Review Article

A Comprehensive Review of Glenohumeral Joint Dislocation in Athletes

ABSTRACT

Glenohumeral joint dislocation is a prevalent issue in athletes, constituting the majority of major joint dislocations, with the anterior dislocation being the most common. This literature review aims to analyze the epidemiology, classification, diagnosis, and management of glenohumeral joint dislocations, focusing on athletes. A thorough literature search was performed using multiple databases, including PubMed, ProQuest, SAGE, EBSCOHost, Wiley Online Library, Google Scholar, and the Cochrane Library. The search utilized keywords and MeSH terms such as "Glenohumeral joint," "Epidemiology," "Classification," "Diagnosis," "Management," and "Athletes," which were combined with related synonyms through Boolean operators (AND/OR). The review highlights that younger male athletes are particularly susceptible due to the high incidence of traumatic events during contact sports. Research shows that the incidence of primary glenohumeral joint dislocations is 153 to 563 per 100,000 person-years, with around 52% of patients experiencing recurrences or needing surgery, while 50% of younger patients aged 12–25 maintained stability over time. Proper diagnosis is crucial and involves detailed patient history and physical examination, including various provocative tests to assess instability. Classification of dislocations (anterior, posterior, and inferior) guides treatment planning, which may include nonoperative management for first-time dislocations in non-athletic populations. However, athletes and younger patients are more likely to benefit from early surgical intervention to prevent recurrent dislocations. Surgical options such as arthroscopic Bankart repair and bone augmentation procedures, including the Latarjet technique, are recommended based on the extent of bone and soft tissue damage. Despite promising outcomes, each surgical approach has its own set of complications. Recent evidence supports early stabilization, particularly in high-risk individuals, to achieve better long-term outcomes. Continued research is needed to refine treatment algorithms and ensure optimal recovery and return to sports for affected athletes.

Keywords: dislocation, athlete, glenohumeral join

A. INTRODUCTION

Shoulder dislocations, accounting for half of all major joint dislocations, occur primarily in the anterior form. Glenohumeral joint dislocations (GHJ), commonly known as shoulder dislocations, are frequently seen both in athletes and the general population. As the most frequently encountered major joint dislocation, it also represents the type most often addressed in emergency medical settings. Due to the inherently unstable nature of the shoulder, facilitated by the shallow glenoid minimal contact with the humeral head, dislocations may occur in various directions forward, backward, or downward either fully or partially, with the anterior dislocations noted as being particularly common. Dislocation can be complicated by the stretching or tearing of the fibrous tissues connecting the bones. Significant forces, such as a direct impact to the

shoulder, are typically required to displace the bone. Additionally, the shoulder may be dislodged from its socket due to excessive rotation. Common causes of shoulder dislocations include injuries from contact sports, motor vehicle accidents, and falls. The importance of an interprofessional team in patient care is emphasized in this review, which outlines the pathophysiology, assessment, and treatment of shoulder dislocations.[1-3]

B. EPIDEMIOLOGY AND ETIOLOGY

A significant health concern for youthful patients, chronic instability frequently results from recurrent shoulder dislocations, which are predominantly seen in male patients below the age of 40. These dislocations, commonly associated with sports-related injuries, often lead to subsequent recurrent events. Studies reveal that the incidence of primary glenohumeral joint dislocations ranges from 153 to 563 instances per 100,000 person-years, with athletes frequently affected.[4] Dislocations, which may manifest anteriorly, posteriorly, inferiorly, or anterosuperiorly, frequently afflict the shoulder, the body's joint most prone to this condition. The anterior position predominates in frequency. It has been noted that individuals who have experienced prior dislocations of the shoulder are at an elevated risk of subsequent episodes. This susceptibility to repeated dislocations arises because the affected tissues either fail to recover adequately or become slackened. A notable correlation exists between younger individuals and an increased likelihood of recurrence, presumably linked to their more vigorous levels of physical activity. Furthermore, those suffering from either tears of the rotator cuff or fractures of the glenoid demonstrate a heightened frequency of recurrent joint dislocations.[4,5]

C. CLASSIFICATION

The classification of dislocations is as follows[5,6]:

- Anterior Dislocation

  Representing up to 97% of all shoulder dislocations, the anterior type is the most prevalent. It typically results from a posterior humeral force or an impact on an outstretched arm when the arm is abducted, externally rotated, and extended. Prominence of the acromion and abduction and external rotation of the arm are common findings upon clinical assessment. Frequently, this form of dislocation is complicated by associated injuries such as nerve damage, or fractures of the humeral head and/or glenoid fossa, occurring in as many as 40% of cases.

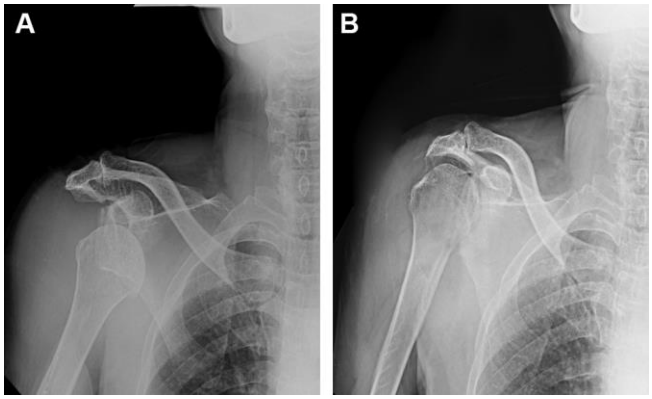

Figure 1. (A) A radiograph of a 68-year-old man with a first dislocation of the right shoulder. (B) After reduction, plain radiography revealed rotator cuff arthropathy with osteophytes under the acromion and superior migration of the humeral head.

