



Managing Shoulder Instability in the Overhead Athlete

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Accepted: 25 September 2022 / Published online: 12 October 2022

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Abstract

Purpose of Review Shoulder instability in the overhead athlete is a difficult problem because of the balance between necessary laxity for athletic movements and stability of the joint. The purpose of this review is to provide an overview of the clinical evaluation of shoulder instability in the overhead athlete and present evidence-based management strategies for each subtype of shoulder instability, including novel techniques and outcomes.

Recent Findings Recent investigation has shown that throwers and other overhead athletes are more likely to present with subtle subluxation events rather than discrete dislocations as their primary symptom. While overhead athletes with discrete anterior dislocation events are likely to begin with non-operative management, many progress on to surgical intervention. Surgical management of glenohumeral joint instability continues to pose challenges due to the potential for over-tensioning for the sake of stability at the expense of the adaptive laxity that often confers performance benefits in the overhead athlete. Novel, individualized, and sport/position specific approaches are needed to address this complex issue.

Summary The optimal management of shoulder instability in the overhead athlete continues to be a controversial topic due to the complex work-up, an increasing number of surgical options with varying indications, and low volume of high-quality studies comparing any of the treatment options. The Anterior Shoulder Instability International Consensus Group guidelines from February 2022 offer the most updated guidelines on work-up and management. Overall, high-quality randomized controlled trials are required to determine the optimal treatment for specific pathologies and aid in creating patient-centered management plans.

Keywords Shoulder instability · Subluxation · Dislocation · Overhead athlete · Return to sport

Introduction

Shoulder instability is a common problem for the overhead athlete; some of the most common etiologies include traumatic shoulder instability events, chronic overuse, and microtrauma [1, 2]. The repetitive stress of the overhead mechanism, specifically excessive abduction and external rotation, places overhead athletes at risk for instability. Although anterior shoulder instability (ASI) is the most common pathology plaguing this athlete population, posterior and

multidirectional instability also occur and require attention to detail in their diagnosis and management [3, 4]. The repetitive arc of motion and extreme forces to which an overhead athlete subjects the shoulder joint can slowly change the form and function of the anatomic stabilizers of the joint during the developmental years. This “normal adaptation” can progress to pathologic dysfunction in a number of ways including glenohumeral internal rotation deficit, internal impingement due to tightening of the posterior capsuloligamentous structures, and a relative loosening of the anterior structures, superior labral tears, biceps tendon injuries, and rotator cuff tendinopathy or tears [5].

Posterior shoulder instability (PSI) resulting from repetitive microtrauma in throwing athletes may present as decreased throwing velocity or pain rather than subjective instability, so a high clinical suspicion is required for diagnosis [6]. Etiologies of PSI in baseball players (besides throwing) include diving with an outstretched arm and “batter’s shoulder” where there is posterior subluxation of the lead shoulder during the batting motion [7]. Multidirectional instability (MDI),

This article is part of the Topical Collection on *Injuries in Overhead Athletes*

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or instability in two or more directions, is common in sports such as swimming, where generalized laxity of the shoulder joint affords the athlete a competitive advantage but can evolve to cause pain and dysfunction of the joint [8–10]. Shoulder instability in the overhead athlete is typically managed first by non-operative methods, in select cases, or various open or arthroscopic procedures with moderately successful outcomes. The substantial variability in study methodologies and limited sample sizes have made it difficult to reach consensus on a gold standard of management of these injuries [11]. This review presents a description of the clinical evaluation of the overhead athlete with an unstable shoulder, management strategies, and expected outcomes as currently reported in the literature.

Patient Presentation

History and Physical Exam

For overhead athletes, a thorough history focuses on distinguishing physiologic laxity from symptomatic instability, and understanding the degree, frequency, etiology, and direction of shoulder instability. While frank dislocations are more common in contact athletes, and overhead athletes are more likely to present with more subtle subluxations, any type of instability can occur in any athlete [12•].

