Current Concepts in the Diagnosis and Management of Traumatic, Anterior Glenohumeral Subluxations

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Traumatic anterior glenohumeral subluxations comprise the majority of glenohumeral instability events and are endemic in young athletes. Unlike the definitive complete dislocation event, subluxation events may often be more subtle in presentation and, therefore, may be overlooked by clinicians. Glenohumeral subluxation events are associated with a high rate of labral tears as well as humeral head defects. While less is known of the natural history of these injuries, young athletes are at risk for recurrent instability events if not properly diagnosed and treated. While reports of surgical treatment outcomes isolated to subluxation events are limited, arthroscopic and open Bankart repair have been shown to result in excellent outcomes. The purpose of this paper is to review the etiology and pathoanatomy of traumatic anterior glenohumeral subluxations as well as to review the appropriate evaluation and management of patients with this injury.

Keywords: subluxation; glenohumeral subluxation; shoulder instability; instability

The glenohumeral joint has the greatest range of motion of any joint in the body, leaving it susceptible to instability, particularly during extremes in ranges of motion, such as those encountered among contact athletes. Glenohumeral instability comprises a spectrum of injuries that range from atraumatic subluxations to traumatic dislocations. Although glenohumeral subluxation accounts for the majority of shoulder instability events, studies that have investigated shoulder instability have focused primarily on glenohumeral dislocations. Glenohumeral subluxation events are more difficult to investigate because of the challenge of precisely defining and diagnosing these events.

In 1980, Protzman clearly delineated glenohumeral subluxation as a unique type of shoulder instability that is present in shoulders that have not previously sustained a glenohumeral dislocation event. In 1983, Warren reported on a series of patients with chronic recurrent glenohumeral subluxations who underwent a stabilization procedure. Radiographic evaluation of these patients revealed that 37% of patients had a Hill-Sachs lesion and 50% had a Bankart lesion. In 1983, Mizuno and Hirohata also reported on a series of 55 patients with chronic recurrent anterior glenohumeral subluxations. They reported that radiographs demonstrated a Bankart lesion in 45 of these patients. In 1992, Burkhead and Rockwood reported on a series of patients with traumatic glenohumeral subluxation, and 55% of these patients had radiographic evidence of an osseous Bankart lesion. In 2007, Owens et al. demonstrated that 85% of traumatic glenohumeral instability events are glenohumeral subluxations rather than dislocations. These were diagnosed by a history of a traumatic shoulder event combined with physical examination findings of a positive anterior apprehension sign and a symptomatic load shift. Despite long-term knowledge of glenohumeral subluxations and the subsequent studies that demonstrated a high rate of associated glenohumeral pathology, research focused specifically on the diagnosis and management of traumatic glenohumeral subluxation as a distinct entity has been lacking. The goal of this article is to provide a focused review of traumatic anterior glenohumeral subluxation events to help clinicians treating patients with this injury.

DEFINITIONS

When initiating a discussion of shoulder instability, it is essential to begin with a clear understanding of definitions.
Glenohumeral instability involves varying degrees of translation of the humeral head beyond its physiologic limits that is associated with symptoms of pain and/or subjective anxiety.27 A glenohumeral dislocation is defined as the complete disassociation of the humeral head from the glenoid, and diagnosis of a glenohumeral dislocation requires the need for a manual closed reduction maneuver or radiographic evidence demonstrating the complete disassociation of the humeral head from the glenoid.27 A glenohumeral subluxation has been defined as translation at the glenohumeral joint beyond physiologic limits with some glenohumeral contact maintained.26,27 By definition, glenohumeral subluxation does not require a manual closed reduction maneuver, and the glenohumeral relationship is maintained on radiographic imaging.27 Owens et al27 further subclassified glenohumeral subluxation as transient luxation or benign subluxation based on the presence or absence of glenohumeral pathology such Bankart or Hill-Sachs lesions, respectively. While glenohumeral subluxations may represent dislocation events that spontaneously reduce, the patient with subluxations will not report a history of dislocation.

EPIDEMIOLOGY

Traumatic anterior glenohumeral subluxation most commonly is the result of contact sports such as American football,26 rugby,32 rodeo,3 wrestling,6 judo,6 lacrosse,6 gymnastics,26 and boxing.26 An examination of the incidence of glenohumeral instability in the United States Military Academy revealed that 85% of the 117 instability events that occurred over a 1-year period were subluxation events.26 A review of the National Collegiate Athletic Association (NCAA) Injury Surveillance System revealed that the incidence of collegiate glenohumeral instability events is 0.12 injuries per 1000 athletic exposures.24 The limitation of the NCAA database is that it combines glenohumeral dislocation and subluxation events into 1 category.