- Posterior Dislocation

  Comprising 2% to 4% of all shoulder dislocations, the posterior type occurs mainly due to a frontal blow to the shoulder or axial load on the arm when it is adducted and internally rotated. This form of dislocation may also arise from intense muscle contractions, like those experienced during electric shocks or seizures. Clinical evaluations often reveal that the arm maintains an adducted and internally rotated position with an inability to perform external rotation. Complications such as reversed Hill-Sachs lesions, fractures of the surgical neck or greater tuberosity, and injuries to the labrum or rotator cuff are more probable.

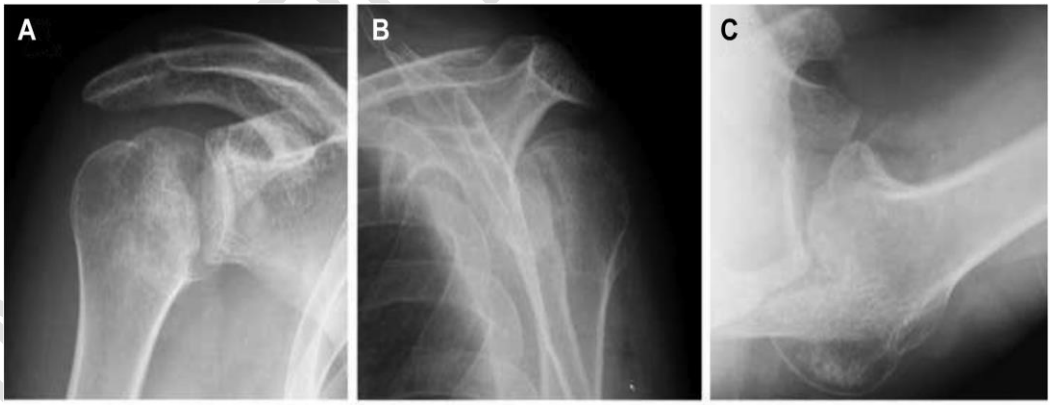

Figure 2. (A-C) Preoperative radiographs of the right shoulder of a patient with a 6-week delay from injury to diagnosis showing a chronic locked posterior dislocation of the shoulder

- Inferior Dislocation

  Known as luxatio erecta, inferior dislocation is exceedingly rare, constituting less than 1% of cases. It primarily occurs from hyperabduction or axial loading when the arm is abducted. The arm's position is typically maintained above and behind the head, and the patient is unable to adduct the arm during examination. This type is particularly notorious

for the high rate of associated injuries, including nerve and axillary artery damage, rotator cuff injuries, and tears in the internal capsule.

Figure 3. Anteroposterior view of the right shoulder joint in anadult patient. The right humeral head is dislocated inferiorly

D. DIAGNOSIS

Anterior dislocation is most commonly observed. It is essential to document thoroughly the characteristics of the shoulder injury initially. A detailed account of the mechanism of the injury, including the nature of the trauma, the force's direction impacting the shoulder, and the perceived direction of instability, must be recorded to accurately delineate the incidence of anterior shoulder instability. In cases of first-time dislocations, it is often reported by patients that the shoulder experienced a single, traumatic event leading to immediate symptoms. Conversely, individuals experiencing recurrent instability often report several incidents of dislocation/subluxation, or they may express concerns about or limitations from ongoing instability. Thus, gathering comprehensive details is critical to understanding the specific dynamics of glenohumeral joint dislocations in athletes.[1]

It is imperative to ascertain the conditions under which the patient underwent reduction, either autonomously in a non-hospital environment or through medical intervention in the emergency room or a similar clinical setting. The distinction between a full dislocation and a subluxation is frequently reported by the patients themselves. Enhanced damage to the glenohumeral joint is often a consequence of enduring locked anterior dislocation incidents. Furthermore, evaluating the frequency of such recurrences is essential. The specific physical activities leading to these instability events should be recorded as well; this includes determining whether instability arises solely during extreme movements such as abduction and external rotation or during routine daily activities, even as mundane as sleeping. Such information is critical for the surgeon to gauge the extent of damage to soft tissues or bone constraints within

the shoulder region. It is also necessary for the physician to identify if there is any voluntary aspect to the shoulder's instability, as these cases typically demonstrate an unfavorable outcome following surgical stabilization procedures. The athlete's history of joint dislocation is a critical component of diagnosis and treatment planning.[1]