In terms of directionality, it can be difficult for an athlete to understand the direction of instability, so it is helpful to determine their position of apprehension. This is typically the abducted/externally rotated position for anterior instability and adducted/internally rotated position for posterior instability. Anterior instability is the most common direction for instability, representing approximately 90% of all instability events [12•, 13••, 14]. Younger age and smaller glenoid width have been linked to increased risk of anterior instability [15•]. Patients who suffer from posterior instability tend to present with posterior shoulder pain with or without subjective instability [12•, 16].

In terms of physical examination, in addition to standard visual inspection, palpation, and ROM, there are several provocative maneuvers which aid in identification of both the direction and degree of instability. The apprehension and relocation tests are important for determining the direction of instability [12•]. The apprehension test has a reported sensitivity and specificity of 98% and 72%, while the relocation maneuver has reported 97% and 78%, respectively [12•]. Additionally, the load-and-shift test can measure glenohumeral translation and passive joint stability in both the anterior and posterior directions with a reported sensitivity of 72% and specificity of 90% [12•].

Posterior instability can be discerned through the jerk or posterior load test. This maneuver is named for the distinctive jerk or clunk appreciated when the humeral head reduces back to its native anatomical position [12•]. The sulcus sign can be

utilized to identify multi-directional instability. This maneuver is considered positive if a sulcus appears between the acromion and superior humeral head with downward traction of the arm [12•, 14]. Notably, Beighton scores have recently been shown to be poor predictors of abnormal shoulder laxity (low sensitivity and positive predictive value), but these can still be helpful for providing an overall idea of the extent of generalized laxity and mobility [17].

Diagnostic Studies

Patients presenting with symptoms of shoulder instability and pain will routinely undergo plain film radiographs (true glenohumeral joint anterior to posterior view, internal rotation, external rotation, axillary, and scapular-Y views) as the preliminary imaging modality. Magnetic resonance imaging (MRI) is typically obtained in the setting of recurrent instability, loose bodies, suspected concomitant rotator cuff injuries, or if surgery is planned. Although rare in the overhead athlete, when anterior glenoid fractures are present or if there is noticeable glenoid or humeral head bone loss, a CT scan is helpful for quantifying the severity of the bone injury.

Management and Outcomes

Non-operative Management

Anterior Instability

The Anterior Shoulder Instability International Consensus Group, which reviewed a variety of concepts regarding management of anterior shoulder instability not specific to overhead athletes, reached 92% consensus on the indications for non-operative management including “low risk of recurrence, absence of glenoid bone loss, timing in-season to allow for return to play, and age <14 or >30 years old” [18•]. These factors are important to consider in the shared decision-making process with the patient. Non-operative management methods are variable depending on the pathology, severity, provider preference, and athlete adherence to the rehabilitation plan. In the absence of fractures, significant bone loss, or concomitant shoulder injuries (rotator cuff tears, biceps tendon ruptures, etc.), the mainstay of treatment of ASI after a first-time instability event is formal physical therapy to work on optimizing ROM, strength, scapular positioning/stability, and muscle synchrony. While this is true for most athletes, it is particularly true for the overhead athlete where surgical outcomes are somewhat less predictable compared to non-overhead athletes.

The current literature tends to consist of small sample sizes of specific patient groups, which makes it difficult to present

generalizable data to patients when deciding what treatment plan to pursue; however, longer-term studies have recently been added to the body of literature. A recent study by Wilbur et al [19••] presented long-term outcomes (mean follow-up for 12 years) from a matched cohort of overhead athletes and non-overhead athletes who suffered from ASI. They included both dislocations and subluxations as well as athletes of different competition levels, which allowed for a broad comparison of these groups. They found that overhead athletes were more likely to present with a higher number of instability events compared to non-overhead athletes, and they also had a predilection for subluxations rather than frank dislocations. Contrary to common opinion, there were no differences in PRO's and clinical outcomes including recurrent instability and revision surgery between non-overhead and overhead athlete cohorts at long-term follow-up. Overhead athletes had a RTP rate of 71% in this study compared to 81% for the non-overhead athlete. Again, with small sample sizes, it is difficult to make generalized statements regarding care of these patients; however, non-operative management is the preferable first-line treatment for these athletes.

