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Clinical Evaluation and Physical Exam Findings in Patients with Anterior Shoulder Instability

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Abstract
Purpose of review The goal of this paper is to provide an overview in evaluating the patient with suspected or known anteroinferior glenohumeral instability.
Recent findings There is a high rate of recurrent subluxations or dislocations in young patients with history of anterior shoulder dislocation, and recurrent instability will increase likelihood of further damage to the glenohumeral joint. Proper identification and treatment of anterior shoulder instability can dramatically reduce the rate of recurrent dislocation and prevent subsequent complications. Overall, the anterior release or surprise test demonstrates the best sensitivity and specificity for clinically diagnosing anterior shoulder instability, although other tests also have favorable sensitivities, specificities, positive likelihood ratios, negative likelihood ratios, and inter-rater reliabilities.
Summary Anterior shoulder instability is a relatively common injury in the young and athletic population. The combination of history and performing apprehension, relocation, release or surprise, anterior load, and anterior drawer exam maneuvers will optimize sensitivity and specificity for accurately diagnosing anterior shoulder instability in clinical practice.

This article is part of the Topical Collection on *Management of Anterior Shoulder Instability*

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Introduction

The glenohumeral joint—due to its relatively unconstrained bony architecture—is one of the most mobile joints in the body [1, 2]. Since the glenohumeral articulation is unconstrained from a bony perspective, stabilization is primarily achieved through an intricate network of dynamic soft tissue structures, such as the capsule, glenohumeral ligaments, rotator cuff, biceps/labrum complex, and surrounding musculature [3]. This anatomical design results in great freedom of movement; however, it also creates a high propensity for instability after dislocation, particularly after a traumatic event [1, 2]. Although posterior and inferior dislocation of the glenohumeral joint is possible, the vast majority of instability cases are due to anteroinferior dislocation of the glenohumeral joint [4•] which is the focus of this review article.

The chief restraint to anterior instability is the confluence of the glenohumeral ligaments. In the abducted position (90°), the anteroinferior glenohumeral ligament (AIGHL) provides the main source of resistance to anterior dislocation, while the middle and superior glenohumeral ligaments provide resistance in the mid-abducted (45°) and adducted positions, respectively. The most common mechanism for anteroinferior dislocation is a traumatic event that places the shoulder in extremes of abduction and external rotation [5]. These exaggerated maneuvers result in injuries to the corresponding soft tissues (anteroinferior capsule-labral complex or Bankart lesion) or bony structures (anteroinferior glenoid or posterosuperior humeral head). In patients over the age of 40, the most commonly injured soft tissue structure is the

rotator cuff [6], as opposed to the anterior labrum, which is often torn in younger patients [7].

Unfortunately, there is a high rate of recurrent dislocation in young patients with history of anterior shoulder dislocation [4•]. Recurrent dislocations may significantly increase the likelihood of persistent pain, disability, apprehension, and even articular cartilage damage [8, 9]. Therefore, comprehensive clinical evaluation of the patient with suspected anteroinferior instability is crucial in beginning to effectively manage this patient and prevent subsequent complications [10]. This review will provide an overview in evaluating the patient with suspected or known anteroinferior glenohumeral instability.

Relevant History

Upon initial presentation to clinic, it is important to first obtain a comprehensive history regarding the nature of the shoulder injury. For first-time dislocators, patients may describe a single traumatic event involving the shoulder that resulted in immediate symptoms. Patients with recurrent instability may complain of several dislocation/subluxation events or limitations/apprehension due to the history of recurrent instability events. Thus, additional information regarding the mechanism of injury, such as the nature of the injury, the direction of force placed on the shoulder, and the direction of perceived instability must be elucidated in order to accurately characterize an event of anterior shoulder instability [11].

It is important to note whether or not the patient required reduction in the emergency room (or other hospital setting), or if it was successfully self-reduced or reduced in the field. Patients will often be able to detail whether or not the injury was a complete dislocation versus a subluxation. Patients with a locked anterior dislocation event may have more damage to the glenohumeral joint. The number of recurrences should be assessed as well. Finally, the level of activity required to cause an instability event is important to note. For example, does the instability only occur in extreme positions of abduction/external rotation, or does it occur in "everyday" positions during sleep or activities of daily living? This may provide clues to the surgeon regarding the severity of the soft tissue or bony restraint damage in the shoulder. Clinicians should also determine if the shoulder instability has a voluntary component, as these patients often have demonstrated poor response to surgical stabilization [12].

