CME

An algorithm for successfully managing anterior shoulder instability

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ABSTRACT

The most common form of shoulder instability involves the anterior glenohumeral joint. Often it is associated with labral and bony injuries with subsequent recurrent instability. To determine optimal management, clinicians should perform a detailed history and physical examination, including appropriate diagnostic imaging to assess for concomitant humeral and glenoid bony deficiencies and other soft-tissue pathologies. Early surgical intervention may reduce risk of recurrence, particularly in young, active athletes. This article highlights the relevant anatomy, pathoanatomy, diagnostic examination including radiologic imaging, management, and prevention of complications for anterior shoulder instability. Minimizing recurrence is key to restoring function for patients to safely return to recreational and sporting activities, and to perform activities of daily living.

Keywords: anterior shoulder, instability, orthopedics, dislocation, Bankart lesion, bony defects

Traumatic shoulder instability occurs in 1.7% of the US population each year, and in 3% of high-risk cohorts such as military athletes and contact athletes.[1] Anterior instability represents nearly 90% of these injuries, and accounts for about 85% of all shoulder instability procedures.[1,2] Recurrence of anterior instability occurs in as many as 80% to 92% of patients who did not receive operative care, and often is the result of bony defects to the glenoid and the humeral head.[3] Because of the prevalence of anterior instability and the potential for bone damage over time, the subject is one of great importance in orthopedic care. This article describes current concepts in anatomy and pathoanatomy relevant to the diagnosis and treatment of anterior shoulder instability.

FIGURE 1. Apprehension and relocation test. Carefully place the involved arm in a position of abduction and external rotation (A). Symptoms of anterior instability or pain or both that resolve with a posteriorly directed force by the examiner (B) is a positive finding for anterior shoulder instability.

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Learning objectives

- Identify appropriate imaging for a patient who presents with anterior shoulder dislocation.
- Describe the anatomy, pathoanatomy, and differential diagnosis when a patient presents with a glenohumeral joint dislocation.
- Evaluate and create a treatment plan for a patient who presents with anterior glenohumeral instability, providing nonoperative, operative, and rehabilitation regimes for successful return to activities.

Key points

- Immediate reduction and appropriate diagnosis and management are essential to prevent recurrence of anterior shoulder instability.
- Anterior shoulder instability has a high recurrence rate, which is an indication for operative management.
- When selecting an operative approach, consider whether the patient has significant osseous deformities.
- Patient education and postoperative rehabilitation protocols can help patients achieve a timely return to sports and reestablishment of full ROM.

ANATOMY AND PATHOPHYSIOLOGY

The area of the humeral head is much larger than that of the glenoid fossa, making it susceptible to instability. In the normal shoulder, static and dynamic stabilizers help keep the humeral head centered in the glenoid fossa, allowing movement in the glenohumeral joint through a large range of motion (ROM) while preventing significant translation of the humeral head. Static restraints include the fit of the humeral head in the labrum (the concavity compression mechanism); the glenoid labrum, which attaches in a ring around the rim of the bony glenoid and deepens the glenoid cavity; the capsuloligamentous complex including the superior, middle, and inferior glenohumeral ligaments (SGHL, MGHL, and IGHL, respectively); and the negative intra-articular pressure of the glenohumeral joint.[4] Dynamic stabilizers of the shoulder include the rotator cuff and deltoid muscles, the tendon of the long head of the biceps, and scapular and periscapular muscles (trapezius, teres major, serratus anterior, levator scapula, rhomboids).[4]

The glenohumeral ligaments play a crucial part in maintaining stability of the humeral head in the glenoid. The SGHL stabilizes the shoulder from zero to 45 degrees of abduction, the MGHL from 45 to 90 degrees of abduction, and the IGHL at 90 degrees or more of abduction and external rotation. The anterior band of the IGHL is the most important restraint to anterior instability.[5] Excessive laxity of the IGHL can cause instability when force is applied to the arm in 90 degrees of abduction and external rotation (the apprehension sign).

Bankart lesions When the integrity of the IGHL-labral complex is compromised by a traumatic event, an avulsion injury involving soft-tissue or bony injury, known as a Bankart lesion, can occur. Bankart lesions have been found in 73% to 100% of patients with anterior dislocations.[4,6-8]

Osseous lesions These include avulsion fractures of the anterior glenoid rim (called bony Bankart) and humeral head impaction fractures as a result of the posterolateral impaction of the humeral head against the anterior glenoid rim during anterior dislocation (called Hill-Sachs lesions).[9] Eighty percent of failures in surgical instability correction can be attributed to bony deformities that are unrecognized or not addressed.[10]

Humeral avulsion of the glenoid ligament (HAGL) Another cause of recurrent instability is HAGL involving the IGHL. HAGL lesions are seen in up to 9.3% of patients with anterior instability.[11] A variety of other concomitant soft-tissue injuries, including superior labrum anterior and posterior (SLAP) tears, near-circumferential labral tears, anterior labral periosteal sleeve avulsions (ALPSA), and rotator cuff tears, have been reported as well in varied frequencies.[9]

HISTORY AND PHYSICAL EXAMINATION

Obtain a thorough patient history to appreciate the direction of instability, recurrent episodes, mechanism of injury including force and direction, whether the event was a subluxation or complete dislocation, and if reduction was required.[12] The typical profile of a patient presenting with anterior shoulder instability is either a young athlete who has experienced some traumatic event, or a nonathlete who has had trauma, usually via a fall on an outstretched arm with the shoulder in an abducted and externally rotated position. The last category occurs more often in older adults who fall and sustain a rotator cuff tear that often is unrecognized at the time of their initial presentation to the ED with a dislocated shoulder.