Posterior Instability

Although uncommon, overhead athletes can experience posterior instability [4•]. Sheean et al recommend a four phase rehabilitation trial prior to proceeding with operative management of these injuries, which includes a progression from pain free range of motion/sleeper stretch, scapular muscle strengthening, advanced strengthening, and finally sport specific rehabilitation, such as a progression to return to throwing [4•]. Blacknall et al [20] presented a consecutive cohort of nineteen patients, many of whom participated in overhead sports, who suffered from atraumatic posterior shoulder subluxation. They reported significantly improved PRO scores following a non-operative rehabilitation program, and all patients were able to return to hobbies/sports at final follow-up. More recently, a study of long-term outcomes after non-operative management of PSI in 37 patients (9 of which were overhead athletes) reported a low rate of recurrent instability (8%) but a high rate of persistent pain (54%) [21••].

Multi-directional Instability

Given the high degree of GH joint motion required for most overhead sports, MDI is relatively common among these athletes. This may be the result of baseline laxity combined with natural adaptations of the shoulder time due to repetitive loads on the shoulder during the developmental years. The problem arises when these “normal adaptations” progress to pathologic dysfunction. Because athletes can present anywhere along this spectrum from “normal anatomy” to “normal adaptation” to

“pathologic dysfunction,” it is critical that care be individualized to the athlete based on their specific anatomy and sport demands. For this reason, nonoperative management is the primary initial treatment strategy for most overhead athletes with symptomatic MDI. To compensate for the lax passive anatomic structures and static stabilizers (capsule, labrum, ligaments), the muscles (dynamic stabilizers) around the shoulder are strengthened to facilitate better active control of the joint [22, 23]. Multiple rehabilitation programs have been proposed for this pathology and each focus on restoring dynamic control of the shoulder and scapula [24–27].

Mid-season Athlete

Patients experiencing symptomatic shoulder instability during their competition season present a challenge for the team physician and athletic training staff, balancing the desires of the athlete to continue competing with ensuring a safe RTP [28•]. Functional bracing has been utilized to temporize the mid-season athlete's injury, though there is a paucity of high-quality evidence to support its use [29•]. For overhead athletes in particular, a functional brace on the dominant/throwing arm is unlikely to allow them to RTP at a similar level.

In the senior author's practice, the ability to RTP depends on satisfying the following four criteria: restoration of full range of motion, full strength, absence of pain, and absence of apprehension. Overall, the process of meeting these criteria can often occur between 1 and 3 weeks depending on the age, sport, position, and severity of instability episode. An older study by Buss et al [30] reported that 87% of in-season athletes suffering from anterior instability episodes returned to play at a mean of 10 days after injury; however, over half of them required surgery in the off-season. Dickens et al further expanded on this, noting almost 75% of their cohort reached RTP at a median of 5 days after aggressive rehabilitation; the primary reason for those unable to RTP was insufficient shoulder function. However, 64% of those who returned experienced instability recurrence [31]. Patients should be counseled on the high likelihood of recurrent instability in both this season and future seasons, as well as the likelihood that they may need surgery in the future.

Operative Management

A review of return to sport criteria by Griffith et al [32•] found there were fourteen different surgical shoulder stabilization procedures reported in the literature, the indications for which tend to be based on patient preference, surgeon preference, and geographic location rather than high-quality outcome studies [33•]. This highlights the absence of consensus on optimal management and the need for additional study in the area, particularly for the overhead athlete.

