in an effort to reduce the rate of recurrence [30]. Placing the arm in 30° of external rotation compresses the subscapularis against the anterior glenoid neck. In doing so, it reduces the anterior joint effusion as well as the separation and displacement of the anterior labrum [31,32]. In their preliminary study, Itoi et al. [30] equally assigned 40 patients to either conventional sling immobilization or immobilization in external rotation after their initial anterior shoulder dislocation. The recurrence rates at 15.5 months were 30% and 0% for the internal rotation and external rotation groups respectively. Unfortunately, these patients were not randomized and the results may have been confounded by the varying ages of the treatment groups [30]. A repeat randomized study and studies by others have not been able to reproduce such dramatic results [27, 33-35].

Athletes may return to play when they have a painless range of motion and have regained normal strength. Commercially available shoulder harnesses are often used to protect these athletes as they return to play. When selecting a harness, one must take into account the sporting demands of the athlete. Some harnesses are rigid and act by reducing range of motion and limiting the shoulders ability to achieve the at risk position of abduction and external rotation. While this type of brace is ideal for a contact athlete, such as an American football lineman, it is not ideal for an overhead athlete who requires greater degrees of range of motion. In these athletes, one can consider a neoprene harness that does not restrict range of motion but improves the position sense of the shoulder joint and may therefore add a protective measure to the individual [36].

## Surgical Management of Glenohumeral Instability

Multiple factors must be considered prior to surgical treatment. These include patient age, activity level, and desired level of sports participation. Surgical management should be considered in patients with recurrent unidirectional shoulder instability and in young active people, particularly those that play high demand and contact sports. In people younger than 25 years of age, the recurrence rate following conservative management has been reported to be between 60 and 90% [37]. Therefore, there is an increasing trend to treating this group of patients operatively, even after their first traumatic anterior shoulder dislocation [38-40]. Contraindications to surgical treatment may include brachial plexus and axillary nerve injuries, deltoid dysfunction and infections [14].

Following a thorough patient history, physical examination, and review of appropriate imaging studies, a discussion should take place between the patient and treating surgeon. Operative management should be customized according to the patient's intra-articular pathology and future lifestyle expectations. No operative intervention can guarantee a 0% recurrence rate. Open procedures may provide lower recurrence rates than arthroscopic management, but open surgery can also result in less post-operative external rotation ability. Therefore, while an open technique may benefit a collision athlete, an arthroscopic stabilization may be better suited for an overhead athlete that relies on high degrees of external rotation to perform their sport.

Once in the operative room, an examination under anesthesia should be performed to confirm the unidirectional nature of

the instability and degree of glenohumeral joint laxity. Specific maneuvers (load and shift and sulcus test) should be performed as described above and compared to the contralateral side. Passive range of motion should be evaluated and documented.

### Open anterior capsulolabral reconstruction (Bankart Repair)

Prior to the advent and popularization of arthroscopy, open stabilization techniques were the mainstay of surgical care of patients with recalcitrant glenohumeral instability. These techniques are time tested, reliable, and continue to have a role even in an era of rapidly evolving arthroscopic techniques [41]. These procedures are typically performed through an anterior deltopectoral approach to the shoulder. To expose the underlying joint capsule, the subscapularis tendon is either split horizontally or released and later repaired. A horizontal incision through the joint capsule is made and "T'd" either medially or laterally. With the joint capsule open, a clear view of the glenohumeral joint is obtained for visual inspection. The antero-inferior glenoid rim should be inspected for a Bankart lesion [42].

The anterior glenoid rim is abraded and suture anchors are inserted and used to repair both the anterior labral tear and the anterior joint capsule. The inferior and superior leaflets of the capsule can be overlapped to improve the tissue quality and reinforce the repair. In doing so, any redundancy in the anterior capsular tissue is effectively diminished. The subscapularis is then repaired [43].

