SHOULDER DISLOCATION AMONG ATHLETES

AN OVERVIEW OF COMMON INJURIES AND IMAGING FINDINGS

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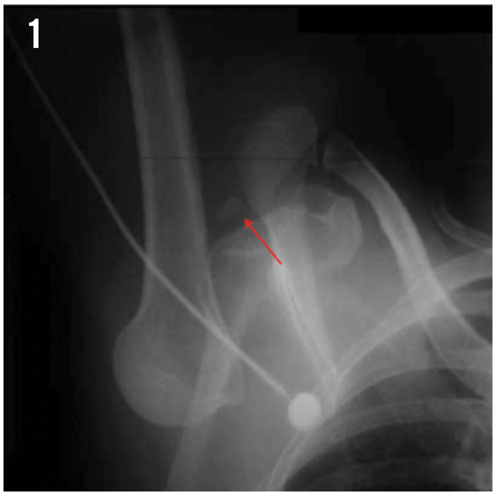
The Glenohumeral (GH) joint has a large range of motion that leaves it prone to shoulder instability, ranging from subluxation to frank shoulder dislocation (SD). Due to the shallow depth of the glenoid's osseous structure, shoulder stability is achieved through a number of additional soft tissue stabilisers (including the glenoid labrum). Rotator cuff muscles are the most important dynamic stabilisers of the GH joint. Other muscles that cross the GH joint, such as pectoralis major and latissimus dorsi, may potentially act as stabilisers as well. SD may arise from abnormal function of either osseous (glenoid fossa and coracoacromial arch) or soft tissue (glenoid labrum, articular cartilage, rotator cuff, long head of biceps and deltoid muscles) structures[1].

Laxity is characterised by mobility of the humeral head on the glenoid fossa. Excessive mobility is often termed hyperlaxity, a common feature among many athletes. Hyperlaxity may help athletes by enhancing their range of motion. However, this may become a problem when it is accompanied by a functional deficit and pathological symptoms. Typical symptoms include pain and a subjective feeling of instability or apprehension. While instability and hyperlaxity are two distinct phenomena, they frequently occur together in athletes suffering from SD[1].

While purely atraumatic causes may account for a number of SDs among athletes, there are two main etiologies, behind athlete SD. First, acute SD may arise as a result of being exposed to a considerable load or bearing a sudden force during a traumatic event. These injuries may also worsen with repetition of similar traumatic episodes during sports activities. Second, SD may arise as a result of chronic injuries, mostly in the form of recurrent microtrauma and overuse. Secondary forms of impingement and injury to the dynamic soft tissue stabilisers may arise from recurrent microtrauma as well[2].

ADVANCED IMAGING FINDINGS – AN OVERVIEW

Radiography remains the primary modality of choice when SD is suspected (Figure 1). However, advanced imaging modalities including computed tomography (CT) and magnetic resonance imaging (MRI) are frequently needed during the course of clinical decision-making for athletes with SD. For advanced radiologic assessment, conventional MRI is the most utilised modality. Intra-articular



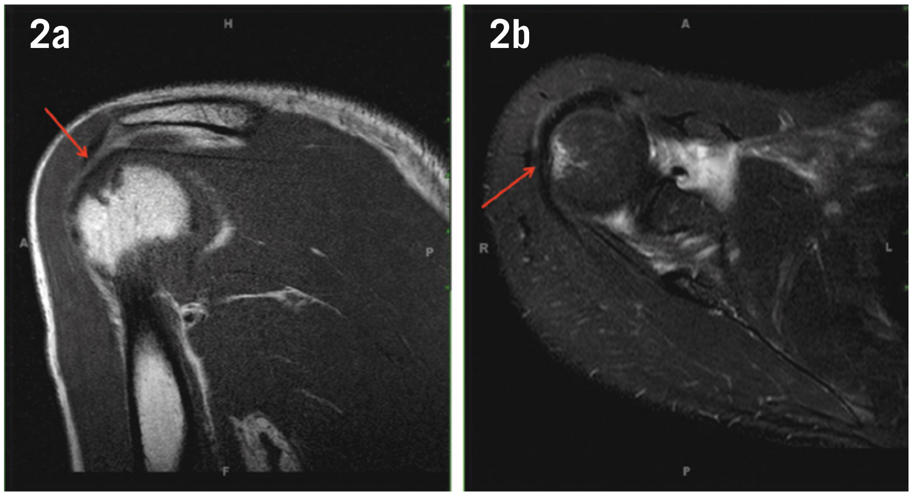


Figure 1: Anteroposterior radiograph demonstrating inferior shoulder dislocation (luxatio erecta) and displaced fracture fragment of the inferior glenoid (red arrow).