The commencement of the shoulder's physical examination entails an assessment of both the anterior and posterior regions of the complete shoulder girdle through visual inspection. It is imperative that any asymmetry between the impacted side and the opposing side is documented, especially in terms of shoulder placement, muscle bulk/degeneration, scapular alignment/protrusion, and the positioning of the acromioclavicular joint. This evaluation may be conducted both when the shoulder is immobile and when it is undergoing its active range of motion. Following this, palpation of the osseous prominences occurs, during which locations of sensitivity are pinpointed, including the areas surrounding the acromioclavicular (AC) and sternoclavicular (SC) joints, along with the biceps tendon, acromion, and the greater tuberosity.[1]

Table 1. Beighton Score Criteria

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

The assessment of cuff strength is paramount, particularly in patients over the age of 40 who present with acute dislocation, as they are prone to rotator cuff tears. Active and passive ranges of motion are evaluated following initial visual inspection and palpation. The motion planes considered relevant include forward elevation, abduction, and internal/external rotation both at the side and in abduction. Frequently, patients exhibiting recent acute injuries display restricted movement attributable to pain and inflammation. The strength of the rotator cuff is determined through various tests: the champagne toast test and the spill test assess the supraspinatus; resistance to external rotation at the side evaluates the infraspinatus; resistance to external rotation in abduction beyond 60° gauges the teres minor; and the internal/press belly test measures the subscapularis' strength.[1]

Patients suffering from shoulder instability, especially those experiencing recurrent or multidirectional instability, must have their general ligament laxity recorded. Documentation should encompass the evaluation of Beighton scores, hypermobility, and skin stretch tests. The need for comprehensive documentation is paramount in assessing the condition of the glenohumeral joint dislocation in athletes.[1]

The detection of inferior laxity in cases of glenohumeral instability often involves specific provocative examination maneuvers beyond the standard physical evaluations. Among these maneuvers, the sulcus sign is notably utilized. Typically, for this examination, the patient's upright position is ensured with the arm resting at the side. Subsequently, the shoulder is secured by the examiner who also exerts a downward force at the elbow (Figure 1). Multidirectional shoulder instability or rotator interval deficiency is indicated by an excessive downward displacement of the humeral head that fails to ameliorate upon external rotation. The degree of inferior translation observed determines the grading of the sulcus sign: grade I involves translation less than 1 cm, grade II ranges from 1 to 2 cm, and grade III exceeds 2 cm.[1]

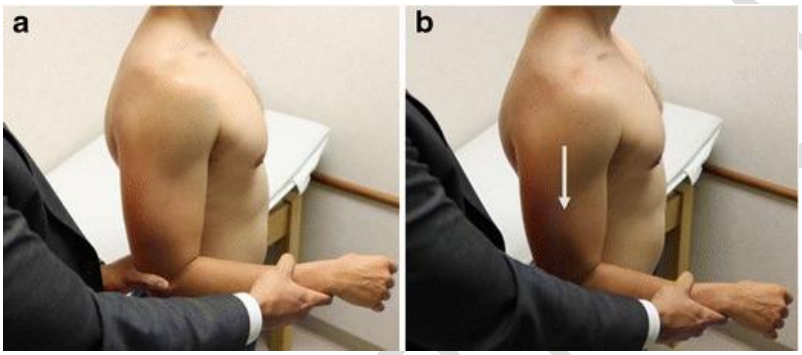

Figure 4. Sulcus Sign. A. The patient is positioned upright with the arm placed at the side. B. The examiner stabilizes the shoulder and applies a downward-directed force on the elbow, pulling the humerus downward (arrow). If a sulcus appears and is not resolved with external rotation, there may be a rotator interval deficiency.

In evaluating inferior glenohumeral instability, the hyperabduction test plays a crucial role by specifically testing the integrity of the IGHL. During this test, the shoulder girdle is stabilized at a low position using the forearm of the examiner, who then actively induces shoulder abduction to assess the joint. This method allows for a precise evaluation of dislocation risks among athletes (Figure 2). Passive abduction greater than 105° in this position is indicative of excessive glenohumeral joint laxity, while most healthy volunteers only exhibit abduction up to 90° passively.[1]

Figure 5. Hyperabduction Test. The examiner assesses the patient's passive shoulder abduction while stabilizing the shoulder girdle. Passive abduction greater than 105° indicates glenohumeral joint instability.

In the assessment of anterior glenohumeral instability, various diagnostic maneuvers exist. The patient is positioned either supine or upright, with their shoulder abducted to 90° and externally rotated to 90° (Fig. 3). This position, considered provocative, may induce a subjective sensation of impending subluxation or dislocation in the athlete. It must be noted that although this sensation might be associated with discomfort, the occurrence of pain by itself does not constitute a positive test outcome.[1]

Figure 6. Apprehension Test. The patient's shoulder is abducted to 90° and the elbow bent to 90°. The examiner then externally rotates the arm and assesses for fear or guarding.

Following a positive apprehension test, symptoms are potentially alleviated through the application of a posterior-directed force on the humeral head by the examiner, who maintains the patient's existing position to stabilize the shoulder. This procedure, known as

the relocation test, serves as a natural advancement from the apprehension test and evaluates the relief from apprehension achieved after manual stabilization of the joint (Fig. 4). In cases of anterior shoulder instability, the maneuver is executed to reposition the subluxated humeral head accurately in relation to the glenoid fossa. A positive relocation test is confirmed by the resolution of guarding and apprehension, which signals anterior instability.[1]

Figure 7. Relocation Test. The examiner applies a posterior-directed force with the patient's shoulder in an abducted and externally rotated position. The disappearance of a sense of security, fear, or instability indicates anterior glenohumeral instability.