Patients experiencing subluxation events often describe a different course of events and may report glenohumeral joint pain and the feeling of the shoulder "sliding out." Other symptoms include shoulder stiffness, sensations of popping, joint grinding or catching, and pain when reaching behind the back or above the shoulder as the humeral head slides anterior to the glenoid rim.

Perform a cervical spine examination to rule out any radicular symptoms. An upper extremity neurologic examination with a focus on the axillary nerve is important. Axillary nerve injuries have been reported in 3.3% to 40% of patients with glenohumeral dislocations and must be identified on the first visit with a healthcare professional.[13]

During visual inspection of the shoulder girdle, assess for postural abnormalities and muscle atrophy or asymmetries in the contour of the shoulder girdle. Asymmetries

are more commonly found in patients with chronic instability due to unrecognized neurologic injury or disease.[14] Note asymmetries in active and passive ROM between the symptomatic and asymptomatic shoulders. Limitations are not uncommon in acute cases or in patients with severe bone loss. Palpate the glenohumeral, acromioclavicular, and sternoclavicular joints to evaluate for any point tenderness. Perform strength testing of the deltoid, rotator cuff, and scapular muscles to assess for any associated weakness, especially in older adults with a shoulder dislocation.

Provocative physical examination maneuvers should include the anterior apprehension test, relocation test, and anterior release or surprise test.

Perform the apprehension test with the patient standing or supine. Performing the test supine is recommended to stabilize the scapula. Place the patient's arm in 90 degrees abduction, then externally rotate it (**Figure 1a**). The apprehension test is considered positive if the patient reports a feeling of apprehension or sense that the glenohumeral joint will dislocate. Pain alone is not indicative of a positive test.

The Jobe relocation test follows the apprehension test. Once the patient reports apprehension, apply a posteriorly directed force on the anterior aspect of the shoulder (**Figure 1b**). The examination is considered positive if the patient reports relief of symptoms.

Next, the examiner suddenly removes the posterior force. If the patient reports increasing pain and apprehension, the patient has a positive release surprise or augmentation test.[15]

Other tests that help confirm the diagnosis of anterior instability include the Gagey test and the load and shift test. The Gagey test assesses the integrity of the IGHL. Stabilize the scapula by placing a forearm on top of the patient's shoulder while passively abducting the patient's arm. Abduction greater than 105 degrees suggests laxity of the IGHL. The load and shift test can be performed with the patient seated or supine (**Figure 2**). Hold the arm in a slightly abducted position while placing anteriorly and posteriorly directed force on the humeral head to assess the degree of glenohumeral joint laxity. Grade 0 is minimal displacement, grade 1 is when the humeral head reaches 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.[12] This test must be conducted carefully to avoid causing pain to the patient in the acute situation.

Always evaluate patients for signs of multidirectional instability. The sulcus test and Gagey test best define inferior laxity. The sulcus test assesses the integrity of the rotator interval formed by the SGHL and the coracohumeral ligament. With the patient seated and the arm resting at the side in neutral rotation, apply downward longitudinal traction to the arm while observing for subluxation of the humeral head inferiorly. The degree of inferior translation is graded as 1+ (a 1-cm translation), 2+ (1- to 2-cm translation), and 3+ (greater than 2-cm translation) (**Figure 3**).

FIGURE 2. Load and shift test. With the patient seated, apply a gentle loading force to center the humeral head in the glenoid (A). Then apply anterior and posterior translational force to assess the degree of glenohumeral translation. The same test can be performed with the patient lying supine (B), this time holding the humerus in a more distal position with the arm over the edge of the examination table.

FIGURE 3. Sulcus sign in a young woman with inferior glenohumeral joint laxity demonstrating 3+ laxity (greater than 2-cm inferior translation)

The test is repeated in external rotation. If the amount of inferior translation persists, it suggests compromise of the rotator interval.

DIAGNOSTICS

Plain radiographs are standard for initial evaluation and should include true anteroposterior (AP), scapular-Y, and axillary views to evaluate occurrence of concomitant pathologies. The true AP view appreciates any humeral head fracture or dislocation (**Figure 4**). The scapular-Y helps evaluate the direction of the dislocation; the Grashey view evaluates the glenohumeral joint space and the direction of dislocation (**Figure 5**). The axillary view allows for visualization of any glenoid bone erosion, humeral head defects, and the positioning of the humeral head in relation to the glenoid (**Figure 6**). Fractures or avulsion of the glenoid rim also can be appreciated easily in this view.

Special views can help identify osseous injuries. The Stryker Notch view is obtained in supine position with the arm abducted, the palm on top of the head, and the elbow positioned in front the patient's face (**Figure 7**).[16]