Figure 2: Coronal (left) proton density-weighted image and axial (right) fat saturated proton density-weighted image of a young patient with anterior shoulder dislocation and Hill Sachs lesion (red arrow).

Figure 3: Anterior shoulder dislocation, large haemarthrosis and osteo-cartilagenous Bankart lesion.

contrast and MR arthrography may provide additional benefits. In athletes with MRI contraindications, CT and CT arthrography provide an acceptable alternative. Nevertheless, multi-detector CT scans are used for optimal characterisation of osseous injuries associated with SD[3].

MR IMAGING AND ARTHROGRAPHY

MRI provides excellent visualisation of soft tissue and osseous abnormalities that can occur in association with SD. With high-resolution 3D acquisition, MRI is the most important imaging tool for pre-operational evaluations. While direct MR arthrography provides clear diagnostic benefits, it is an invasive procedure. Recent research has proposed indirect MR arthrography as a non-invasive alternative method with a comparable diagnostic yield to direct MR arthrography. Indirect MR arthrography includes enhancement with intravenous gadolinium-based contrasts. The major drawback of indirect MR arthrography is a lack of joint space distension. Indeed, direct arthrography achieves joint space distension by introducing the contrast agent into the GH joint space. In the setting of acute trauma, haemarthrosis can result in similar joint space distension leading to better visualisation of the articular surfaces, glenoid labrum, and ligamentous structures. In general, MRI and MR arthrography provide excellent sensitivity and specificity for detecting glenoid labrum and ligamentous abnormalities (Figures 2 and 3)[3].

CT IMAGING AND ARTHROGRAPHY

CT imaging and arthrography provide acceptable alternatives when MR imaging and arthrography are contraindicated or unavailable. In fact, studies have declared an almost identical accuracy when arthrography is performed in the course of shoulder CT, in comparison with MRI. In general, CT provides a powerful tool for the assessment of osseous injuries and small fractures. Nevertheless, it has an inferior performance when compared with MR imaging in terms of contrast resolution for soft tissue visualisation. While CT exposes the patient to a considerable amount of radiation exposure, the conversion factor and thus the effective radiation is much lower. CT has the advantage of providing a rapid image acquisition, with better compliance in claustrophobic patients. Finally, in subjects with metallic artefact (frequently during post-operative assessments) CT provides fewer artefacts while the use of MRI may not be applicable in such patients (Figures 4 and 5)[3].