An alternative evaluation technique utilized is termed the anterior release test, also known as the shock test. This technique is comprised of elements from both the apprehension and relocation tests. Within this procedure, the patient is positioned supine upon the examination surface. The shoulder is maneuvered into an abducted and externally rotated position once more. It is during this phase that a posterior-directed force is applied to the shoulder by the examiner's hand. Upon the shoulder attaining its peak of external rotation, the force is abruptly withdrawn, thereby permitting the shoulder to transition anteriorly (Fig. 5). Should signs of guarding, apprehension, or instability manifest subsequent to the withdrawal of the posterior-directed force, the anterior release test is deemed positive, suggestive of anterior glenohumeral instability. It is imperative to exercise caution to avoid dislocating the joint during the execution of this examination maneuver.[1]

Figure 8. Anterior Release Test. The patient's shoulder is brought to an abducted and externally rotated position while applying a posterior-directed force. The examiner suddenly releases this stabilizing force and assesses for guarding, fear, or instability.

The examination of the left shoulder, as an instance, is conducted differently during the load and shift test. Initially, the patient is situated in a supine position. Adjacent to the patient, the examiner positions themselves. Employing the left hand, the examiner secures the patient's left wrist, which is maintained in a condition of slight flexion and relaxation. The humeral head is subsequently grasped using the examiner's right hand. Once the humeral head is positioned within the glenoid fossa, an anterior-directed force is applied to the humerus. The degree of anterior laxity is then evaluated by the examine (Fig. 6).[1]

Figure 9. Anterior Load Test. The examiner holds the patient's wrist and humeral head, "loading" the humeral head into the glenoid fossa and applying an anterior-directed force on the humerus (arrow).

For the diagnosis of posteroinferior labral lesions within the glenohumeral joint, the execution of either the jerk test or Kim test is recommended. Initially, the patient’s arm is positioned by the examiner at 90° abduction and 90° internal rotation. Subsequently, the scapula is stabilized by the examiner who simultaneously holds the elbow, loads the humerus

axially into the glenoid, and horizontally adducts the arm across the body. The presence of a posteroinferior labral lesion is indicated by the shifting of the humeral head off the glenoid, accompanied by pain or clicking. In the execution of the Kim test, the patient assumes an initial position identical to that of the jerk test. Unlike the jerk test, the examiner does not stabilize the scapula but rather holds the arm and proximal elbow. An axial load is applied to the glenohumeral joint by the examiner, who then lifts and abducts the arm at a 45° angle (Fig. 7). While conducting this maneuver, an additional posterior and inferior force is applied to the arm. The indication of a posteroinferior labral tear is given by the occurrence of pain during the procedure.[1]

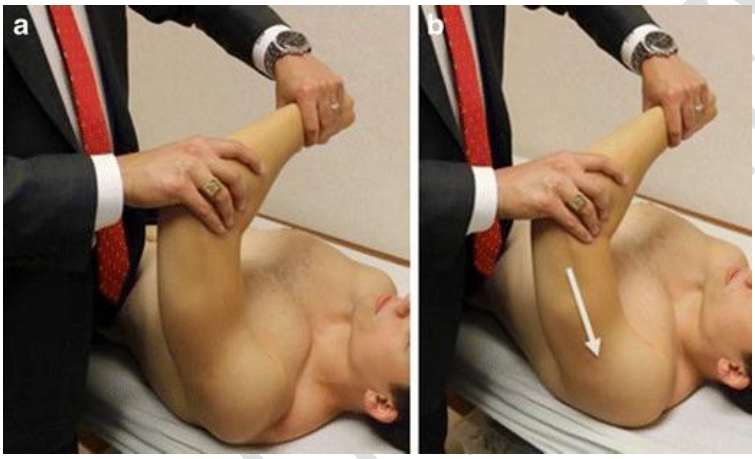

Figure 10. Kim Test. a. The patient is positioned with the arm at a 90° abduction and 90° internal rotation angle. b. The examiner applies a posterior and axial directed force to the glenohumeral joint (arrow) and adducts/lifts the arm at a 45° angle.

E. MANAGEMENT

The creation of a care algorithm for initial glenohumeral joint dislocations entails a comprehensive evaluation encompassing various factors such as demographics, specific patient risk factors, functional requirements, and an examination of bone and soft tissue pathology. Treatment decisions are driven primarily by the objectives of reducing the probability of dislocation recurrence and enhancing the athlete's ability to resume sports and other activities.[7,8]