## Arthroscopic Surgical Management

An initial diagnostic shoulder arthroscopy is performed through a posterior portal. The surgeon confirms the expected intra-articular pathology and investigates for other concomitant pathology. The examination should be thorough, and include inspection of the glenoid and humeral head articular surfaces; the glenoid labrum should be visualized circumferentially and probed; the rotator cuff should be visualized and inspected for tears. Particularly in cases of instability, the surgeon should carefully examine the joint for HAGL and ALPSA lesions, engaging Hill Sachs lesions, and determine the percentage of anterior glenoid bone loss using a calibrated probe. A "drive through sign" is indicative of increased laxity or overall glenohumeral joint volume, and is noted to be positive when the surgeon can easily translate the arthroscope across the glenohumeral joint from back to front.

Much more commonly undertaken today than the above described open techniques is the arthroscopic Bankart repair (anterior arthroscopic capsulolabral reconstruction) [44]. The procedure is considered by many to be the procedure of choice for anterior instability, and offers excellent objective long-term outcomes with a high degrees of patient satisfaction [45]. Following a diagnostic arthroscopy through a posterior portal, two additional anterior portals are routinely used to accomplish the repair [46]. The labrum is elevated off of the anterior edge of the glenoid and the anterior glenoid and scapular neck is prepared using a rasp and arthroscopic shaver. Suture anchors are then placed into the anterior glenoid near its rim, beginning with the most inferior anchor and working superiorly. Sutures are passed through the labrum and capsular ligaments to account for the elongation of these tissues as a result of the dislocation. These sutures are then tied from inferior to superior, restoring the anteroinferior sling and static stabilizers of the glenohumeral joint [43].

Several studies have evaluated clinical outcomes after open *versus* arthroscopic Bankart repair and found them to be comparable [47,48]. A meta-analysis of 501 patients treated surgically for anterior shoulder instability using suture anchors (234 arthroscopic and 267 open) found similar rates of recurrent instability (6% *versus* 6.7%) and need for re-operation (4.7% and 6.6%) [49]. Subjective evaluations show no significant difference between the two treatment methods, although loss of range of motion (notably external rotation) may be increased with open repairs [50-52]. Some have shown that patients treated with open techniques have a lower rate of recurrent shoulder dislocations or instability than those treated with arthroscopic techniques, with the caveat that almost half of those treated with open techniques had loss of external rotation (range 10-40° loss) [53]. Hence, as previously discussed, patients participating in sports where performance could be compromised by loss of external rotation (such as swimming, certain skilled positions in football, and overhead athletes), may achieve a better functional result with an arthroscopic stabilization [54]. The overall cost of the procedures was less for arthroscopic repairs, but this discrepancy lies in the fact that more patients undergoing open repairs are admitted overnight for pain control and observation [55].

Risk factors for failure following arthroscopic labral repair include male sex, younger age at the time of first dislocation, the time from the first dislocation until surgery, joint laxity, ALPSA lesions, engaging Hill-Sachs lesions, and glenoid bone loss greater than 20% [17,56]. Open Bankart repairs may be directly addressing ALPSA lesions by reinforcing the anterior capsular tissue during the repair and perhaps indirectly addressing the engaging Hill-Sachs lesions by limiting the external rotation that previously allowed them to engage. To address these risk factors and achieve similar result, arthroscopic surgeons have suggested closing the rotator interval or plicating the posterior joint capsule to reduce laxity and capsular volume. While aimed at reducing the recurrence rate, they too may reduce post-operative joint range of motion. Recent studies found that closure or the rotator interval during an arthroscopic Bankart repair significantly reduces post-operative external rotation and plication of the posterior capsule significantly reduces post-operative forward flexion [57,58].

Large Hills Sachs lesions may require open reconstruction with a transhumeral bone graft or osteoarticular allograft reconstruction [59]. Recently, an arthroscopic technique, known as a remplissage, has been describe to address these engaging Hill-Sachs lesions. Using rotator cuff suture anchors, a capsulotenodesis of the posterior infraspinatus tendon and posterior capsule is performed to fill the Hill-Sachs defect, thus preventing it from engaging with the anterior glenoid [60,61]. While some results are promising, others raise the concern of losing post-operative external rotation *via* a mechanical block of the posterior capsule on the posterior glenoid [62-64].