General Physical Exam

Proper physical exam of the shoulder begins with visual inspection of both the front and the back of the entire shoulder girdle. Care should be paid to note any asymmetry between the affected and contralateral side, particularly regarding overall position of the shoulder, muscle bulk/atrophy, scapular position/winging, and acromioclavicular position, This inspection may be performed with the shoulder in a static position, as well as during active arc of motion of the shoulder.

The bony prominences are then palpated and elicited for areas of tenderness, such as over the AC joint, SC joint, biceps tendon, acromion, and greater tuberosity.

Following visual inspection and palpation, it is necessary to assess active and passive range of motion. Relevant planes of motion include forward elevation, abduction, internal/external rotation at the side, and internal/external rotation in abduction. Patients with recent acute injury will often have limitations of motion due to underlying pain and inflammation. Rotator cuff strength is then assessed using the champagne toast and spill tests for the supraspinatus [13], resisted external rotation at the side (infraspinatus), resisted external rotation in abduction (teres minor) greater than 60°, and resisted internal rotation/belly press test for the subscapularis. It is important to note that patients over the age of 40 with acute dislocation will have a high likelihood of rotator cuff tear [14•]. Thus, it is important to assess for cuff strength in these subset of patients.

It is also important to document presence of generalized ligamentous laxity in patients with shoulder instability, and in particular in those with recurrent or multi-directional instability. This includes documentation of a hypermobility of the skin test as well as performing a Beighton score assessment [15] (Table 1).

Provocative Exam Maneuvers

In addition to the standard physical exam maneuvers described above, there are a number of provocative exam maneuvers that are specific in detecting inferior laxity in the setting of glenohumeral instability. One commonly performed exam maneuver is that of the sulcus sign. To perform the sulcus sign, the patient is first positioned upright with their arms resting at their side. The examiner then stabilizes the shoulder and applies an inferiorly-directed force on the elbow (Fig. 1). Excessive downward displacement of the humeral head that does not improve with external rotation suggests multi-directional instability of the shoulder or deficiency of the rotator interval. The sulcus sign is graded by the amount of inferior translation; grade I is less than 1 cm translation, grade II is 1–2 cm translation, and grade III is greater than 2 cm translation.

The hyperabduction test is another maneuver for detecting inferior glenohumeral instability and specifically assesses the integrity of the IGHL [16]. To perform this maneuver, the examiner evaluates the passive abduction of the shoulder while using his or her forearm to stabilize the shoulder girdle

Table 1 Assessment criteria for the Beighton score (maximum score of 9) [15]

Maneuver	Positive finding	Scoring
Passive dorsiflexion of fifth metacarpophalangeal joint	≥ 90°	1 point per side
Passive hyperextension of elbow	≥ 10°	1 point per side
Passive hyperextension of knee	≥ 10°	1 point per side
Passive apposition of thumb (to flexor side of forearm)	Entire thumb in contact with flexor side of forearm	1 point per side
Forward flexion of trunk	Palms in contact with ground	1 point

in a low position (Fig. 2). Most healthy volunteers in this position only demonstrate passive abduction up to 90°, whereas passive abduction over 105° suggests excessive laxity of the glenohumeral joint.

Additionally, there are a number of other exam maneuvers that directly assess for anterior glenohumeral instability. Anterior apprehension may be elicited by bringing the patient's shoulder into a position of 90° of abduction and 90° of external rotation (Fig. 3) in either the supine or upright position. A positive exam finding is the subjective feeling of impending subluxation or dislocation when in this provocative position. It is important to note that although these symptoms may be accompanied by pain, pain itself does not produce a positive test.

The bony apprehension test is a variant of the traditional apprehension test and is used to detect the involvement of bony lesions, specifically, as a contributing cause of anterior glenohumeral instability [17]. Rather than bringing the shoulder into 90° of abduction and 90° of external rotation, the shoulder is instead positioned at 45° of abduction or less and at 45° of external rotation or less. A positive finding is the same as the traditional apprehension test, that is, a sensation of apprehension or symptoms of instability. Interestingly, the bony apprehension test has been shown to be more sensitive than preoperative plain radiographs for detecting bony lesions at time of surgery [17].