The prevalence of returning to sporting activities and the likelihood of recurrence following an initial joint dislocation have been extensively explored through nonoperative treatments. Studies focusing on athletes who have experienced primary anterior shoulder dislocations have shown significant findings. In an observational cohort study, it was recorded that 85% of high school athletes who received nonoperative treatment after a glenohumeral dislocation managed to resume their pre-injury sports activities for an entire season without experiencing further instability. In a related evaluation, Buss et al. monitored athletes across a two-year span following

an anterior shoulder dislocation. It was noted that, despite 10 out of 30 athletes encountering repeated instability episodes associated with athletic endeavors, almost 90% succeeded in returning to their sports for a complete season after an average absence of merely 102 days. Despite the initial success in returning athletes to play following a first-time shoulder dislocation, over half of the participants (16 out of 30) subsequently underwent surgical interventions during the off-season, suggesting potential limitations of nonoperative management in the long term. Evidence from these studies indicates some success in using nonoperative strategies to manage first-time dislocations in athletes. Nevertheless, the enduring effects and stability provided by early nonoperative management warrant further discussion. In a long-term prospective study spanning 25 years, Hovelius et al. analyzed the outcomes for patients aged 12–40 who were treated nonoperatively after experiencing a primary anterior dislocation. Findings revealed that while 50% of younger patients aged between 12–25 did not suffer from recurrences or maintained stability over time, approximately 52% of patients, regardless of their level of engagement in sports or recreational activities, faced recurrences or required surgical stabilization within the duration of the study.[7,8]

The viability of nonoperative management for certain patients is determined in part by the absence of specific pathological conditions. It has been noted that when injuries like tears of the rotator cuff or humeral avulsion on the glenohumeral ligament occur, there is a heightened risk of ongoing instability. Furthermore, significant biomechanical implications and a higher likelihood of recurrence arise from the loss of bone in the glenoid and/or humeral areas, which leads surgeons to reconsider nonoperative approaches. Nonoperative strategies, however, might still be appropriate for older patients or those who are less active, provided they do not exhibit these pathological features.[9]

In recent times, there has been a noticeable movement towards early surgical interventions, especially for athletes and younger individuals suffering from initial glenohumeral joint dislocations. This trend is largely influenced by the comparative effectiveness of surgical versus nonsurgical treatments, with the former significantly reducing the likelihood of repeated joint instability. Several high-quality randomized controlled trials have established that, compared to nonoperative management, operative intervention following a first-time shoulder dislocation significantly diminishes the risk of recurrence. These studies have also highlighted the advantages of early stabilization, such as improved patient-reported outcomes, enhanced event-free survival, and a substantially better likelihood of returning to pre-injury activity levels, particularly among young athletes.[10]

Recent studies have focused on pinpointing specific demographic risk factors that might rule out nonoperative management for certain patients. It has been discovered that younger individuals and male athletes are particularly prone to recurrent instability of the glenohumeral joint, suggesting nonoperative approaches are likely ineffective in these groups. In the domain of athletic injuries, the emphasis has shifted towards identifying those athletes who are most susceptible to recurrent instability of the glenohumeral joint. Recent findings corroborate earlier

studies which reported that athletes involved in collision sports are at an elevated risk of shoulder dislocation and its recurrence. Consequently, immediate surgical intervention is advocated for young male athletes involved in direct collisions or overhead sports activities, aiming to optimize functional outcomes and mitigate the risk of future dislocations.[10,11]

In a research analysis led by Kavaja et al., it was indicated that the recurrence of dislocation or chronic shoulder instability was not influenced by the arm's position following a primary traumatic shoulder dislocation. In comparisons drawn over one and two-year periods, it was observed that patients who underwent surgical labral repair (such as Bankart repair) experienced significantly fewer redislocations than those who received non-surgical treatment or underwent arthroscopic joint lavage. Specifically, at the one-year mark, across four studies encompassing 273 patients, the relative risk (RR) for labrum repair in contrast to non-surgical management stood at 0.08 (95% CI 0.02 to 0.27, $p<0.0001$), and against arthroscopic lavage at 0.23 (95% CI 0.08 to 0.67, $p=0.0007$). Similar trends were noted at the two-year interval within a slightly smaller cohort of 243 patients; the RR for labrum repair relative to non-surgical management was 0.15 (95% CI 0.03 to 0.27, $p<0.0001$), and compared to arthroscopic lavage, the RR was 0.21 (95% CI 0.05 to 0.91, $p=0.0037$). Interestingly, a benefit was noted with arthroscopic lavage over non-surgical management at one year (RR 0.34; 95% CI 0.14 to 0.86, $p=0.0023$) as depicted in Figure 2A; however, this advantage was not observed at the two-year follow-up (RR 0.71; 95% CI 0.14 to 3.68, $p=0.686$). The outcomes indicate that surgical intervention in repairing labral injuries substantially reduces the risk of redislocation among athletes suffering from glenohumeral joint dislocation.[4]

In the United States, the preference for managing anterior shoulder instability generally leans towards soft tissue stabilization procedures, either through arthroscopic or open methods, particularly in situations where there is minimal loss of glenoid bone. These surgical interventions are categorized into three primary types: arthroscopic soft tissue stabilization, open soft tissue stabilization, and procedures that involve bone augmentation. The selection of a specific procedure is influenced by several factors including the surgeon’s expertise and preference, anatomical risk factors present, and the preferences of the patient. The ultimate objectives of these interventions are to reduce the likelihood of recurrence and to facilitate the athlete’s return to their activities. For initial anterior shoulder dislocations, Figure 1 outlines a variety of surgical strategies, derived from a model originally aimed at recurrent anterior shoulder instability, now reoriented to address first-time events. When the loss of glenoid bone is severe, exceeding 20%, bone augmentation techniques are typically selected. In scenarios where the glenoid bone loss is less severe, termed "subcritical" and generally falling between 10% and 20%—though some studies extend this up to 25%—the choice of treatment becomes more debatable. The literature does not consistently favor one approach over another, oscillating between arthroscopic and open soft tissue stabilization, with or without the addition of remplissage or further bone augmentation. These methodologies and their applications are set to be elaborated upon subsequently.[12-14]