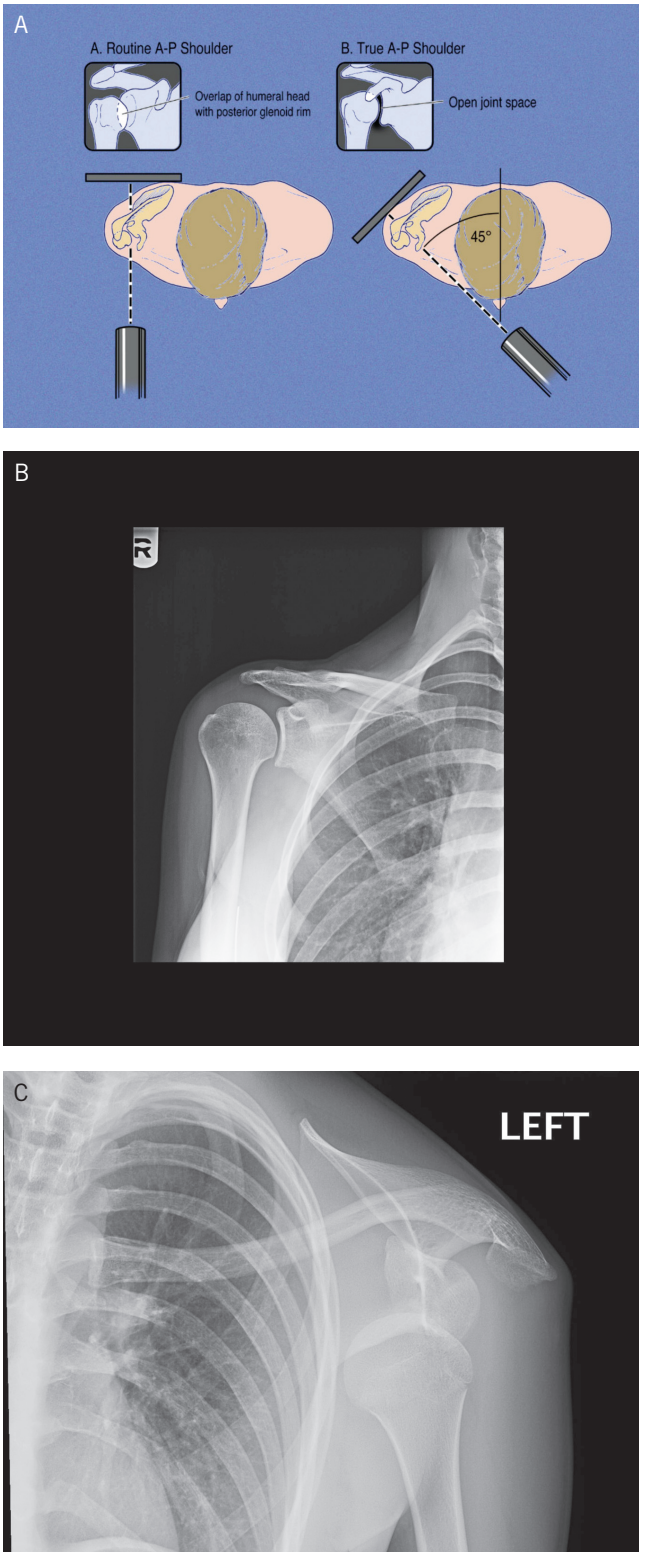

FIGURE 4. AP plain radiograph. Drawings of radiograph position and patient position for a routine AP view versus a true AP view (A). Radiograph of a true AP view in a right shoulder (B). Note the opening of the glenohumeral joint. AP plain radiograph of a dislocated left shoulder in a skeletally immature person (C).
Illustration by Kevin Plancher, MD

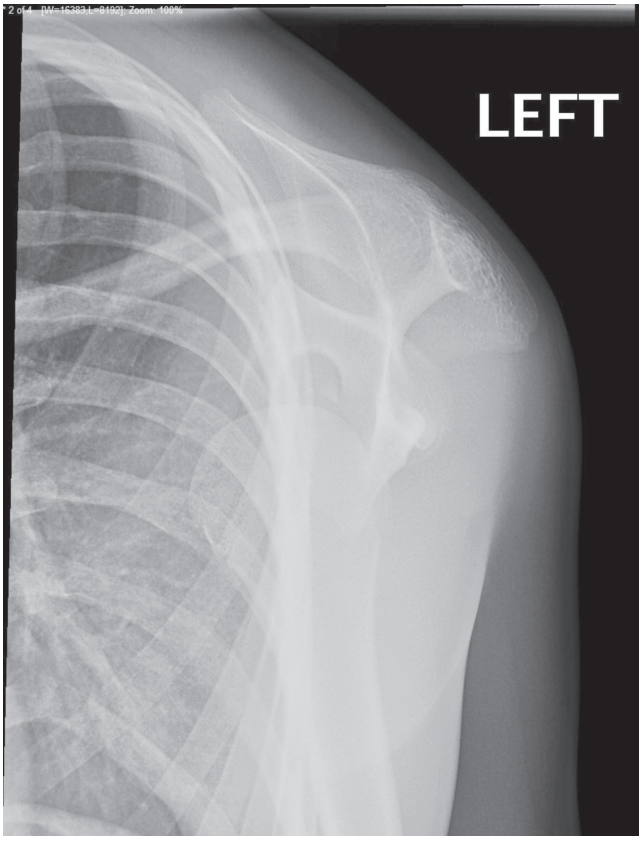

FIGURE 5. Scapular-Y view plain radiograph of an anterior-inferior dislocated left shoulder

Hill-Sachs lesions are best visualized on this view or with an AP internally rotated view. West Point radiographs taken with the arm abducted 90 degrees can visualize the anterior glenoid and bony Bankart lesions.[16] The Bernageau view can measure glenoid bone loss and has been shown to have similar results when compared with a three-dimensional CT (**Figure 8**).[16] This view is obtained with the patient standing with the arm flexed to 160 degrees, the chest in contact with the radiographic cassette at a 70-degree angle, and the radiography tube at a 30-degree craniocaudal angle and centered on the spine of the scapula.[17]

Advanced imaging aids in identifying and quantifying osseous defects and soft-tissue pathologies of the labrum, ligaments, joint capsule, and rotator cuff.