The relocation test is a natural progression of the apprehension test and assesses for relief of apprehension after manual stabilization of the shoulder. After eliciting a positive apprehension test, the examiner maintains the patient in their current position and applies a posteriorly-directed force on the humeral head in an attempt to stabilize the shoulder and correct the symptoms (Fig. 4). In a patient with anterior shoulder instability, this maneuver should bring a subluxed humeral head back into the correct position relative to the glenoid fossa. Resolution of guarding and apprehension suggests anterior instability and is considered a positive relocation test.

Another similar exam maneuver is the anterior release or surprise test. This maneuver contains aspects of both the apprehension test and relocation test. In this maneuver, the patient is supine on the exam table and the shoulder is again brought into an abducted and externally rotated position. During this time, the examiner places his/her hand on the shoulder with a posteriorly-directed force. Once the shoulder is at maximal external rotation, the hand is then suddenly removed, thus allowing the shoulder to translate anteriorly (Fig. 5). If the patient demonstrates guarding, apprehension, or instability once the posteriorly-directed force is removed, the test is considered positive and indicative of anterior glenohumeral instability [18]. Care is taken not to dislocate the patient's shoulder with this exam maneuver.

For the load and shift test, the patient is positioned supine while the examiner is to the side of the patient. In order to examine the left shoulder, for example, the patient's left wrist is first held by the examiner's left hand at a slightly flexed and limp position. The examiner then uses their right hand to grasp the humeral head. After loading the humeral head into the glenoid fossa, the examiner places an anteriorly-directed force

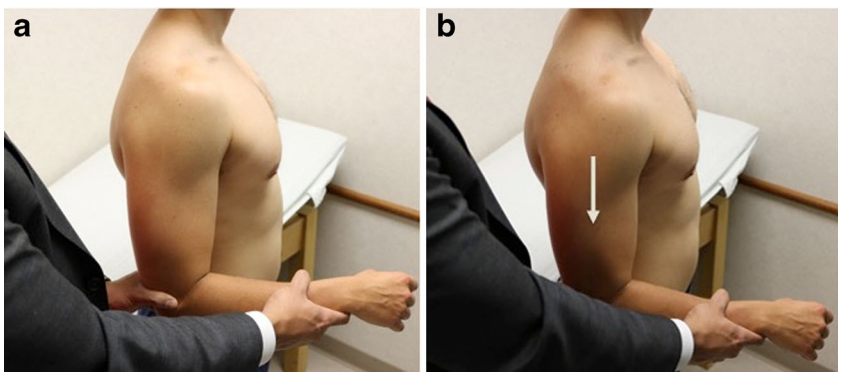

Fig. 1 Sulcus Sign. **a** Patient is positioned upright with arms resting at the side. **b** Examiner stabilizes the shoulder and applies an inferiorly-directed force on the elbow, pulling down on the humerus (arrow). If a sulcus appears and does not resolve with external rotation, there may be a deficiency of the rotator interval

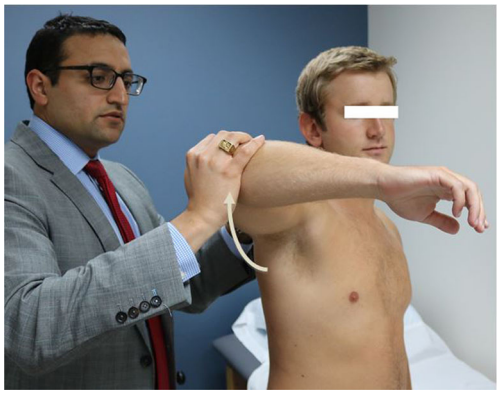

Fig. 2 Hyperabduction test. Examiner assesses passive abduction of patient's shoulder while stabilizing the shoulder girdle. Passive abduction greater than 105° suggests instability of glenohumeral joint

on the humerus and assesses for the amount of anterior laxity [19] (Fig. 6).

Rather than simply declaring the load and shift test positive or negative, there are a variety of grading systems used to describe the degree of glenohumeral translation. While some grading systems attempt to quantify the amount of translation, it is more practical and common to use a clinical-based grading system [20], where grade 0 is defined as minimal displacement, grade 1 is the humeral head reaching the glenoid rim, grade 2 is when the humeral head can be dislocated but spontaneously resolved, and grade 3 is when the humeral head does not spontaneously reduce [21].

The load and shift test is very similar to the anterior drawer test. However, the anterior drawer test does not involve loading the glenohumeral joint prior to translating the humeral head along the glenoid [22].