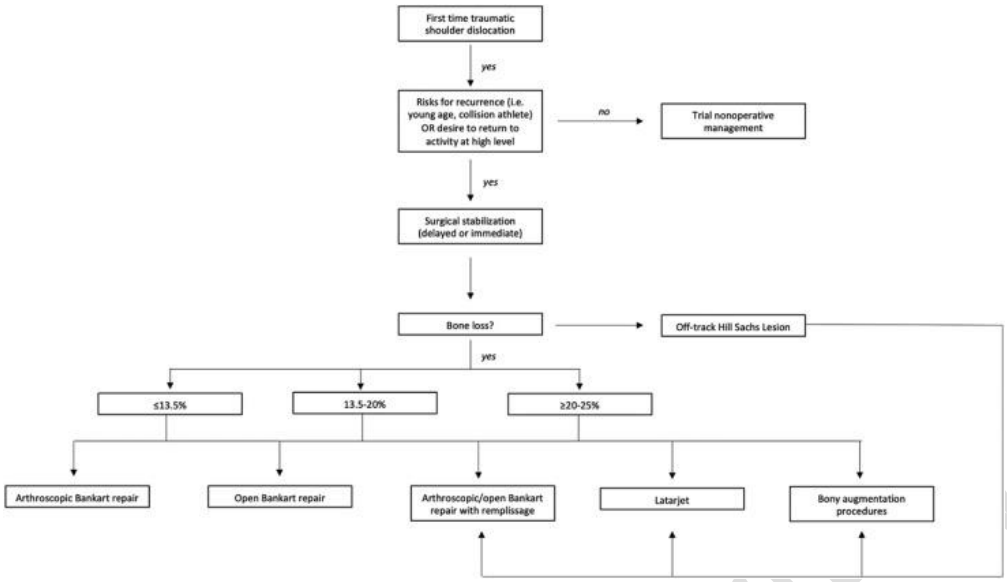

Figure 11. Treatment Algorithm for First-Time Traumatic Anterior Shoulder Dislocation Adapted from the Algorithm for Recurrent Anterior Shoulder Instability

Open Bankart Stabilization

In the realm of treating glenohumeral joint dislocation among youthful collision athletes, the open Bankart repair approach has been historically embraced as a reliable method. Documented follow-ups, both short-term and long-term, reveal a recurrence rate below 1%, this holds even when confronted with bipolar bone loss scenarios.[15] The method's superiority lies in its provision for an expansive and detailed examination of the capsule, allowing for a more comprehensive and vigorous replication of the capsule than what is possible with arthroscopic techniques. On the flip side, it is acknowledged that this technique might lead to more significant surgical cuts and dissections, along with potential disruptions to the subscapularis muscle, a possible diminution in external rotation capacity, and the risk of developing post-capsulorrhaphy arthropathy. These complications are essential factors in the decision-making process regarding the choice of therapeutic strategies and are highlighted during preoperative consultations.[15,16]

Arthroscopic Stabilization (Bankart Repair, Bankart Bone Repair, and Bankart + Remplissage)

Over the past few decades, open Bankart repair has largely been supplanted by arthroscopic Bankart repair in scenarios involving minimal bone loss from the glenoid and/or humerus, owing to its less invasive nature and capability to address concurrent injuries, such as tears of the posterior labrum. Discussions in the literature comparing open to arthroscopic Bankart repair indicate that both methods yield similar frequencies of complications, recurrence, and outcomes reported by patients when contemporary arthroscopic methods are employed. However, there persists a debate about the long-term reliability of arthroscopic Bankart repair, particularly in high-risk patients where incidences of recurrence can escalate to as much as 70%. The risks and complications associated with arthroscopic stabilization include potential recurrent instability, where the shoulder may continue to dislocate even after surgery. There is also the possibility of nerve injury, most commonly affecting the

axillary nerve. Other risks include stiffness in the shoulder joint, infection, and complications related to hardware used in the procedure, such as suture anchors. Additionally, some patients may experience post-operative pain, and in rare cases, damage to the cartilage or surrounding structures may occur.[17] It has been acknowledged that the success of arthroscopic Bankart repair hinges on several factors: the judicious selection of patients, the integrity of soft tissues, and the precision of the surgical technique employed. This technique includes the strategic placement of suture anchors, the quantification of sutures used, and ensuring that at least three anchors are utilized to diminish the likelihood of dislocation recurrence. Locher et al., in a case series, observed that the recurrence rate increased by 83 times in patients treated with isolated arthroscopic Bankart repair who had concurrent bone injuries such as glenoid fractures and extensive off-track Hill-Sachs lesions. This finding underscores that despite the application of proper surgical techniques, the likelihood of recurrence remains substantially elevated with arthroscopic Bankart repair alone when these specific injuries are present. In a longitudinal study spanning two years, Park et al. observed that arthroscopic Bankart repair accompanied by remplissage in patients with off-track Hill-Sachs lesions yielded recurrence and clinical outcomes that were comparable to those exhibited by patients with on-track Hill-Sachs lesions. This was similarly underscored in a separate study by Scanaliato et al., conducted on active-duty military personnel monitored for over four years. It was demonstrated in this analysis that the integration of remplissage into the treatment of off-track Hill-Sachs lesions enabled 90% of the individuals to resume activities, with the incidence of treatment failure not exceeding 5%.[18,19]