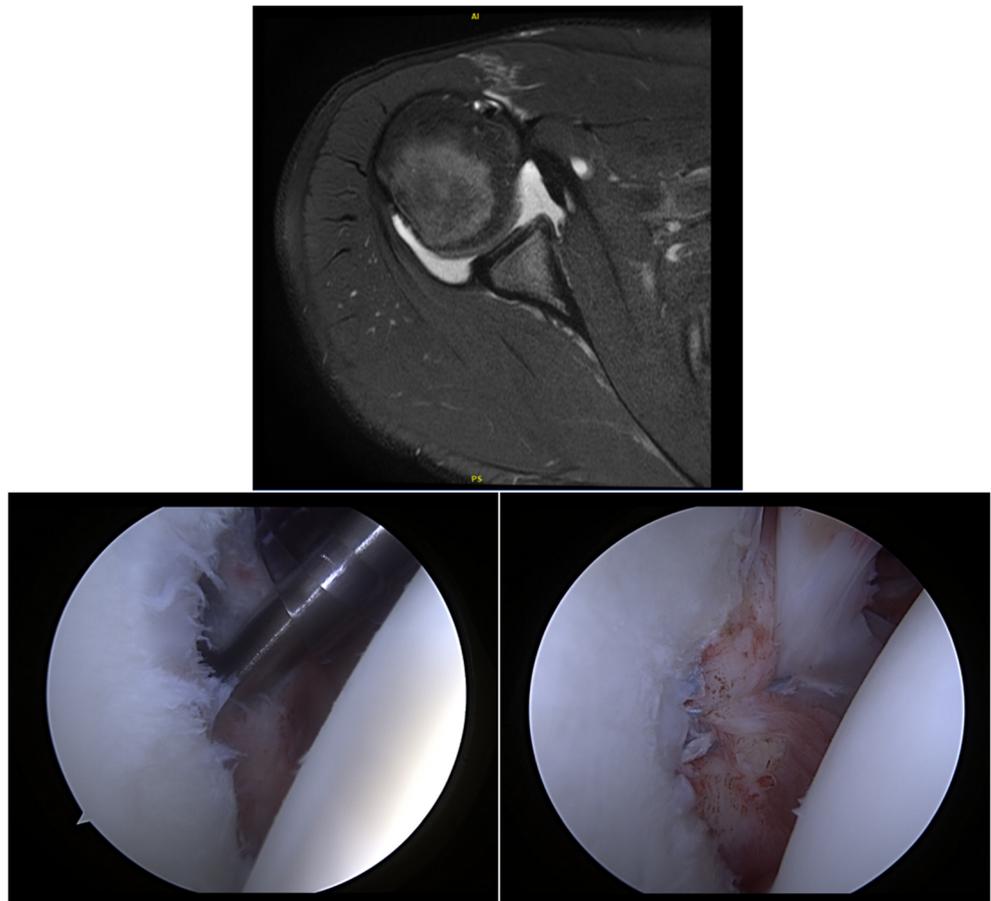
Anterior Instability

Surgical options for patients with ASI include, but are not limited to, arthroscopic capsulolabral repair (Bankart repair), open labral repair, bony augmentation procedures, remplissage, and capsular plication (Fig. 1). In a prospective study of overhead athletes with ASI treated with arthroscopic labral repair from the MOON Shoulder Instability Consortium, the rate of recurrent instability was low (4%); however, only 63% of athletes returned to sport and 45% were able to return to their pre-injury level of competition [34]. A similar study reported a 0% recurrence rate for overhead athletes undergoing arthroscopic Bankart repair on the dominant shoulder, but only 63% were able to return to the same level of sport [35]. In a baseball specific study, Park et al reported an average RTP of 8.4 months and a RTP rate of 82% after arthroscopic labral repair [36]. Wilbur et al found overhead and throwing athletes to suffer from more subluxation rather than frank dislocation compared to matched non-overhead athletes (56% vs 80%). Additionally, although overhead athletes were more likely to undergo initial operative management, there were not significant differences in RTP, recurrent instability, or revision surgery between the groups [19]. As

expected, those who had injuries to their non-throwing shoulder and those who play in the in-field had more favorable outcomes, and pitchers had the worst outcomes. These recent studies give important insight to the post-operative course of overhead athletes undergoing arthroscopic capsulolabral surgery with intermediate-term follow-up.