MRI is the preferred method of evaluation and is considered the gold standard for evaluating soft-tissue injuries when bony abnormalities are not visualized on plain radiographs (**Figure 9**). Tears of the rotator cuff (the dynamic glenohumeral joint stabilizer) have been found in 81% to 100% of patients older than age 40 years requiring surgical intervention for glenohumeral instability; therefore, referral for an MRI is important in these patients to ensure complete diagnosis and proper treatment planning.[18] Positioning the limb in abduction and external rotation (ABER sequence) may enhance visualization of the anteroinferior labral complex, but may not be well tolerated by patients with an acute dislocation causing motion artifacts.[19]

Magnetic resonance arthrography (MRA) involves injecting contrast material such as gadolinium into the joint under ultrasound or fluoroscopic guidance to delineate the glenohumeral ligaments. MRA is superior to conventional MRI in identifying Bankart and SLAP lesions, although MRI is superior in identifying anterior labral lesions.[20,21] However, in patients with acute dislocation and in the ED, MRI is preferred because joint effusion or hemarthrosis mimics the contrast medium used in MRA, reducing its accuracy.[22] Traditionally, MRA has been reserved for younger athletes to appreciate injuries of the anterior and superior labrum that may alter treatment. However, when advanced imaging is required, referral to a trained radiologist for evaluation is essential, because imaging protocols and sequences can vary and alter the sensitivity and specificity of these imaging modalities.

A Bankart lesion may be visualized on the axial images with contrast material seen between the anteroinferior labrum and glenoid rim. A nondisplaced labral tear with intact scapular periosteum is called a Perthes lesion. In an ALPSA lesion, the labrum appears as a hypointense structure that is medially displaced with an intact anterior scapular periosteal sleeve.[16]

CT is the preferred imaging modality to evaluate the location and severity of humeral head and glenoid bone loss when there is a high suspicion of bone loss due to recurrent subluxation or dislocation.[23] CT also can rule out suspected fractures not visible on plain radiographs. Three-dimensional CT is superior to conventional CT and MRI in measuring glenoid bone loss with ease and accuracy through software programs and mathematical models to estimate the percentage of glenoid bone loss (**Figure 10**).[23] After digitally subtracting the humeral heads, three-dimensional images with high resolution provide better *en face* visualization of the glenoid for bone loss estimation.[16]

Several methods have been described for measuring glenoid bone loss, though the best-fit circle method is most commonly used.[24] An assumed circle is drawn to cover the inferior glenoid margin. The size of the bone defect (the line between the anterior margin of the circle and the anterior margin of the injured glenoid) is then divided by the glenoid width (the diameter of the drawn circle) to provide an estimate of the percentage of glenoid bone loss.

In summary, plain radiographs should always be performed before reduction of the anteriorly dislocated shoulder to determine the direction and degree of dislocation. They should be repeated post reduction to confirm the reduction and evaluate for any fractures or osseous deformities. MRI is recommended in the acute period to identify

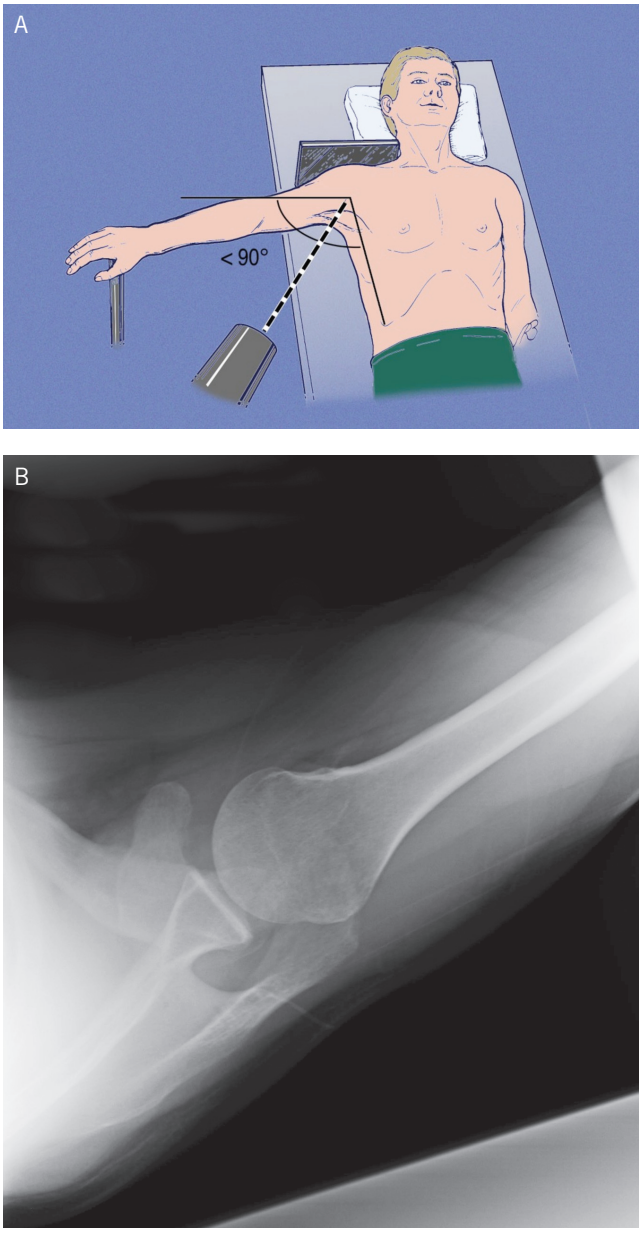

FIGURE 6. Axillary plain radiograph. Artwork demonstrating patient position for an axillary view (A). Plain axillary view radiograph demonstrating a normal glenohumeral joint relationship (B). Illustration by Kevin Plancher, MD

soft-tissue pathology because the joint effusion provides the same distension effect as arthrography.[20,21] MRI also is recommended in patients older than age 40 years to assess for concomitant rotator cuff pathology.[22] MRA may be preferred in the postacute phase and particularly in younger athletes to improve diagnostic accuracy of subtle labroligamentous pathologies that might alter treatment decisions. If there is a high suspicion of osseous deformity, particularly in a patient with recurrent instability, CT can be used to identify and quantify osseous lesions and guide preoperative decisions.