The "bone Bankart bridge" technique for the reduction and internal fixation of bone Bankart lesions was elucidated by Millett and Braun. This method entails the positioning of suture anchors adjacent to the medial aspect of the glenoid neck fracture and threading sutures through the bone fragment and surrounding soft tissues, which include the inferior glenohumeral ligament complex. Additionally, in cases of glenoid fractures, contemporary methods such as arthroscopic use of suture anchors along the glenoid rim or the employment of cannulated screws have been documented. Addressing these defects is crucial to halt the progression of defect size and diminish the likelihood of further instability episodes. Bone fragments, notably large ones resulting from initial joint dislocations, often accompany labral damage, necessitating prompt intervention.[20]

Following a first-time dislocation, it is essential to address bipolar bone loss through bone Bankart fixation and/or remplissage. In situations where excessive bone loss inhibits isolated fixation, the necessity for considering bone augmentation alternatives becomes apparent. The initial insertion of the suture anchor into the subsequent anchor on the glenoid surface facilitates a dual-point fixation, which effectively reattaches the fragment to the intact area of the glenoid. Evidence gathered over a span of nearly three years post-procedure indicates that this method yields improved outcomes as reported by patients, exhibits a high level of patient contentment, and maintains a minimal failure rate.[18,20]

Bone Augmentation Procedures

Biomechanical alterations in shoulder function and heightened instability risk are potential outcomes for patients facing subcritical bone loss; this condition affects approximately 33% of individuals after their initial dislocation. It has been demonstrated through prior research that recurrent instability plagues nearly two-thirds of those whose "inverted pear" glenoid configuration, stemming from bone loss, is treated solely via soft tissue stabilization.[9] During follow-up of bone augmentation process in athletes, it was reported that 94.6% of the patients experienced postoperative instability.[c] Bone augmentation procedures in athletes, commonly performed to address significant bone loss or recurrent shoulder instability, carry several risks and complications. One of the primary concerns is infection, which can delay recovery and may require further medical intervention. Graft failure is another risk, where the bone graft may not properly integrate with the native bone, leading to instability recurrence. Additionally, complications such as non-union or malunion can occur if the graft does not fuse correctly, resulting in pain and ongoing instability. Hardware issues, including loosening or breaking of screws or plates used to secure the graft, may necessitate further surgery. Athletes may also experience post-operative stiffness, limiting their range of motion and impacting their rehabilitation and performance. Nerve injury, particularly to the axillary nerve, is a potential risk, which could lead to temporary or permanent loss of sensation or muscle weakness. Despite the procedure, there remains a risk of recurrent shoulder instability, especially in athletes who return to high-impact sports or do not follow a rigorous rehabilitation program. These complications can be particularly challenging for athletes, as the physical demands of their sport place additional stress on the repaired shoulder. Consequently, for athletes with significant or even moderate glenoid bone loss, bone augmentation procedures are often required to both preserve movement and avert further dislocations even though the risk, complication and recurrent instability is inevitable sometimes.[21,22]

Latarjet

Anterior shoulder stability is reinstated by the Latarjet procedure, which operates via a trio of mechanisms collectively referred to as the "triple-blocking effect." Initially, the conjoint tendon, particularly during movements of abduction and external rotation, serves as a sling on the inferior subscapularis, thus furnishing dynamic stability. Subsequently, stability is enhanced through the reconstruction of the capsule using the coracoacromial ligament. Finally, by restoring or augmenting the glenoid morphology and its pathway, the coracoid bone block amplifies the necessary functional range of motion for the humeral head to become disengaged, effectively managing the risk of glenohumeral dislocation in the athlete (Fig. 2).[23]

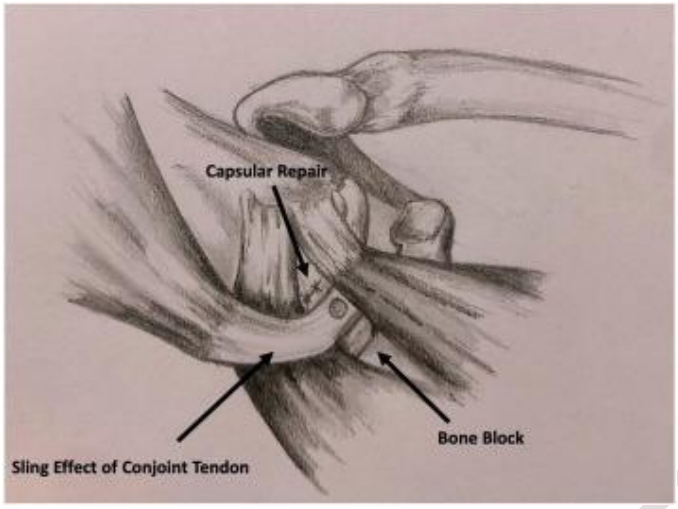

Figure 12. Triple Blocking Effect Seen in Latarjet, consists of capsule repair, transfer of bone block from coracoid, and sling effect of the conjoint tendon.