ANATOMY

The anatomy of the glenohumeral joint allows it to have the greatest range of motion of the joints in the human body.19,26 The maximal area of humeral head cartilage that articulates with the glenoid is 30% due to the mismatch in the humeral head radius of curvature relative to the glenoid. Although the osseous glenohumeral articulation is limited, preserving this osseous anatomy is critical to stability.19 The stability depends on the glenoid labrum as well as on the static and dynamic stabilizers of the surrounding shoulder girdle musculature.

The static stabilizers of the glenohumeral joint include the glenoid labrum, glenohumeral ligaments, joint capsule, and the limited interaction between the glenoid and humeral head.19 The glenoid labrum is a ring of tissue attached to the periphery of the glenoid that increases the stability of the glenohumeral joint by deepening the glenoid concavity by 50% and allowing for a suction phenomenon to occur at the glenohumeral articulation.19 The glenohumeral ligaments are lax through mid-ranges of motion and primarily serve to limit motion at the extremes of motion. Each ligament provides stability in a unique combination of shoulder positions.

The dynamic stabilizers of the glenohumeral joint include the rotator cuff and scapulothoracic muscles.19 The rotator cuff muscles centralize the humeral head on the glenoid and limit shear stresses of the glenohumeral joint by compressing the humeral head against the glenoid.19 Additionally, the rotator cuff muscles act in association with the static glenohumeral ligaments to appropriately tension these ligaments during motion. The scapulothoracic muscles maintain optimal orientation of the scapula. The dynamic stabilizers contribute to glenohumeral stability through passive muscle tension, interaction with the passive ligament stabilizers, and persistent redirection of the humeral head, allowing for continual centralization within the glenoid.

PATHOANATOMY

The mechanism of injury is usually hyperabduction and external rotation, with the generation of a force directed from posterior to anterior that displaces the humeral head out of the glenoid. In a young athlete, this event typically results in avulsion of the anterior inferior aspect of the glenoid labrum and capsular attachments at the glenoid rim, termed a Bankart lesion (Figure 1).35 A Hill-Sachs lesion can also be observed due to impaction of the anterior glenoid rim against the posterior humerus.35

In 2010, Owens et al27 obtained advanced imaging within 2 weeks on 27 patients with first-time traumatic anterior

Figure 1. Arthroscopic image of a Bankart lesion in the right shoulder of a patient who sustained a traumatic, anterior subluxation event. This was visualized using a 30° arthroscope through the posterior portal in the beach-chair position.
glenohumeral subluxation events to investigate the pathoanatomy associated with this diagnosis. Examination of patients with a first-time traumatic anterior subluxation revealed that 96% of these patients sustained a Bankart lesion and 92.5% sustained a Hill-Sachs lesion. This is comparable to the incidence of these lesions that occurs in complete glenohumeral dislocations.

**DIAGNOSIS**

**Clinical Presentation**

Glenohumeral instability resulting from traumatic anterior glenohumeral subluxation is one of the most common causes of shoulder pain in young athletes. Unlike glenohumeral dislocation, which requires a manual reduction, the diagnosis of traumatic anterior glenohumeral subluxation is often more elusive and cannot be objectively documented and quantified with similar accuracy.

Accurate history and physical examination is essential in the diagnosis of a traumatic anterior glenohumeral subluxation. An anterior glenohumeral subluxation event is considered to be traumatic if it is associated with a definitive athletic action such as a collision involving another player or object that results in temporary cessation of participation in play. Details regarding the traumatic event must be obtained, including arm position and direction of subluxation. Additionally, it is important to understand the sport the patient plays as well as the factors that aggravate and alleviate the pain and instability that persists after the initial event. Patients may present with a history of their shoulder “slipping out” but may also only be able to report pain associated with making a tackle, for example. Therefore, a high index of suspicion for shoulder instability is needed when treating young athletes.

After obtaining a thorough clinical history, physical examination, including assessment of motion, strength, and stability, should be performed to identify objective signs of instability. Patients with traumatic anterior glenohumeral instability often have anterior apprehension that is resolved with a relocation maneuver and pain with anterior translation on load-shift testing. This test involves abducting and externally rotating the affected extremity and is positive if the patient feels a sensation of instability in this position.

The Jobe relocation test is positive when a posteriorly directed force applied to the extended arm held at the patient’s side. This sign is often positive in patients with inferior or multidirectional laxity.

**Imaging**

Plain radiographs should include an anteroposterior view in neutral rotation and a West Point axillary view. Magnetic resonance imaging (MRI) without contrast performed with an MRI scanner that has at least a 1.5-tesla magnet should be obtained in acute injuries to evaluate the soft tissue glenohumeral stabilizers (Figure 2).