ADVANCED IMAGING FINDINGS IN ANTERIOR SHOULDER DISLOCATION

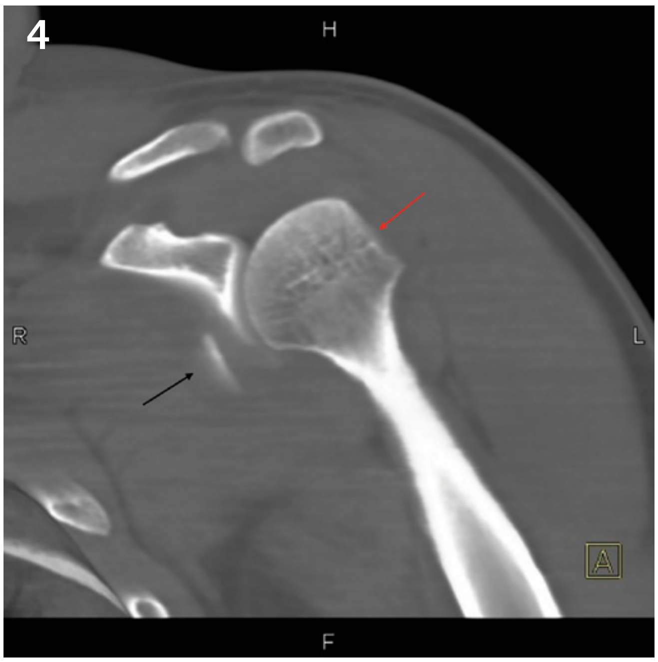
Anterior SD is the most common type of SD among professional athletes. In anterior SD, the introductory force may involve an anterior-inferior movement of the humeral head (in relation to the glenoid fossa). After dislocation, the inferior glenohumeral ligament (IGHL) frequently pulls on the margin of the osseous glenoid fossa, and subsequently an avulsion fracture can occur. This avulsion fracture is also known as a Bankart lesion. Depending on the presence (or absence) of osseous tissue in the avulsed IGHL, Bankart lesions are classified as fibrous or osseous lesions. In fibrous Bankart lesions, labral tears and disruption of the scapular periosteum occur. In either case, when the displaced fragment is distant from its original position, the chance of spontaneous healing will be minimal. With antero-inferior labrum detachment, administration of a contrast agent into the joint space and visualising its extension beyond the detachment helps establish the suspected diagnosis. In cases with associated avulsed osseous components in the avulsed IGHL, CT has an excellent accuracy in detecting the fragment. In fact, even simplified diameter measurement derived from the CT scan can be used to provide clinically decisive information (Figure 5; the b/a ratio may indicate the need for surgical management).

Perthes lesion is a distinct phenomenon which is closely related to the Bankart lesion. In some instances, during dislocation and while the IGHL is dragging the glenoid labrum, the scapular periosteal sleeve remains intact. This preserves the anatomical position of the avulsed site and results in what is known as a Perthes lesion. Perthes lesions would be more likely to heal spontaneously. Diagnosis can be established by visualising the distinct line of signal contrast that lays between glenoid's osseous structure and the glenoid labrum. In some cases, the scapular periosteal sleeve may be stripped medially, but remains intact. This results in another phenomenon, known as anterior labral posterior sleeve avulsion (ALPSA). The medially displaced scapular periosteal sleeve may be partially healed. Visualising a glenoid rim that is devoid of labral tissue is indicative of this diagnosis. Diagnosis can be confirmed by visualising the medially displaced and deformed complex of the labrum and the adjacent ligamentous structures.

The humeral head may also be injured during SD in athletes. The humeral head may impose a compression on the glenoid rim and the glenoid labrum when athletes fall on an outstretched hand with their arms abducted. The compression may result in glenoid articular disruption and may impose a superficial injury to the cartilage lining of the antero-inferior portion of the glenoid fossa. Cortical depressions may or may not occur. Sometimes a flap tear is visible after the introduction of the contrast agent (either in CT or MRI arthrography). Osseous avulsion may occur at the humeral attachment site of the IGHL (in contrast to the osseous Bankart lesion that avulses from the glenoid rim) during SD. Unlike Bankart lesions, humeral avulsion of the glenohumeral ligament (HAGL) is not a common pathology, given the anatomical position and biomechanical function of the IGHL. A HAGL lesion changes the shape of the axillary recess from the normal 'U-shape' to a 'J-shape', which can be visualised in an arthrogram.

ADVANCED IMAGING FINDINGS IN POSTERIOR SHOULDER DISLOCATION

Posterior SD is not as common as the anterior SD. It usually requires an overwhelming posteriorly directed force to