In the realm of shoulder stabilization procedures, two principal techniques involving coracoid transfer are employed to address glenohumeral dislocations. The classic technique entails aligning the inferior aspect of the transferred coracoid parallel to the anterior glenoid. Conversely, in the congruent arc technique, the coracoid is rotated 90 degrees, utilizing its inferior surface to augment the functional area of the glenoid. Despite the congruent arc technique's ability to enhance stability by enlarging the glenoid's surface area, it poses significant challenges, notably a constrained space for screw placement, which heightens the likelihood of intraoperative fractures.[23] Furthermore, the Latarjet procedure can be executed either arthroscopically or through open surgery. The primary objectives of conducting a fully arthroscopic Latarjet include achieving precise graft positioning, improved cosmetic outcomes, and a reduction in postoperative stiffness. Nevertheless, the viability of this fully arthroscopic approach is subject to debate due to its demanding learning curve and intricate array of potential complications. In academic settings, the Latarjet procedure has been corroborated as efficacious through clinical evaluations, demonstrating a notably low two-year rate of redislocation at 0.8% and high long-term patient satisfaction, achieving up to 98%. Enhanced outcomes reported by patients and increased rates of athletes returning to sports activities are significant results of the Latarjet technique. Comparative analyses of the Latarjet procedure and arthroscopic Bankart repair supplemented with remplissage have been conducted. These studies focused on patients manifesting off-track lesions with less than 25% loss of glenoid bone. Findings indicated no substantial differences in terms of patient-reported outcomes, mobility range, pain levels, recurrence frequencies, and the athletes' re-engagement in sports following either treatment. However, the research by Yang et al. revealed a superior advantage of the Latarjet procedure over the arthroscopic Bankart repair with remplissage for collision athletes and individuals with more than 15% bone loss. The advantages were observed in patient-reported outcomes, reduced rates of instability recurrence, and lower revision surgery requirements.[23,24]

It has been identified that the Latarjet procedure, although providing potential benefits, carries a significant risk of complications, which are reported to reach up to 25%. This includes issues such

as arthrosis, malpositioning of the graft, fractures of the graft, and screw breakage. Particularly in the youthful, athletic demographic, these complications pose a grave concern, despite their typically minor clinical relevance over shorter to medium durations. To secure favourable results, the execution of the procedure demands both precise surgical methods and high levels of surgeon proficiency.[12]

Emerging Technologies and Advancement

Emerging technologies and advancements in surgical techniques are significantly improving the management of glenohumeral joint dislocations in athletes. One such innovation is the use of 3D imaging and patient-specific surgical planning, which allows for more precise preoperative assessments, particularly in cases of complex shoulder instability or bone loss. These advancements enable surgeons to tailor procedures to the unique anatomy of each athlete, enhancing the accuracy of repairs.[25] Additionally, robotic-assisted surgery is gaining traction, offering greater precision and control during arthroscopic procedures, minimizing errors and improving outcomes.[26,27] Biologic augmentation, including the use of platelet-rich plasma (PRP) and stem cell therapies, is also being explored to accelerate healing and enhance tissue regeneration, promoting faster recovery and potentially reducing the risk of re-injury.[28,29] Furthermore, improved suture anchor designs and bioresorbable implants are helping to secure repairs more effectively while reducing long-term complications. Virtual reality (VR) training tools are also advancing surgeon proficiency in complex stabilization techniques. These technological innovations are particularly beneficial for athletes, as they facilitate quicker recovery, lower recurrence rates, and improve overall shoulder function, allowing for a safer and more efficient return to sports.[30] However, all these developments are still not popular considering the limitations of extensive and global clinical trials but can still be considered.

F. CONCLUSION

Glenohumeral joint dislocations, notably prevalent among athletes, represent the most frequently encountered major joint dislocation in emergency settings. This issue predominantly arises from trauma, contact sports, and falls, with anterior dislocations being particularly common. The susceptibility to recurring instability is higher among younger, male athletes, presenting a considerable health concern. The assessment of the nature and extent of this instability is conducted through a comprehensive physical examination and detailed patient history. While nonoperative treatments have shown efficacy, particularly among first-time dislocations in older, less active individuals, an increasing shift towards prompt surgical interventions can be observed in athletes and the younger demographic to reduce the likelihood of recurrence and enhance outcomes related to returning to sports. Depending on the extent of damage to bone and soft tissues, surgical techniques such as arthroscopic soft tissue stabilization and bone augmentation procedures, including the Latarjet, are employed. Each treatment approach aims to minimize recurrence and facilitate a return to activity, with the choice guided by patient demographics, functional demands, and anatomical risk factors. Further research is necessary to optimize treatment algorithms and enhance long-term outcomes for patients with glenohumeral joint dislocations.

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