ASSESSMENT AND DIFFERENTIAL DIAGNOSIS

Generalized ligamentous laxity also can be associated with anterior instability. Patients with anterior shoulder instability should be evaluated to determine if they have a component of multidirectional instability.[15] The Beighton score is used to diagnose and quantify generalized ligamentous laxity and ensure correct treatment. This scoring system consists of five components:

- passive dorsiflexion of the little finger beyond 90 degrees
- passive apposition of the thumb to the ipsilateral forearm
- active hyperextension of the elbow beyond 10 degrees
- active hyperextension of the knee beyond 10 degrees
- forward flexion of the trunk with knees fully extended and able to rest the palms flat on the floor. A score of 4 or more out of the maximum score of 9 confirms generalized ligamentous laxity.[3] Patients with hyperlaxity have unacceptably high rates of failure of soft-tissue repair procedures alone; an inferior capsular shift procedure addresses the capsular redundancy by shifting the superior band of the IGHL to tighten the joint capsule and prevent recurrence. The inferior capsular shift has been shown to lead to successful results in patients with multidirectional instability.[11,17] Patients with multidirectional instability also may have a component of posterior instability. The posterior load and shift, jerk, and Kim tests can aid in identifying posterior shoulder instability.

TREATMENT

The optimal management of anterior shoulder dislocation is dictated by patient-specific factors including age; sporting activity level; and pathoanatomic features including soft-tissue pathology, glenoid and humeral bone loss, capsular laxity, and associated concomitant lesions such as rotator cuff tear (**Figure 11**). Always discuss nonoperative and surgical strategies with any patient who has anterior shoulder instability.

Nonsurgical management Immediate reduction is essential whether the shoulder dislocation is acute or recurrent. A delay of more than 24 hours makes closed reduction more difficult and increases the risk of recurrent instability.[25] Closed reduction may be performed with sedation in the ED or, if necessary, under anesthesia. Numerous techniques have been described in the literature. A 2017 systematic review of 13 studies demonstrated scapular manipulation to be superior and the least painful reduction maneuver.[26] This technique is performed with the patient in a prone position with the forearm hanging from the edge of the table and elbow flexed to 90 degrees (Figure 12). Initially, a gentle downward traction is applied to the forearm. After about 30 seconds, while the assistant maintains traction on the forearm, the clinician uses one hand to stabilize the superior portion of the scapula and the other hand to push the inferior tip of the scapula medially. A pop or relief of symptoms indicates a successful reduction. Reduction must always be verified with plain radiographs.

Shoulders that cannot be successfully reduced by closed means must be treated surgically with open reduction in the OR. Reasons for irreducibility by closed reduction include fractures of the glenoid rim and nondisplaced greater tuberosity fractures (which often are age-associated injuries), interposition of the subscapularis and long head of biceps tendon, and incarceration of the humeral head in the glenoid track.

Immobilize the patient's shoulder in a sling after successful closed reduction. The duration and position of immobilization is controversial. A systematic review found no difference in the rates of recurrence when the shoulder was immobilized in internal rotation for less than a week compared with immobilization for more than 3 weeks.[27] Although a systematic review of several studies found immobilization in external rotation to be superior in reducing recurrence, a recent literature review found no difference between immobilization in external and internal rotation.[28,29] We recommend using a sling for comfort and to protect the shoulder for 1 to 3 weeks during the immediate postdislocation period.

Physical therapy After discontinuing sling use, patients should begin physical therapy with a focus on restoring pain-free ROM and enhanced function of the dynamic glenohumeral joint stabilizers. Rotator cuff and periscapular progressive, resistance strengthening exercises, and neuromuscular and proprioceptive exercises promote coactivation of the muscles and help keep the humeral head centered in the glenoid. Concentric and eccentric strengthening exercises should be incorporated and progressed to include activities in provocative functional positions for enhancing joint position sense and functional stability.

A recent randomized controlled trial of 56 participants with primary or recurrent anterior shoulder dislocation compared home exercises with a physical therapist-supervised neuromuscular training program.[30] The supervised neuromuscular training program led to higher Western Ontario Shoulder Instability Index scores compared with the home exercise program and resulted in fewer referrals for stabilization surgery.

Evidence to support nonoperative management as the mainstay treatment in young patients is limited. Recurrence rates after successful closed reduction are alarmingly high and have been shown to be age-dependent, ranging from 40% to 92% in the literature.[29] A 25-year longitudinal study of patients with anterior shoulder dislocation treated nonsurgically reported recurrence rates of 72% in patients ages 12 to 22 years, 56% in those ages 23 to 29 years, and 27% in patients older than age 30 years.[31] We believe in using caution when proceeding with nonoperative treatment in young, active patients.

