ANATOMY
The shoulder suspensory complex (SSC) is an interconnected structure that links the axial and appendicular skeleton. The articulations of the SSC include the glenohumeral, acromioclavicular, sternoclavicular and the scapulothoracic joints. The interplay of these structures allows the shoulder to be the most mobile joint in the body. The nearly-spherical chondral surface of the humerus articulates with a shallow pear-shaped glenoid. The glenohumeral joint has been compared to a golf ball on a tee. In reality, the bony glenoid concavity is quite shallow, with a depth of only a few millimeters. The cartilage is thinner in the center of the glenoid and progressively thickens toward the periphery, thus increasing the functional depth of the glenoid.

To confer some stability, the depth of the glenoid cavity is increased by the circumferential fibrocartilaginous structure, the glenoid labrum. This triangular structure acts as a mechanical restraint to humeral translation. The labrum encircles the glenoid to both increase the depth of the glenoid concavity and the overall surface area of the glenoid in contact with the humeral head, by approximately 50%. The tendon of the long head of the biceps brachii originates from the superior labrum and exits the shoulder joint anterosuperiorly within the intertubercular (biceps) groove.

The shoulder joint is comprised of both static and dynamic stabilisers which limit humeral translation. The static stabilisers include bone, capsule and labrum, whereas the dynamic stabilisers are primarily muscles and their associated tendons. These dynamic stabilisers provide joint stability though contraction of the muscles that span the joint (Figure 1).

The capsule surrounds the glenohumeral articulation and is reinforced by several glenohumeral ligaments, which provide both restraint to motion as well as additional stability to the joint (Figure 1). Anteriorly, the superior, middle and inferior glenohumeral ligaments provide increased strength to the shoulder capsule. The inferior glenohumeral
The ligament is shaped like a hammock, spanning the inferior aspect of the glenoid. It has an anterior and a posterior band. The most important of these is the anterior band; this structure provides resistance to anterior humeral translation when the shoulder is in the maximally abducted and externally rotated position. The other two, the middle and superior glenohumeral ligaments provide resistance to anterior humeral translation with lesser degrees of shoulder abduction.

The shoulder’s primary function is to allow the hand, through articulations at the wrist and elbow, to be placed precisely in space. Through the complex articulations and ligamentous restraints, the shoulder can achieve a tremendous range of motion, including forward flexion, extension, abduction, internal and external rotation.

To co-ordinate motion, multiple muscles and their respective tendons act across the shoulder joint. Joint stability is sacrificed, however, to achieve this increased range of motion.

Shoulder laxity is a term that is associated with a relatively increased passive and active range of motion, but does not imply instability. Increased shoulder laxity is often seen in competitive overhead athletes, including baseball pitchers, tennis players and swimmers. Patholaxity, or symptomatic instability, implies a subjective feeling of pain or glenohumeral subluxation. Patholaxity can result from a single dislocation or repeated traumatic events. The most common direction of a shoulder dislocation is anteroinferior and results in the most frequently observed type of shoulder instability. Traditionally, glenohumeral instability has been classified according to direction (anterior, posterior or inferior), etiology (traumatic, atraumatic) and frequency. However, glenohumeral instability is better evaluated as a spectrum that spans from atraumatic (often seen with multidirectional instability) to repetitive microtrauma (as found in overhead athletes), to the more common traumatic unidirectional dislocation and its resultant anterior instability. The incidence of an anterior dislocation is between 0.08 and 0.24 per 1000 person-years in the civilian population. It most frequently affects patients between the ages of 15 and 40 years.

The prevalence of glenohumeral dislocation in the general population is around 1 to 2%, although this number is much higher in athletes. For example, in ice hockey players, the incidence rises to 8%.

Figure 1: The Intra-articular components of the glenohumeral joint. The static and dynamic restraints are clearly illustrated.
Recurrent instability occurs in 75 to 92% of patients under the age of 30 who have suffered an acute anterior shoulder dislocation. Landmark studies have shown that surgical intervention can reverse the natural history and significantly decrease recurrent anterior instability\(^{2-4}\). Therefore, surgical management is usually recommended in a young athlete following a traumatic anterior shoulder dislocation to decrease the risk of recurrent instability episodes. The description by Perthes\(^{7}\) in 1906 of the injury to the capsulolabral structures, followed by the finding in 1938 by Bankart\(^{8}\), that the capsulolabral injury is the ‘essential lesion’ (Figure 2), established the foundation for the surgical treatment of anterior glenohumeral instability.