### Glenoid bone loss

Glenoid bone loss is a true concern to some degree in most cases of recurrent glenohumeral instability, and can contribute to failure of soft tissue reconstruction [65,66]. Ideally the surgeon will be able to identify and quantify anterior glenoid bone loss preoperatively. Imaging techniques best suited for accurate assessment of bone loss are still a topic of investigation. Although plain film roentography

can sometimes demonstrate glenoid bony Bankart injuries or bone loss [18,19,21], recently computed tomography, including three-dimensional reconstructions has gained popularity. Using three-dimensional reconstructions, a circle can be drawn over the inferior two thirds of the glenoid. The amount of bone missing from this circle is thought to be an accurate quantification of bone loss [67]. At the center of the glenoid lies a "bare spot" which can often be viewed arthroscopically. An equal length should be measured on the glenoid posterior and anterior to this "bare spot" [68]. Glenoid bone loss greater than 25% is a contraindication to arthroscopic Bankart repair [67,69]. Some advocate an open bony procedure for bone loss exceeding 20% of the glenoid [65].

Well studied techniques to address cases of anterior instability with significant bone loss include the Bristow and Latarjet procedures [70,71]. Both techniques involve transfer of the coracoid and the attached conjoint tendon (short head of the biceps and coracobrachialis) to the anterior scapular neck at the anterior glenoid rim. The bony augmentation serves to increase the arc of the glenoid. When performed through a split in the subscapularis, the inferior one-third of the subscapularis tendon provides an additional buttress to anterior translation. The conjoint tendon acts as a dynamic anterior soft tissue sling as the arm is brought into the high-risk position of abduction and external rotation. The procedure has typically been performed through an open anterior approach, however recently arthroscopic coracoid transfer has been described [72]. In revision cases where the coracoid is no longer available, iliac crest bone autograft or allograft bone can be used for the bony augmentation [73,74]. These techniques lack the benefit of the soft tissue buttress provided by the Latarjet and Bristow techniques.

In a study evaluating patients treated with the Bristow-Latarjet procedure *versus* open Bankart repairs, patients treated with the Bristow-Latarjet had lower rates of recurrence/dislocation, higher rates of very satisfied/satisfied patients, and better Western Ontario Shoulder Index (WOSI), Disabilities of the Shoulder and Hand (DASH), and Simple Shoulder Value (SSV) outcome scores. This study, however, did not differentiate patients with or without glenoid bone loss [75].

### Postoperative care

The general goals of postoperative rehabilitation after shoulder instability surgery are to encourage progressive mobilization and protect the surgical repair. In open procedures where the subscapularis is incised, active internal rotation and passive external rotation is avoided while the subscapularis heals. Postoperative rehabilitation protocols typically include a period of immobilization in a sling for 3-4 weeks. Pendulums exercises are begun immediately. Active assisted range of motion exercises, external rotation (0-30°) and forward flexion (0-90°) are also begun at this time. From weeks six to twelve active and active assisted motion is emphasized to re-establish full range of motion. Strengthening is begun once full, painless, range of motion has been restored. Sports specific exercises are started around 16-20 weeks post-surgery. Patients may return to contact sports at 20 and 24 weeks following Latarjet and arthroscopic stabilization respectively.

## Conclusion

The glenohumeral joint is inherently predisposed to instability by its bony architecture. The incidence of traumatic shoulder instability is 1.7% in the general population. Associated injuries to the capsulolabral structures of the glenohumeral joint have been described and may play a role in predicting recurrent instability. Advanced imaging, computed tomography or MRI may be necessary to adequately evaluate for associated glenohumeral pathology. Treatment algorithms have traditionally included a period of non-operative management in all patients, however young athletic patients may often benefit from early operative treatment. Various open and arthroscopic surgical options exist to address anterior glenohumeral instability. Bony injuries including bony Bankart lesions and Hills Sachs lesion have been implicated in failed surgical management using techniques that address only the soft tissues. An individualized treatment approach, based upon the patient's injury pattern and expectations, will likely lead to the most successful outcome.

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