Surgical management The most common indications for surgical management of anterior shoulder instability are failed closed reduction, recurrent instability episodes, young patients (under age 25 to 30 years), contact athletes,

FIGURE 7. A modified Stryker Notch plain radiograph view of a left shoulder with a small bony defect

glenoid bone loss greater than 20% to 25%, and engaging Hill-Sachs lesions.[32] Systematic reviews and meta-analyses have found arthroscopic primary Bankart repair to be superior to conservative management with lower recurrence and failure rates, particularly in active patients under age 25 years.[33] A systematic review of 558 patients (mean age 21.3 years) found that for patients who had arthroscopic primary repair for a first-time dislocation, the pooled failure rate was 13.7% (7.7% to 19.6%) and the revision rate was 7.1% (3.8% to 10.4%).[34]

The most common surgical procedures for patients with first-time dislocations are the Bankart repair (arthroscopic or open) and the Latarjet procedure. The Bankart and Latarjet procedures are indicated when a Bankart lesion is evident on MRI and the patient has no to minimal bone loss (less than 25%).[32] The Bankart procedure repairs the torn labrum back to the glenoid rim using sutures or suture anchors. The arthroscopic technique is the preferred method, with improved cosmesis, decreased surgical site morbidity, an ability to treat concomitant intra-articular pathology, and minimal loss of external rotation.[35] A 2019 systematic review of 89 studies revealed the results of the arthroscopic Bankart repair with a minimum 10-year follow-up.[33] Average patient age was 28 years with a mean follow-up of 149.4 months. Thirty-one percent experienced recurrent instability and 16% had recurrent dislocations. The overall revision rate was 17%.[35] A 2020 meta-analy-

FIGURE 8. Bernageau view plain radiograph of a right shoulder

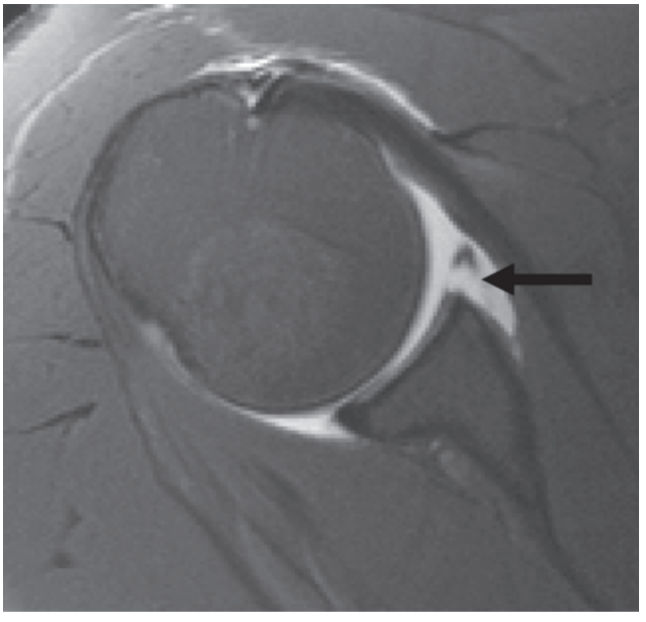

FIGURE 9. T1-weighted MRI in a patient with anterior glenohumeral instability and a glenoid defect

sis of 10 studies included 299 patients after arthroscopic Bankart repair and reported that 9.7% of patients experienced recurrence of instability.[36]

Open Bankart repair may be superior and reduces recurrence rates in high-risk patients (contact athletes, wrestlers, patients with ligamentous laxity, and military personnel).[37] The open Bankart repair involves splitting the subscapularis to repair the labrum and Bankart lesion. Postoperative loss of external rotation has been reported to be up to 8 degrees with the arm positioned in 90 degrees of abduction after an open Bankart repair.[38] A 20-year follow-up study after open Bankart repair found a 12% redislocation rate, with 82% of patients returning to their previous level of sports.[38] Overall, studies support good outcomes with both open and arthroscopic Bankart repair, with multiple studies demonstrating no difference in recurrence rates.[37] However, a 2005 meta-analysis of 11 clinical studies revealed that open repairs have more favorable recurrence rates and return to sporting activities.[39]

The Latarjet procedure has been used since 1954 and augments the glenoid with bone to restore shoulder stability.[40] This procedure is used by 72% of physicians in Europe to treat first-time shoulder dislocation.[41] In some systematic reviews and meta-analyses, better clinical outcomes were reported with the Latarjet procedure compared with the Bankart repair.[41,42] Bliven and colleagues reported fewer recurrences, better patient-reported outcomes, and less restricted external rotation ROM with the Latarjet procedure compared with open and arthroscopic Bankart repairs.[41] Unfortunately, the open Latarjet procedure is not without significant complications, including glenohumeral osteoarthritis. Rollick and colleagues reported a 10.6% complication rate with the Latarjet procedure compared with 4.3% with open Bankart repair.[42] Other Latarjet complications include superficial infection, superficial vein thrombosis, musculocutaneous neuropraxia, graft nonunion, and intra-articular hardware, all attributed to the technically demanding nature of the procedure with a large learning curve.[40,42]

Managing bone loss Burkhart and De Beer reported a 67% failure rate after arthroscopic Bankart repair in patients with more than 20% anteroinferior glenoid bone loss and an engaging Hill-Sachs lesion, compared with 4% in patients without these pathologies.[10] Bony augmentation procedures now are recommended routinely when glenoid bone loss is greater than 20% to 25% or in patients with an engaging Hill-Sachs lesion.[43] Options include the Latarjet procedure with a coracoid transfer, iliac crest autograft, and distal clavicle autograft or with an allograft bone. In a standard, open Latarjet procedure, the coracoid process is osteotomized, transferred to the anterior glenoid, and fixed with screws.[3] The Latarjet also can be reliably performed arthroscopically by highly skilled surgeons. The Latarjet is indicated when the patient has MRI evidence of a soft-tissue Bankart lesion and an isolated glenoid defect greater than 25%.[32] A systematic review of 45 studies analyzing outcomes of the Latarjet procedure (9.3% were performed arthroscopically) with a 6.8-year average follow-up demonstrated low recurrence of instability (2.9%