Although arthroscopic anterior capsulolabral repair is a reasonable surgical option for some overhead athletes, one study found that overhead sports are a risk factor for recurrence of instability after arthroscopic Bankart repair [37]. This has led some authors to attempt to augment the anterior capsular repair with a remplissage of the Hill-Sachs defect. Unfortunately, outcomes of remplissage in the overhead athlete have been relatively poor. The Anterior Shoulder Instability International Consensus Group achieved strong consensus (95% of experts agreed) in recommending against remplissage for overhead athletes [38]. This recent consensus statement is in line with the study by Garcia et al [39] which reported that 65.5% of the throwing athletes who had undergone a remplissage procedure had difficulty throwing post-operatively. This is likely due to decreased shoulder ROM and inability to achieve the necessary amount of shoulder external rotation to be able to throw.

Fig. 1 Shoulder MRI (1) of anterior labral tear with chondral delamination. Arthroscopic images before (2) and after (3) surgical repair



For athletes with significant glenoid bone loss, reconstruction procedures such as Latarjet may be indicated. However, overhead athletes who undergo Latarjet are less likely to return to sport, and this is likely due to the alterations in shoulder biomechanics that make the shoulder stable but unable to get in position for peak athletic performance. A recent MOON Shoulder Group study found that only 63% of athletes undergoing Latarjet were able to eventually return to sport [40]. In a recent systematic review, RTP after open Latarjet to any level was 84%, with 75% able to return to the same level of play for all athletes [41].

Posterior Instability

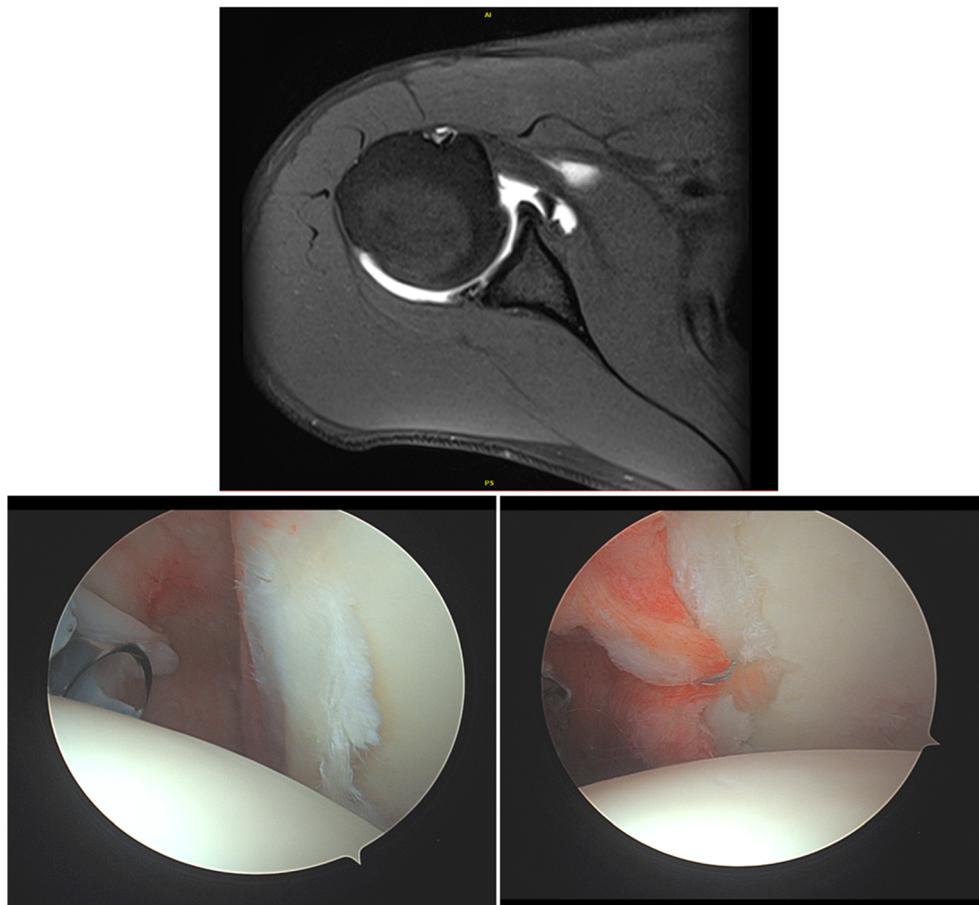
Overhead athletes with posterior shoulder instability without satisfactory results from nonoperative care may be candidates for posterior capsulolabral repair using anchors (Fig. 2) [4]. Because of the potential detrimental effects of over tensioning of the posterior shoulder during repair, aggressive posterior plication is generally avoided in this athletic cohort unless the instability is severe. McClincy et al reported outcomes after arthroscopic posterior capsulolabral repair in 48 throwing athletes, 60% of which returned to their pre-injury level of