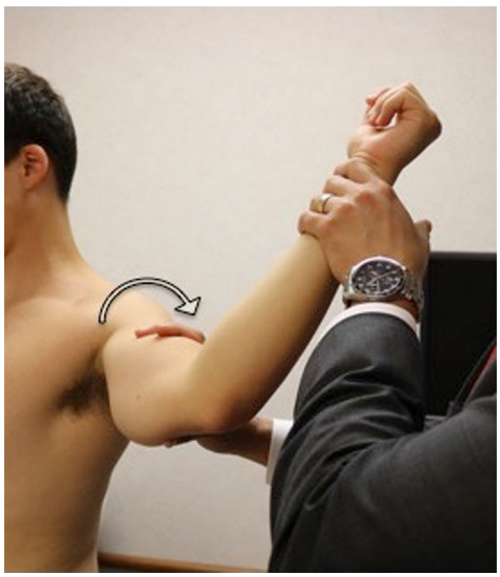

Fig. 3 Apprehension test. Patient's shoulder is abducted 90° and elbow flexed to 90°. The examiner then externally rotates the arm and assesses for apprehension or guarding

Fig. 4 Relocation test. Examiner applies a posteriorly-directed force with the patient's shoulder in abduction and external rotation. Relief of guarding, apprehension, or instability suggests anterior glenohumeral instability

The load and shift test also closely resembles the anterior jerk test, which similarly involves loading the humeral head into the glenoid fossa. The anterior jerk test differs in that the patient is positioned with his or her shoulder at 60–80° of abduction and 45° of flexion before applying an anteriorly-directed force on the humeral head [23]. The purpose of this test is to evaluate for subluxation of the humeral head, which is perceived as a noticeable jump or clunk due to excessive anterior translation over the glenoid rim. A similar finding may be demonstrated upon reentry of the humeral head into the glenohumeral joint.

An overall summary on how to perform each physical exam maneuver for anterior shoulder instability can be found in Table 2. An overview of the statistical measures of performance for several of these physical exam maneuvers can be found in Table 3.

Lastly, the shoulder should be evaluated for possible injury to the biceps/labral complex as well as posterior labrum. The O'brien's active compression test, in particular, is very useful for testing the superior labrum and biceps anchor. With the patient's shoulder in 90° flexion, 10° adduction, and maximum internal rotation, the patient resists a downward force placed on the hand. This is repeated with the shoulder in full external rotation. A positive result is when there is deep

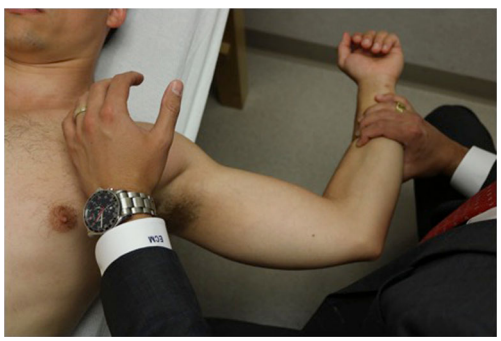

Fig. 5 Anterior release test. Patient's shoulder is brought into an abducted and externally rotated position while applying a posteriorly-directed force. The examiner suddenly releases this stabilizing force and assesses for guarding, apprehension, or instability

Fig. 6 Anterior load test. Examiner grasps the patient's wrist and humeral head, "loads" the humeral head into the glenoid fossa, and applies an anteriorly-directed force on the humerus (arrow)

shoulder pain on internal rotation that is partially or completely lessened during external rotation. Associated-point tenderness over the biceps provides further evidence that the tear may extend to include a SLAP component. It is essential to elicit the location of the pain with this provocative exam. Dr. O'Brien originally described this exam for AC joint pain. If the location is on top of the shoulder then that indicates AC pathology, whereas if the pain is within the shoulder joint, then a SLAP tear is suspected.

The newly described "3-pack" examination, which includes the O'Brien sign, throwing test, and bicipital tunnel palpation, has demonstrated excellent sensitivity, negative predictive value, and inter-rater reliability for comprehensive evaluation of the biceps/labral complex pathology, making it an ideal screening tool for this purpose [29].