There are several methods of surgical stabilisation for the shoulder, broadly classified into open and arthroscopic techniques. Arthroscopic or open anatomic repair of the detached labrum and capsule to the anterior glenoid rim is known as the Bankart procedure and is considered the gold standard to improve quality of life\(^{4-6}\) for a first-time dislocator. Although the Bankart procedure was originally described by per an open approach, over the past 3 decades the use of arthroscopic techniques has demonstrated comparable success\(^{4-6}\). Despite advances in arthroscopic techniques and implants used for shoulder instability repair, the failure rate is still between 5 to 30%. In a population of young athletes, the loss of functional performance is particularly detrimental. Management of anterior shoulder instability is an important concept for physicians who care for athletes. It is imperative to be aware of the diagnosis and available treatment options as well as the expected outcomes.

**DIAGNOSIS**

The clinical evaluation of an athlete with anterior shoulder instability includes a thorough history, physical examination and appropriate radiographic assessment. It is crucial to ascertain when the injury occurred and whether a glenohumeral reduction was required. This may differentiate a dislocation from a glenohumeral subluxation. Although it is possible to self-reduce an anterior shoulder dislocation, it is not common. Frequency of subjective instability and its effect on performance should be elicited. Physical examination should include inspection of the posture and determination of any muscle atrophy or asymmetry between the right and left shoulders. An assessment of active and passive shoulder motion in comparison to the normal contralateral side should be recorded. The asymmetrical loss of internal rotation may identify adaptive stretching of the capsule and is often seen in throwers, including baseball pitchers, handball and volleyball players. Examination for apprehension and instability in all ranges of motion should be determined. Classically, the athlete with anterior instability will demonstrate apprehension with the shoulder in abduction and external rotation (Figure 3). The apprehension will be eliminated with a posteriorly directed force applied to the proximal humerus. This is called a positive ‘relocation sign’ (Figure 4). Strength testing of the dynamic stabilisers should be performed and compared to the opposite side.

**RADIOGRAPHIC IMAGING**

Plain radiographs should be obtained to assess for bony injuries commonly seen following an anterior dislocation. The impaction fracture of the posterosuperior humerus, a Hill-Sachs lesion, is easily identified with an anteroposterior radiograph taken with slight humeral internal rotation (Figures 5a and b). An axial radiograph is imperative following any shoulder injury to confirm glenohumeral reduction. It can also be used to assess for anteroinferior bone avulsions, also called ‘bony Bankart’ lesions. Magnetic resonance imaging (MRI) has become the modality of choice to evaluate patients with anterior instability. MRI can identify capsulolabral tears or ‘Bankart lesions’. Additionally, MRI can identify whether a concomitant superior glenoid labrum anterior to posterior (SLAP) tear is present. Arthograms with either MRI or computed tomography will distend the joint and improve the ability of the musculoskeletal radiologist to identify subtle lesions. Bone loss of either the humeral or glenoid side can be identified with MRI, while computed tomography scan can be more useful in determining the extent of glenohumeral bone loss.

**BONE LOSS AND INSTABILITY**

Bone loss in either the glenoid or humerus has become a more important assessment with recent literature demonstrating higher failure rates with increased bone loss. In a landmark study, Burkhart and DeBeer stated that glenoid bone loss of over 22% resulted in a much greater risk of recurrence following arthroscopic treatment of anterior instability. However,
another study by Shaha et al, found glenoid bone loss of even 15% greatly increased the risk of recurrence. Subsequently, the use of a concept called the ‘glenoid track’ has been proposed by Giacomo to assess the risk of recurrence, based on a calculation of bone loss in the glenoid compared to the estimated size of the Hill-Sachs lesion in the superolateral humeral head. The ability to precisely calculate the amount of bone loss is challenging, however. The use of three-dimensional computed tomography scans has proven to be the most reproducible imaging modality to determine the extent of glenoid and humeral bone loss.

The treatment of patients with anterior instability who have been diagnosed with either glenoid or humeral bone loss is a topic of significant debate. The ability to maintain the glenohumeral stability in the face of either glenoid and/or humeral bone loss may necessitate additional procedures. These options will be the topic of the next article, ‘The athlete’s shoulder part II’.