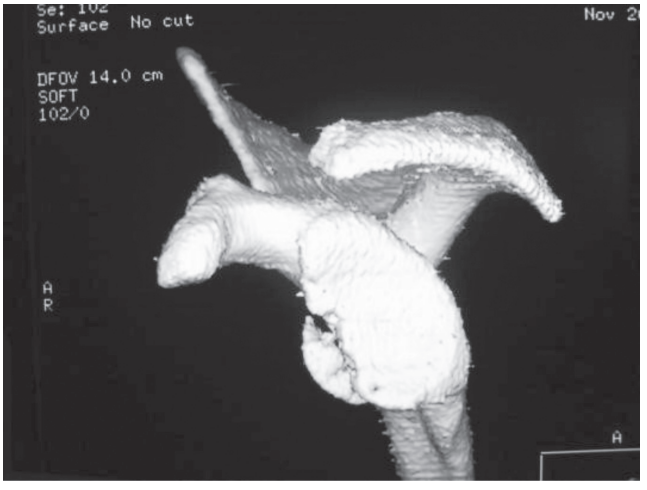

FIGURE 10. Three-dimensional CT scan demonstrating glenoid bone loss in a patient with anterior glenohumeral instability

dislocation and 5.8% subluxation).[44] Most recurrences occurred within the first year. The overall complication rate was 30%, with the most common being coracoid fracture, nonunion, and graft lysis.[44] The arthroscopic bony Bankart repair also can accomplish stability if the bone is stabilized with sutures or screws.[44]

Patients who present with an isolated humeral defect greater than 30% often require an augmentation procedure such as the remplissage. The remplissage involves suturing the infraspinatus into the posterolateral humeral head defect, and has been reported to yield superior results compared with a Bankart repair alone in this subset of patients.[45]

Glenoid track The concept of the glenoid track was introduced by Yamamoto and colleagues in 2007.[46] They noted that a portion of the humeral head is in contact with the glenoid in varying degrees of abduction, external rotation, and horizontal extension. This area of contact, the glenoid track, occupies 84% of the width of the glenoid.

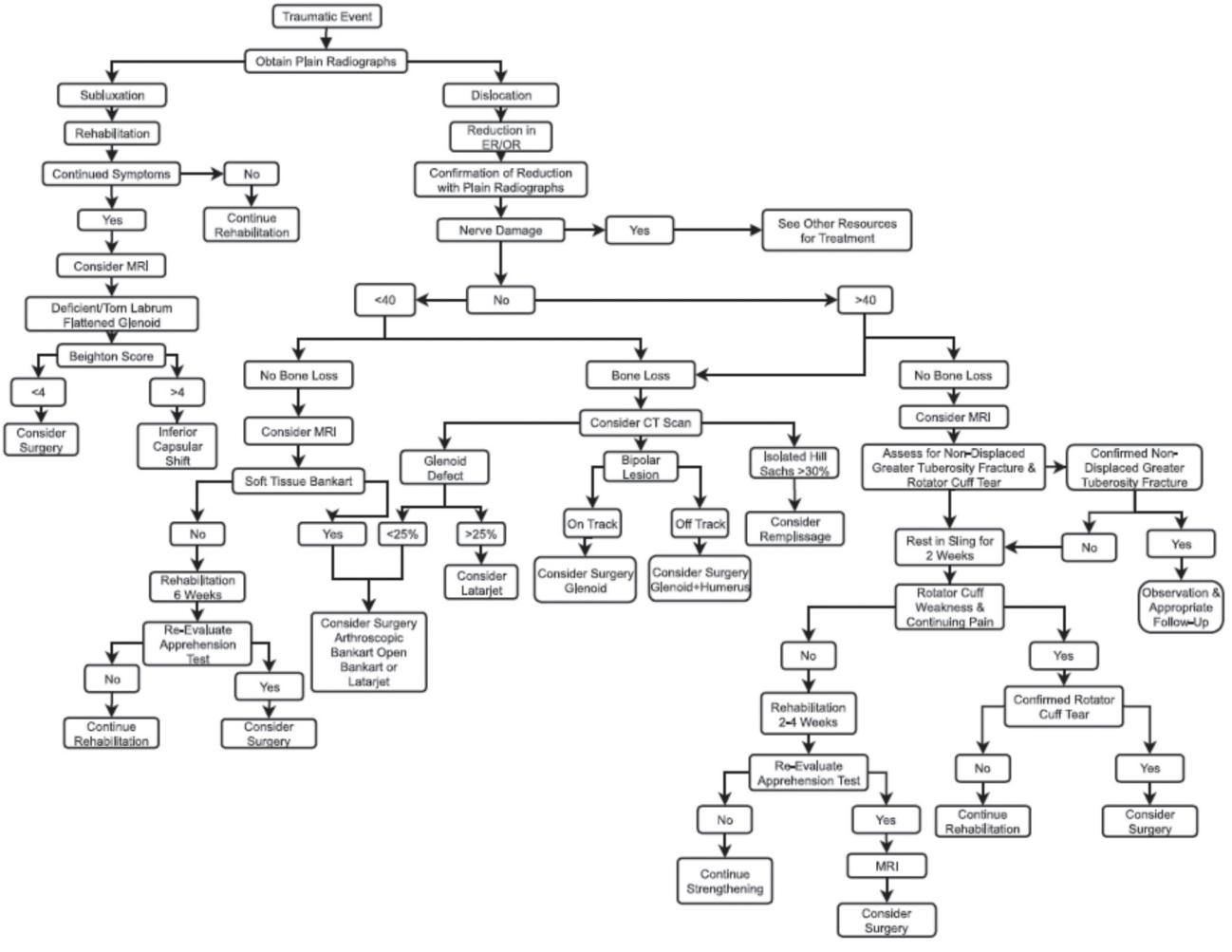

FIGURE 11. Treatment algorithm for anterior shoulder instability

FIGURE 12. Scapular manipulation technique for reduction of shoulder dislocation. Position the patient prone with the forearm hanging from the edge of the table and elbow flexed to 90 degrees. Place the stabilizing hand on the superior portion of the scapula. With the other hand, push the inferior tip of the scapula medially while maintaining a gentle downward traction force to the forearm. A pop or relief of symptoms indicates a successful reduction. Verify reduction with plain radiographs.