Other tests used for identifying SLAP tears include the biceps load tests, crank test, and dynamic labral shear test. To perform the biceps load test I, the patient is positioned supine with their shoulder at 90°, elbow at 90°, and forearm supinated. The examiner then performs the apprehension test. After producing instability symptoms, the patient is instructed to flex their elbow against resistance. Worsening of pain or symptoms is suggestive of a SLAP lesion [30]. A variant of this maneuver is the biceps load test II, which differs in that the shoulder is abducted to 120° instead of 90° [31].

The crank test is performed by abducting the patient's shoulder to 160°, applying an axially-directed force from the humeral head into the glenoid, and alternating between

Table 2 Summary of physical exam maneuvers for evaluating anterior shoulder instability

Test name	Patient position	Maneuver	Positive finding
Apprehension	Supine or upright, shoulder at 90° abduction and elbow flexed at 90°	Bring shoulder into 90° of external rotation	Sensation of apprehension or instability (not pain)
Bony apprehension [17]	Supine or upright, shoulder at 45° abduction and elbow flexed at 90°	Bring shoulder into 45 degrees of external rotation	Sensation of apprehension or instability (not pain)
Relocation	Supine, shoulder at 90° abduction and 90° external rotation	Apply posteriorly-directed force on the humeral head	Resolution of guarding and apprehension
Release [18]	Supine, shoulder at 90° abduction and 90° external rotation, posteriorly-directed force applied to humeral head	Suddenly release posteriorly-directed force on the humeral head	Sensation of apprehension or instability (not pain)
Load and shift [19, 21]	Supine, shoulder at 90° abduction and elbow slightly flexed	Load the humeral head into the glenoid fossa with axially-directed force, then apply anteriorly-directed force on the humerus	grade 0 = minimal displacement grade 1 = humeral head reaches glenoid rim grade 2 = humeral head can be dislocated but spontaneously resolved grade 3 = humeral head does not spontaneously reduce
Anterior drawer [21, 22]	Supine, shoulder at 90 degrees abduction and elbow slightly flexed	Apply anteriorly-directed force on the humerus	grade 0 = minimal displacement grade 1 = humeral head reaches glenoid rim grade 2 = humeral head can be dislocated but spontaneously resolved grade 3 = humeral head does not spontaneously reduce
Anterior jerk [23]	Supine, shoulder at 60–80° abduction and 45° flexion, elbow flexed at 90°	Apply longitudinal force from humeral head into glenoid, then apply antieriorly-directed force on humerus	Sudden jump or clunk as humeral head slides over glenoid rim

Table 3 Statistical measures of performance for common physical exam maneuvers in evaluation of anterior shoulder instability

	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Inter-rater reliability
Apprehension test [24–27]	0.68–0.88	0.5–1.00	1.1–53	0.23–0.89	0.47
Relocation test [24–28]	0.57–0.85	0.87–1.00	3.0–67	0.18–0.33	0.71
Release test [18, 25–27]	0.85–0.92	0.87–0.89	8.3	0.09	0.63
Anterior load test [21, 25–27]	0.50–0.54	0.78–1.00	2.5– over 100	0.50–0.59	0.72
Anterior drawer test [28]	0.53	0.85	3.6	0.57	Unknown

internal and external rotation. Reproducible pain or clicking is indicative of a labral tear.

The dynamic labral shear test is performed by applying an anteriorly-directed force on the humeral head while passively elevating the arm from neutral position to maximal abduction. A positive finding is defined as pain or clicking between 90 and 120° of abduction and is suggestive of a SLAP lesion [32].

To identify posteroinferior labral lesions, the jerk test or Kim test should be performed. To perform the jerk test, the patient is first positioned with their arm at 90° of abduction and 90° of internal rotation. The examiner then grasps the elbow while stabilizing the scapula, axially loads the humerus onto the glenoid, and then horizontally adducts the arm across the body. The sliding of the humeral head off of the glenoid with associated pain or click indicates a posterior or posteroinferior labral lesion [33]. To perform the Kim test, the patient begins in the same position but the examiner does not stabilize the scapula and instead holds the proximal arm and elbow, applies an axial load to the glenohumeral joint, and adducts/elevates the arm at 45° (Fig. 7). This maneuver is performed while placing additional posterior and inferior force on the arm. The presence of pain during this maneuver suggests a posterior or posteroinferior labral tear [34].