**TREATMENT OPTIONS**

The treatment of shoulder dislocations has traditionally entailed a variable period of immobilisation in a sling, followed by gradual return to activities over several weeks or even months. This was believed to produce a high rate of return to sport. Those that developed recurrent instability of their shoulder joint, including repeated dislocations or subluxations, required an open shoulder repair. A landmark study at the United States Military Academy at West Point revealed a recurrence rate of greater than 90% for young cadet-athletes who sustained a first-time traumatic shoulder dislocation and were treated with a nonoperative regimen of immobilisation followed by a physical therapist-directed rehabilitation programme. Alternatively, a similar group of cadets in their study was treated with an arthroscopic repair of the ligamentous avulsion. This approach resulted in a recurrence rate of less than 20% for the preliminary study and less than 15% in a second study where a new arthroscopic technique was used. In this study, Dr. Robert Arciero used a bioabsorbable tack inserted arthroscopically to repair the torn ligament. Following healing of the tissue, the tack was resorbed by the body.

Since these studies, several other groups, including a study performed at Tripler Army Medical Center, have reported similar high recurrence rates for young athletes treated nonoperatively for traumatic shoulder dislocations. The recurrence rate was significantly decreased following arthroscopic shoulder stabilisation and allowed return to pre-injury athletic activities in the majority of subjects. Compared to open surgery, the use of arthroscopy allows better joint visualisation and ability to repair the torn tissue back to its anatomically correct location following an injury. Arthroscopic instruments are inserted into the joint through small plastic cannulas after locating the precise position with a spinal needle (Figure 6). Through these portals, the ligament is reattached to the bone much the way it is performed through the traditional ‘open’ surgery (Figures 7a and b). Immobilisation is still required for several weeks following surgery, after which rehabilitation is initiated. Four to 5 months following surgery, athletes are allowed to return to full activities if they have normal shoulder motion and strength.

**Patholaxity can result from a single dislocation or repeated traumatic events**
Figure 5: (a) Anteroposterior shoulder radiograph with an anterior glenohumeral dislocation. (b) Anteroposterior shoulder radiograph in humeral internal rotation demonstrating a Hill Sachs Lesion, the compression fracture of the posterosuperior humeral head.

Figure 6: Arthroscopic view of two plastic cannulas inserted into the anterior shoulder joint to allow repair of the torn labrum.

Figure 7: (a) Arthroscopic Bankart repair, capsule is being retrieved with curved instrument. (b) Arthroscopic view of completed arthroscopic Bankart repair.
Recurrent instability occurs in 75 to 92% of patients under the age of 30 who have suffered an acute anterior shoulder dislocation.

Although this does not guarantee success, it offers the best opportunity to return to a pre-injury level of play. Currently, shoulder arthroscopy is performed in an outpatient setting, allowing patients to return home the same day of their surgery.

The salient question for athletes who have sustained a traumatic dislocation is whether or not they should proceed with surgery. The most important factor to consider is their age at the time of the first dislocation, because the younger the age of the patient when a dislocation is first sustained, the higher the likelihood that subsequent instability will occur. The subjects in the study at West Point were all young cadet-athletes (18 to 24 years) who were required to participate in intercollegiate, intramural or club sports as well as obligatory military training. Recurrent shoulder instability is poorly tolerated and typically precludes commissioning as an active duty military officer. Therefore, the consequences of recurrent instability were significant for these athletes. For athletes who are older than 30 when they sustain their first dislocation, the recurrence rate in most studies drops precipitously. Therefore, a high school or collegiate athlete who desires to continue participating in sport would most often benefit from operative treatment, while older patients may not.

CONCLUSION

In summary, anterior shoulder dislocations are common injuries sustained by young athletes in almost all sporting events. They typically occur when the arm is forced into an abducted and externally rotated position. The current literature suggests an unacceptably high rate of recurrent instability among young athletes that sustain a first-time traumatic anterior dislocation, especially if they desire to continue athletic pursuits. Advancements in arthroscopic technology, bioabsorbable implants and surgical training have allowed for a minimally invasive surgical approach to repair damaged tissue. This treatment has resulted in a decreased rate of recurrent shoulder instability and has reversed the natural course of this injury, especially in young patients. The young athlete who sustains a first-time, traumatic shoulder dislocation now has a surgical alternative to increase his or her chance of returning to athletics without chronic shoulder instability.

References


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