MR arthrograms have been demonstrated to have a greater sensitivity for detecting labral tears compared with MRI without contrast and are especially helpful in chronic situations. Computed tomography could be obtained to evaluate bone loss in patients with either large osseous Bankart lesions or in patients with chronic instability or history of prior surgery.

In an evaluation of 27 military cadets who sustained a first-time traumatic anterior glenohumeral subluxation, Owens et al demonstrated that plain radiographs revealed 3 osseous Bankart lesions and 2 Hill-Sachs lesions. MRI revealed 6 osseous Bankart lesions, 26 soft tissue Bankart lesions (96%), and a Hill-Sachs lesion in 25 (92.6%) cadets enrolled. Additionally, MRI revealed 2 capsular stretch injuries in addition to the Bankart and Hill-Sachs lesions. This study demonstrated that traumatic anterior glenohumeral subluxations are associated with an incidence of Bankart and Hill-Sachs lesions that is comparable to the incidence of these lesions found in glenohumeral dislocations. Other prior series have also identified the presence of Bankart lesions in 40% to 100% of patients with a history of anterior subluxation. These pathologic lesions are responsible for persistent shoulder pain and recurrent instability, which has been shown to range from 39% to 94%.
CLASSIFICATION

Multiple classification systems have been published describing shoulder instability.7 These classification systems take into account the etiology, direction, and type of instability.37 The type of instability ranges from subluxation to dislocation. The etiology is traumatic, traumatic, congenital, neuromuscular (eg, cerebral palsy), or seizure related.

The Rockwood classification divides shoulder instability into 3 types based on the history of subluxation or dislocation and based on the volition associated with the instability event.31 The Thomas and Matsen classification, which is currently the most commonly utilized classification, divides shoulder instability events into the traumatic, unidirectional, Bankart lesion, and surgery (TUBS) and the atraumatic, multidirectional, bilateral, rehabilitation, and capsular shift (AMBRI) categories.36 Most recently, the frequency, etiology, direction, and severity (FEDS) classification was designed to be a classification system that has content validity, is highly reliable and reproducible, and is less dependent on examiner opinion than other classifications.15,16 Other classifications that are less commonly utilized to describe instability include the Kessel and Bayley, Schneeberger and Gerber, and Stanmore classifications.13,33

NATURAL HISTORY

While the natural history of glenohumeral dislocations has been studied, less is known of the natural history of glenohumeral subluxation events. However, much can be gleaned from the dislocation literature, with recurrent instability occurring in 92% of young athletes.38 While not designed as a natural history study, in a cohort of 27 patients who sustained a first-time traumatic anterior shoulder subluxation, 14 underwent stabilization surgery.27 Of the 13 patients who chose nonoperative management, 4 had recurrent instability.

There have been 2 studies of in-season athletes that have included subluxation patients and helped inform our decision making when treating young athletes. Buss et al5 evaluated nonoperative management for 30 in-season athletes with anterior shoulder instability; 11 of these were shoulder subluxations. The protocol included no immobilization. Range of motion exercises and strengthening of the rotator cuff and periscapular muscles using weights less than 1 pound was begun immediately after injury. Athletes returned to sport when they had symmetric strength bilaterally and a functional range of motion that allowed them to play their sport. If the sport allowed, nonoverhead athletes returned wearing a Duke Wyre brace while overhead athletes wore a Sully brace. Of the 30 enrolled athletes, 27 (90%) were able to return to sport for either part or all of their season. On average, 1.4 recurrent instability episodes occurred per athlete per season. Of the 27 patients who returned to complete the season, 12 patients (46%) underwent surgical stabilization after the end of their season; 9 of these patients initially had a dislocation and 3 had a subluxation. Overall, 16 (55%) underwent surgical stabilization.

Dickens et al prospectively evaluated 45 intercollegiate athletes with anterior shoulder instability; 17 of these were subluxations.6 All patients immediately began an accelerated rehabilitation program. Phase 1 of the program focused on regaining range of motion through repetition and low-weight rotator cuff strengthening. The second phase included periscapular strengthening and resistance exercises. The patient was cleared to return to sport if they were asymptomatic and had no functional limitations; 33 (73%) athletes returned to sport for either all or part of the season. Overall, there was a mean 2.2 recurrent instability events per athlete per season for athletes who returned to sports. There was no significant difference in recurrent instability between athletes who initially had a subluxation (10/17, 59%) compared with athletes who had a dislocation (11/16, 69%) (P = .554). Seven of the 12 who were not able to return to sport underwent elective surgical stabilization. Data regarding postseason surgical stabilization of the 33 athletes who returned to sport were not provided.