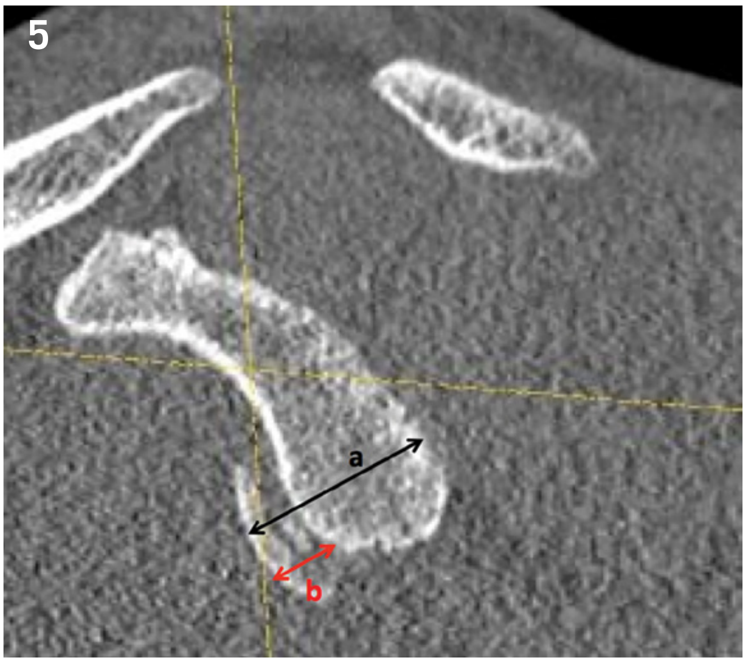


Figure 4: Coronal CT image demonstrating Hill Sachs deformity of the posterolateral humeral head (red arrow) and Bankart lesion in the anterior/inferior glenoid (black arrow).

Figure 5: Sagittal CT image demonstrating Bankart lesion (b/a ratio is less than 0.20 to 0.25) therefore, bony Bankart repair (e.g. Latarjet procedure) may not be necessary. CT=computed tomography.

rupture the joint capsule and/or associated periosteum. Similar to Bankart lesions in anterior SD, 'reverse' Bankart lesions occur in posterior SD when a posterior portion of the glenoid labrum is avulsed. 'Reverse' Bankart lesions can be diagnosed by visualising contrast entry into the posterior glenoid fossa, beyond the glenoid labrum. In some cases, the posterior scapular periosteal structure may remain intact to some extent. The partially avulsed posterior scapular periosteal structure can be medially displaced; resulting in what is also known as posterior labro-scapular sleeve avulsion. A distinct line of intra-articular contrast between the medially displaced posterior scapular periosteal structure and the glenoid indicates the diagnosis.

An incomplete, superficial tear in the posterior glenoid labrum can be easily missed. Known as a Kim lesion, it is associated with a loss in height of the glenoid labrum and an abnormal contour of the posterior labrum. Finally, similar to HAGL in anterior SD, posterior HAGL may occur during posterior SD. It is important to diagnose muscular injuries associated with posterior HAGL, including disruptions in the insertion of the teres minor.

INJURIES RELATED TO VARIOUS SPORTS

SD happens during a variety of sports and among a variety of age groups. Associated sports include overhead sports, volleyball, baseball, contact sports, rugby, basketball and weightlifting. However, other sports including swimming, gymnastics, dancing and rowing are also associated with an increased risk of SD[2]. High school athletes may be at higher risk of SD. Previous reports have shown that athletic activities may be associated with up to four times higher risk of SD among high school athletes[4]. The rate ratio was highest for American football players, among high school students. Nevertheless, senior athletes in contact sports may bear an increased risk of SD. While SD corresponds to the more intense spectrum of injuries, other milder injuries such as strains and sprains are much more common. These injuries are frequently associated with time loss from athletic activities. Boys are more likely to sustain significant injuries than girls. Importantly, a significant portion of associated injuries may require surgical intervention. In general, experts agree that epidemiologic surveillance systems should be improved to warrant the infrastructure that is needed to implement preventive measures[4].

Regarding the mechanism of injury; throwing, a missed punch, falling and weight bearing (especially in an overhead arm) are of the most common etiologies. However, a significant portion of athletes may not specify a distinct etiology for their SD. Subluxations and instabilities are similar common pathologies that may or may not lead to SD[5].

Overhead athletes: tennis serve and baseball pitch

Overhead sports have higher rates of both common and uncommon injuries associated with SD. Besides Bankart lesions and other common injuries, baseball pitchers may present with HAGL and axillary pouch avulsions that are not common to other groups of athletes. MRI evaluation of these patients may also reveal glenoid labrum and rotator cuff tears. Careful evaluation of cartilage linings is necessary to diagnose associated cartilage defects[6].

Image: Illustration of the tennis serve.