play and 85% returned to sport at some level compared with 88% in the non-throwing comparison cohort [42]. Similar rates of return to sport at their pre-injury level of play were reported by Kercher et al [43], with 61% returning at the same level after arthroscopic posterior labral repair, and a recent metaanalysis of 1153 shoulders with a pooled return to preinjury level of play of 68% [44]. Vaswani et al [45] reviewed a series of 105 throwing athletes following posterior shoulder stabilization and found that the revision rate was 9%, though they did not find significant factors associated with revision apart from female sex. In this cohort, only 37% were able to RTP at the same level. These recent findings allow for optimal patient selection and allow for setting realistic patient expectations for the postoperative course.

Multidirectional Instability

For those who fail a comprehensive rehabilitation program, surgical management remains a possibility for patients with MDI. Surgical options for MDI include open labral repair with capsular shift. Open repair with capsular shift is the relative gold standard for MDI management as it offers successful stabilization and a long-term recurrent instability rate as low

Fig. 2 MRI of posterior labral tear (1). Intra-operative arthroscopic image of tear (2) and after repair (3)



as 8% in a recent systematic review of 226 shoulders [46]. The technique described by Carlson Strother et al utilizes all-suture anchors in the humeral head to achieve lateral and superior capsular shift after repairing the labral Bankart lesion (Figs. 3 and 4) [47]. However, the procedure is technically challenging and commonly results in over-stabilization, thus limiting its feasibility in practice. Similar to the Latarjet procedure, open labral repair with capsular shift allows for dramatic and robust stabilization of the shoulder, but this may come at the cost of athletic performance as patients may not be able to get the shoulder into extreme degrees of abduction and external rotation after surgery. Accordingly, a very thoughtful approach should be taken when surgically addressing MDI in the overhead athlete.

Recommendations

For all forms of glenohumeral instability in overhead athletes (anterior, posterior, or MDI), the authors strongly prefer to begin with a comprehensive course of non-operative treatment. This primarily focuses on physical therapy with the aim at restoring motion, improving strength, reducing pain, eliminating the sensation of apprehension, and optimizing

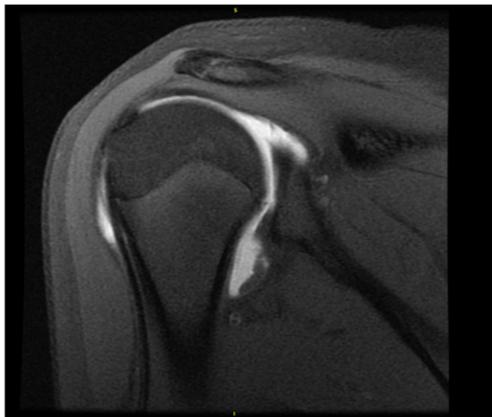


Fig. 3 MRI of a left shoulder showing increased capsular volume (1). Intra-operative image of open capsule (2)