A Hill-Sachs lesion that is small and stays confined in the glenoid track is called an *on-track* lesion. These lesions infrequently engage with the glenoid and have a low risk of creating added instability. In contrast, *off-track* lesions, in which the Hill-Sachs lesion is large and the medial margin of the defect is outside the track, pose a greater risk of engagement with the glenoid to create recurrent instability.[47,48] The Hill-Sachs index (HSI) is the distance between the medial margin of the defect and the medial border of rotator cuff insertion. In an off-track lesion, the HSI is greater than glenoid track; in on-track lesions, the HSI is small. Shaha and colleagues evaluated 57 patients with anterior shoulder instability treated with arthroscopic Bankart repair, with an average follow-up of 4 years.[47] Patients were classified as either on-track or off-track based on preoperative MRI. Eight percent of patients with an on-track lesion had recurrent instability compared with 75% of those with an off-track lesion.[47] Similarly, Locher and colleagues found higher rates of revision surgery in off-track versus on-track lesions (33% versus 6%, respectively).[48]

Treatment of bipolar lesions, defined as glenoid bone loss and humeral bone loss, often is dictated by the size of the glenoid defect. On-track lesions with a glenoid defect less than 25% should be treated with a soft-tissue open or arthroscopic Bankart repair.[46] When the glenoid defect is greater than 25% with an on-track lesion, a Latarjet procedure is indicated to fill in the glenoid bony defect.[49] Remplissage may be sufficient to restore joint stability in a patient with an off-track lesion and less than 25% glenoid bone loss; a Latarjet procedure can be considered in the high-risk athlete to convert an off-track lesion to an on-track lesion.[44] For patients with an off-track lesion and glenoid bone loss greater than 25%, the humeral and glenoid defects must be addressed with remplissage and a Latarjet procedure, respectively.[44]

REHABILITATION

After shoulder surgery, rehabilitation aims to protect the surgical repair and progressively establish the patient's return to full ROM. After a Bankart or Latarjet procedure, the patient's shoulder is immobilized in a sling. Passive ROM exercises in the supine position are started 1 to 2 weeks postoperatively. Active assisted external rotation is initiated but carefully monitored for the first 4 weeks. External rotation is increased but limited to half the ROM of the contralateral shoulder for 12 weeks. Muscle strengthening is initiated once the patient has recovered full, painless, active forward flexion. Timing for strengthening usually begins no earlier than 8 weeks but can be held back until 12 weeks. Return to noncontact sports is permitted at 3 to 4 months and contact sports return no earlier than 6 months postoperatively.[45]

COMPLICATIONS AND PREVENTION

To reduce the risk of recurrent instability, educate patients about risk factors: age under 30 years, male sex, glenoid bone loss greater than 25%, Hill-Sachs lesions, presence of an ALPSA lesion, generalized ligamentous laxity, contact sports, positive apprehension test after failure of a rehabilitation program, and a Hill-Sachs lesion size greater than five-eighths of humeral head radius.[3]

Complications of arthroscopic Bankart repair include osteolysis, chondrolysis, synovitis, foreign body reactions, cystic resorption, arthropathy, persistent pain, and loss of ROM. Although infection rates are low (arthroscopic Bankart repair, 0.33%; open Bankart repair, 0.22%) as reported by the American Board of Orthopedic Surgery certification examination, clinicians must be able to recognize the signs of postoperative infection.[50] Suspect infection if the patient reports pain, redness, or discharge at the surgical site; if the wound dehisces; or the patient develops a fever. Diagnostic blood tests should assess for high white blood cell count (normal is less than 4,500 cells/mm^3) and high erythrocyte sedimentation rate (normal range is 0 to 20 mm/h). Joint aspiration and fluid analysis (for color and consistency) can

help identify the infecting organism. The most common pathogens causing shoulder infections are *Staphylococcus aureus* and *Propionibacterium acnes*, which may require joint lavage and treatment with appropriate antibiotics.[51]

The rate of nerve injury with the Bankart procedure ranges from 0.3% in the arthroscopic procedure to 2.2% in an open Bankart repair.[51] The axillary nerve is most commonly injured due to its close proximity to the inferior capsule and glenoid rim. Axillary nerve damage is best indicated by deltoid paresis at 1-week postoperative and often is accompanied by neuropathic pain.[13] Most axillary nerve injuries and neurapraxia are transient and progress to full recovery; however, in some patients, surgery with a suitable donor graft may be necessary if neurotmesis or axonotmesis has occurred.[13]

CONCLUSION

Anterior shoulder instability is a common shoulder injury, particularly among young athletes. Appropriate diagnosis and management are essential to prevent recurrence of instability and associated injuries. The goal of operative management is to restore labral anatomy and shoulder stability. When indicated, significant osseous deformities should be addressed to prevent recurrence. Surgical repair can lead to successful outcomes with the patient returning to sports. Patient education and strict adherence to a postoperative rehabilitation protocol are important for soft-tissue healing and to restore shoulder ROM, strength, and function so that the patient can return to all activities of daily living and recreational sporting activities, including throwing and contact sports. **JAAPA**

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