> **Overhead sports have a higher rate of both common and uncommon injuries associated with shoulder dislocation**

The overhead throwing motion is a combination of a chain of sequential (kinetic) positions and actions. Such motions are thoroughly studied for the two prototypic examples, namely the tennis serve and the baseball pitch. When performed in the optimised fashion, they result in maximised functionality and superior athletic performance. However, improper motion chains (including motions from a defined 'node' to the next) may result in SD. Shoulder rotation, flexibility and strength are some of the other determining factors[7]. In-depth biomechanical studies of these motions lead to the definition of disabled throwing shoulder (DTS). DTS has several determinants that may be under the influence of scapular and GH rotational deficits. Superior labral and rotator cuff injuries may compromise GH joint function and contribute to DTS as well[8].

Volleyball players

Volleyball players share common injuries with overhead athletes due to the nature of shoulder's movement; hyperabduction and external rotation are common manoeuvres in these athletes. HAGL and axillary pouch avulsions may also occur in this group of patients. Patients may bear capsular laxity and sub-clinical levels of instability. Repetitive microtrauma contributes to the development of HAGL and axillary pouch avulsion in these athletes. Other commonly-associated injuries include labral tears, rotator cuff tears and cartilage injuries[9].

Baseball batters

The distinctive pathology of the shoulder in baseball batters has led to attempts to define and describe the diagnosis of 'batter's shoulder'. Batter's shoulder is defined as posterior instability of the shoulder as the result of common swinging motions associated with missed balls. It contributes to injuries of the glenoid labrum. In an acute injury, radiography is the first modality of choice and can help exclude associated fractures and dislocations. An axillary view may be helpful in these cases. While radiography provides the initial clue, advanced evaluation using MRI help reveal associated injuries, glenoid hypoplasia, HAGL and other IGHL lesions. Careful evaluation of glenoid labrum, joint capsule and chondral lesions are important for optimal treatment[10].

Contact athletes

The shoulder is the most common joint to be dislocated in contact athletes. SD may occur in contact athletes following acute trauma or as the result of cumulative microtraumas. In the clinical evaluation of athletes in sports such as American football, wrestling, ice hockey and rugby, posterior instability should be a major concern. Imaging evaluations starts with radiography. Axillary and supraspinatus (apical oblique) views are particularly helpful in these cases. Radiography can help diagnose associated glenoid rim abnormalities, glenoid dysplasia and lesser tuberosity fractures associated with direct trauma. Advanced evaluation using MRI is usually performed to help the clinician in making the final decision for the choice of treatment in an athlete. MRI may reveal cartilage defects and soft tissue abnormalities that contribute to SD. Finally, dynamic ultrasound can be useful in determining the joint laxity as well[11].

Ice hockey players

Ice hockey players may also be at high risk of shoulder injuries. Previous reports suggested an injury rate of up to 20% in these athletes. Incidence appears to be increased among those playing at higher levels. In a studied sample of National Hockey League players, 75% of the athletes had Bankart lesions in their affected shoulders. IGHL tears, biceps subluxations, rotator cuff tears, GH chondral lesions and early osteoarthritis were some of the other associated injuries[12].

Rugby players

Rugby players are also prone to a variety of common and uncommon shoulder injuries. Tackling other players may impose a great load on the anterior aspect of the shoulder. On the other hand, being tackled and landing in an improper position may accompany a risk of SD as well. In MRI evaluations of these patients, anterior glenoid labrum tears, antero-inferior translations and even superior labral lesions are commonly detected. Injury repair may be challenging. Repeated injuries and recurrent tears are common detrimental factors in these athletes[13].

Other sports: basketball, wrestling, and weight lifting

Almost every professional athlete (especially in sports with workloads on the shoulders) may be at risk of SD. The most commonly associated sports have been outlined above; nevertheless, current literature is forming around establishing individualised types of shoulder injuries in athletes from different sports. Beside common injuries that are shared among all sports, uncommon shoulder injuries leading to SD are of important diagnostic value in the evaluation of professional athletes. Such uncommon injuries may include HAGL and its associated nerve injuries among basketball athletes or SD in the setting of pectoralis major tendon injuries in wrestlers[14,15]. In each case, advanced imaging is an inseparable part of individualised patient care.

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