The long-term outcomes for subluxation patients also remain unclear. However, the combined instability literature suggests that arthritic changes do occur. An evaluation of radiographs and computed tomography scans that were obtained in patients with chronic unilateral instability and without previous surgery found that 88 shoulders (31.2%) demonstrated arthritic changes.25 The total number of dislocations and/or subluxations and the number of subluxations were significantly higher in arthritic shoulders.

TREATMENT

While there are few studies that have focused on subluxation patients, there have been many studies on the outcomes of stabilization for combined instability populations. Gill et al10 evaluated the outcomes of 60 shoulders in 56 patients who underwent open Bankart repair. Fifty-three required at least 1 closed reduction, suggesting that 7 had shoulder subluxations. The Bankart lesion was repaired with a series of mattress sutures that were secured to the glenoid through bone tunnels at the superior and inferior extent of the lesion. An additional suture was utilized to plicate any redundancy of the inferior capsule by advancing it to the tissue on the Bankart repair. Fifty-five of 56 patients returned to their baseline level of work, and 52 of 56 patients rated their result as good or excellent. The only reports of recurrent instability were in 3 patients who had another traumatic event after repair.10

Pagnani and Domo26 evaluated 58 high school, college, and professional football players who were treated with an open anterior stabilization procedure for shoulder instability after failure of a rehabilitation program. Bankart lesions were fixed with suture anchors, and an anterior capsulorraphy was performed to eliminate excess capsular laxity. Eleven patients who were enrolled had a glenohumeral subluxation, and 47 had dislocations. Three of these 11 patients with shoulder subluxations were found to have a Bankart lesion. All patients enrolled underwent open anterior stabilization to address their instability. There
were no dislocations postoperatively at 2-year follow-up. However, 2 patients reported postoperative episodes of subluxation. Interestingly, both of these patients had subluxation preoperatively. Fifty-two of 58 patients returned to play football. Of the 2 patients with postoperative subluxation, 1 did not return to sport while the other returned with persistent subluxation.

Bottoni et al\textsuperscript{a} randomized 64 patients to undergo open or arthroscopic stabilization for recurrent anterior shoulder instability. Included patients failed to improve with 6 months of rehabilitation, reported subjective instability, and had physical examination signs consistent with instability. Fifty-three (87\%) patients had a traumatic dislocation; the other 8 patients had recurrent subluxation events. All subjects underwent diagnostic arthroscopy and had arthroscopic repair of a superior labral anteroposterior (SLAP) lesion if present. The open technique was performed through a deltopectoral approach. The Bankart lesion was exposed and anatomically repaired with suture anchors. A capsular shift was performed to eliminate capsular redundancy. The arthroscopic technique repair includes repair of the lesion with suture anchors and imbrication of capsular redundancy. At 32-month follow-up, 29 patients who had open repair and 32 who had arthroscopic repair were assessed, revealing comparable clinical outcomes. The Single Assessment Numeric Evaluation (SANE) scores significantly improved in both groups, and subjective evaluations were equivalent. The mean loss of motion and the operative time were significantly greater in the open repair group.

Owens et al\textsuperscript{a} compared open versus arthroscopic shoulder stabilization for anterior shoulder subluxations. All subjects underwent diagnostic arthroscopy and repair of a SLAP lesion if present (Figure 3). In the arthroscopic arm of the study, the Bankart lesion was fixed with suture anchors. In the open repair, the Bankart lesion was repaired with the same suture anchors through an open exposure via a deltopectoral approach. There was no significant difference in outcomes between the 2 groups. There were 6 (31\%) patients who had recurrent subluxation, 3 in each group. They found that outcomes were superior in patients who underwent early surgical stabilization, which was defined as 3 or less subluxation events prior to stabilization, compared with late surgical stabilization, which was defined as more than 3 subluxation events.

Given the paucity of research specifically on the outcomes of stabilization techniques in subluxation patients, clinicians must rely on their clinical judgment. However, unless patients present with significant glenoid or humeral bone loss, instability patients who have never experienced a complete dislocation event are generally well managed with arthroscopic stabilization alone.\textsuperscript{25}

CONCLUSION

Traumatic anterior glenohumeral subluxations commonly occur in young athletes and comprise the majority of shoulder instability events. Unlike the diagnosis of glenohumeral dislocation, the diagnosis of subluxation may be elusive and demands a high level of clinical suspicion when treating young athletes. Pathologic changes resulting from shoulder subluxation events are best demonstrated with early MRI, which has shown a high incidence of Bankart lesions. Nonoperative management of in-season athletes with immediate rehabilitation without immobilization has been demonstrated to allow athletes to return to complete their season; however, recurrence has been demonstrated to occur in up to 59\% of these athletes. Young athletes with initial subluxation events with demonstrated labral lesions as well as patients with recurrent instability are indicated for surgical stabilization. Arthroscopic Bankart repair has been shown to result in excellent outcomes.

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