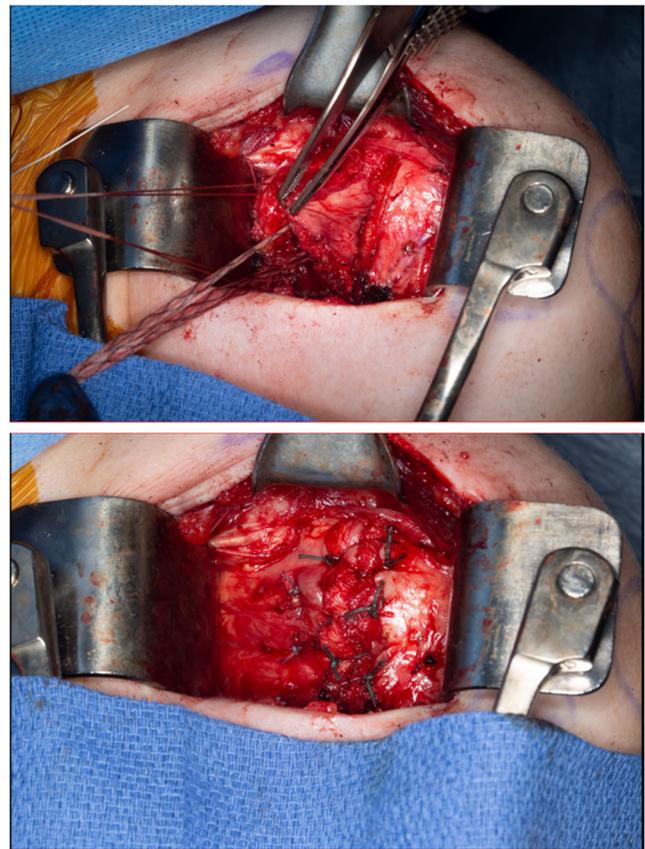


Fig. 4 Intraoperative image demonstrating excess capsule after shift (1), note the subscapularis is not yet repaired. Intra-operative image showing restored capsule anatomy after final repair (2)

the dynamic stability of the shoulder through the rotator cuff and scapular musculature. In the setting of severe bone loss, fractures, substantial concomitant shoulder pathology (i.e., full thickness rotator cuff tears), or when non-operative treatment fails, surgical repair can be considered. Typically, when treating shoulder instability in the overhead athlete with surgery, it is best to do the smallest surgery that is able to restore appropriate joint stability. More specifically, we prefer an arthroscopic approach whenever feasible, and great care is taken not to over tension the shoulder and substantially alter post-operative shoulder motion. This is typically accomplished with an arthroscopic labral repair with limited incorporation of the capsule. It is worth noting that this is in stark contrast to stability surgery in the non-overhead athlete where the capsule is aggressively incorporated into the repair to maximize shoulder stability. In instances when an overhead athlete needs a more aggressive surgical intervention (such as remplissage, open labral repair with capsular shift, or bony reconstruction of the glenoid with Latarjet or allograft) in order to restore joint stability, appropriate expectations should be set pre-operatively. Although these procedures are highly successful in eliminating shoulder instability, they decrease an athlete's chance of returning to high level overhead athletics.

Conclusions

Shoulder instability in the overhead athlete encompasses multiple pathologies with complex evaluation and management. While expert opinion consensus studies and longer-term outcome studies have been recently published, there remains a need for high-quality, randomized studies of overhead athletes so that shoulder instability can be treated in an evidence-based manner that does not rely on studies with small sample sizes or surgeon preference. Until that time, a non-operative approach with a focus on physical therapy and rehabilitation is the mainstay of treatment as surgical treatment is reserved for cases failing non-operative management or for athletes with substantial concomitant shoulder pathology.

Declarations

Conflict of Interest Christopher L. Camp has received personal fees and non-financial support from Arthrex, personal fees and non-financial support from Zimmer Biomet, non-financial support from Stryker Corporation, and personal fees from Gemini Inc. Jonathan D. Barlow has received personal fees, non-financial support, and other from Arthrex; personal fees and other from Stryker Corporation; personal fees and other from Zimmer Biomet Holdings Inc.; and personal fees from DePuy Synthes Sales Inc. Kelechi R. Okoroa has received grants, personal fees, and other from Arthrex; personal fees and other from Stryker Corporation; personal fees and other from Zimmer Biomet Holdings Inc.; personal fees from Medical Device Business Services Inc.; personal fees from Smith & Nephew, Inc.; personal fees from Medtronic USA, Inc.; personal fees from Wright Medical Technology, Inc.; personal fees from Lilly USA, LLC; other from Pinnacle, Inc.; other from Medwest Associates; personal fees from Bioventus LLC; personal fees from Vericel Corporation; and other from Endo Pharmaceuticals, Inc. Alexandra M. Arguello, Sara E. Till, and Anna K. Reinholz declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

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