Comparative Studies

Several studies have directly compared the ability of various physical exam maneuvers to accurately diagnose anterior shoulder instability. A prospective cohort study by van Kampen et al. assessed several clinical tests for traumatic anterior shoulder instability and found the apprehension test to be the most sensitive and anterior drawer test to be the most specific [35]. Generally, the apprehension, relocation, and release tests had the strongest sensitivities (ranging from 91.7 to 98.3) while the anterior drawer and load and shift tests had the strongest specificities (92.7 and 89.9, respectively). In addition, the release test had the best profile of diagnostic performance as calculated by overall accuracy in diagnosing anterior shoulder instability, although all tests were characterized by diagnostic accuracies above 80% [35]. Many of these findings have been corroborated in other studies as well [25, 26, 36, 37].

In general, combining physical exam tests for anterior shoulder instability has been shown to significantly improve specificities, likelihood ratios, and posttest probabilities, but at the cost of diminished sensitivities [28]. Interestingly, overall sensitivity is largely maintained

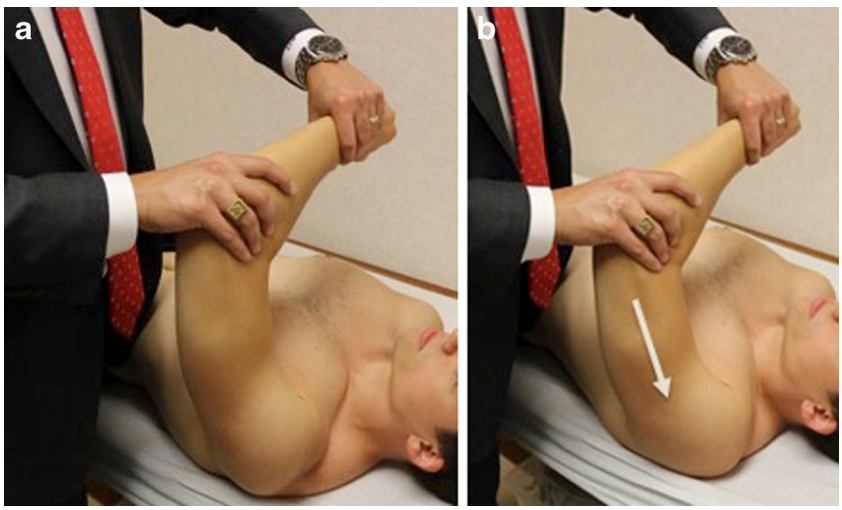

Fig. 7 Kim test. **a** Patient is positioned with their arm at 90° of abduction and 90° of internal rotation. **b** Examiner applies a posteriorly- and axially-directed load to the glenohumeral joint (arrow), and adducts/elevates the arm at 45°

when apprehension and relocation are performed together. Due to the ease at which these maneuvers can be performed together, it would be prudent for examiners to conduct these tests in succession.

In regard to inter-examiner reliability, a study by Tzannes et al. found that the load and shift test generally demonstrates the best agreement [27]. In addition, it was determined that the reliability of the provocative tests (apprehension, relocation, and release) significantly improves if examiners assess for apprehension and do not assess for pain.

A study by Sciascia et al. that surveyed shoulder and elbow specialists found that providers utilize a wide variety of physical exam maneuvers for diagnosing anterior shoulder instability [38]. However, the apprehension, relocation, load and shift, and anterior drawer tests are each utilized by over 50% of responding surgeons. In fact, 100% of surgeons specifically reported using the apprehension test for diagnosing anterior shoulder instability. Thus, the maneuvers described in this review represent the most common tests used in routine clinical practice.

Patient-Reported Outcomes

As a complement to more commonly collected objective outcomes and physical exam findings, patient-reported outcomes should also be collected to track recovery from the patient's perspective. The most commonly described patient-reported outcome measures for shoulder instability in orthopedic literature include the Western Ontario shoulder instability index (WOSI), the Rowe score, and the Oxford shoulder instability score. These disease-specific outcome measures have all demonstrated adequate validity, reliability, and responsiveness for shoulder instability patients [39–41]. Alternatively, general physical function scores, such as the new PROMIS measures, may also be helpful in patients with shoulder instability [42].

Conclusion

Anterior shoulder instability is a relatively common injury in the young and athletic population. The combination of history and performing apprehension, relocation, release or surprise, anterior load, and anterior drawer exam maneuvers will optimize sensitivity and specificity for accurately diagnosing anterior shoulder instability in clinical practice.

Compliance with Ethical Standards IRB approval is not required for reviewing current literature.

Conflict of Interest All authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Disclosure There are no financial disclosures for any author.

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