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Posterior Shoulder Instability in the Throwing Athlete

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Posterior capsulolabral injuries are common problems faced by athletes, especially throwing athletes. Posterior shoulder instability can occur as a result of multiple mechanisms, including acute traumatic events, or a more insidious process of repetitive throwing. An understanding of the pathomechanics and pathoanatomy of posterior instability in the throwing shoulder is essential in order to effectively manage throwing athletes. Athletes will more commonly complain of shoulder pain and difficulty with throwing rather than of shoulder instability. A thorough physical examination to identify potential underlying causes as well as specific maneuvers to elicit posterior instability are important in the evaluation and workup of the throwing athlete. Appropriate imaging, including with plain radiographs and advanced imaging assist in decision-making. Treatment options include both nonoperative intervention with a heavy reliance on physical therapy and surgical intervention consisting of arthroscopic posterior labral repair. Recent advancements in our understanding of shoulder biomechanics and posterior shoulder instability, improvements in diagnostic abilities via examination, imaging, and intraoperative evaluation, as well as advancements in arthroscopic techniques have allowed surgeons to better identify and appropriately manage posterior capsulolabral pathology in athletes.
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Introduction

Labral pathology is a common finding among athletes. Although posterior instability has previously been reported to account for only 2% to 5% of all instability cases,[1-3] recent advances in imaging techniques and a better understanding of the pathology of posterior instability have led to higher reporting of the incidence and prevalence of posterior shoulder instability, especially among throwing athletes. The prevalence of posterior instability as a proportion of all shoulder instability cases reported in various series has ranged from 10% to 24.2%,[2,4-6] with most cases being due to subluxation or incomplete events rather than frank posterior dislocations.[5] Posterior labral injuries have traditionally been reported in association with a posteriorly directed axial force, frequently with the upper extremity in a position of shoulder forward flexion, adduction, and internal rotation, following an acute traumatic event or due to repetitive microtrauma in both collision athletes and those who participate in repetitive maneuvers. Throwers, on the other hand, comprise a unique subset of athletes for whom posterior labral tears and posterior instability occur through a different mechanism. Posterior labral pathology in throwers is an insidious process that can occur as a result of repetitive microtrauma[7-9] and capsular contracture[10], as well as a breakdown in the complex interplay between the biceps anchor, the more mobile superior labrum, adaptive capsular laxity, and the buttress effect of the inferior labrum. This current concepts article will review the current understanding of the pathomechanics and pathoanatomy of posterior

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instability in throwers, its evaluation and diagnosis, and management strategies in order to allow for better identification and treatment of posterior labral pathology.

Pathomechanics and Pathoanatomy

Posterior instability in throwers occurs through an indirect mechanism as a result of chronic overuse and repetitive microtrauma to the posterior capsulolabral complex, which then leads to capsular attenuation and subsequent repetitive posterior subluxation.[7,10-12] This is in contrast to the more direct mechanism of injury that more commonly occurs in contact athletes and those athletes who sustain recurring posteriorly directed axial load to the shoulder related to repetitive arm motions,[12-14] such as American football linemen, weightlifters, gymnasts, archers, rowers, golfers, swimmers, racket sport athletes, and athletes who fall onto an outstretched hand.[2,13,14] In addition to injuries related to throwing, baseball players can sustain injuries to the posterior labrum due to landing onto an outstretched arm such as when diving for a ball or sliding headfirst into a base, or sustaining posterior subluxation of the lead shoulder during batting – known as batter's shoulder.[10,15]

Due to the different pathomechanics of throwing and pathophysiology associated with posterior capsulolabral tears in throwers, the associated labral pathology typically arises just posterior to the biceps anchor along the superior labrum (type IIB SLAP tear) and then extends posteriorly and inferiorly.[12] The throwing shoulder is unique in that the presence of relatively increased capsular laxity accommodates the extremes of motion required during the pitching motion in order to generate the torque and velocity necessary for proper and effective throwing and pitching mechanics.[12] Therefore, there is a balance between this adaptive capsular laxity and injury to the capsulolabral complex resulting in pathologic instability.[12] Once the homeostasis of the throwing shoulder is disrupted, pathology ensues, which then causes shoulder dysfunction.

Both the posterior capsule, specifically the posterior inferior glenohumeral ligament (PIGHL), and the posterior labrum are important structures for generating compression across the glenohumeral joint.[12,16] Because the PIGHL is relatively thinner than the anterior band of the inferior glenohumeral ligament,[17] there is a propensity for this portion of the posterior capsule to undergo plastic deformation in response to repetitive forces.[12] Glenohumeral internal rotation deficit (GIRD) is a common finding in the disabled throwing shoulder, and was originally attributed to posteroinferior capsular tightness caused by repetitive traction injury to the posterior capsule on follow-through in pitching.[18] Increased humeral retroversion may contribute to increased posterior capsular thickness by placing additional stress on the posterior capsule during the deceleration phase of throwing.[12,18-21] A tight posterior and inferior capsule leads to an alteration in the mechanics of throwing by changing the center of rotation of the humeral head on the glenoid and can lead to progressive injury of the posterior capsulolabral structures as well as the rotator cuff.[10]

There is a distinction between true posterior shoulder instability causing symptoms in the throwing athlete and posteroinferior capsular contracture leading to GIRD and internal impingement affecting the posterosuperior labrum.[12,18] The concept of adaptive capsular laxity in throwers needs to be taken into account in order to fully understand the pathophysiology of posterior instability and throwing athletes. True posterior shoulder instability in the thrower occurs when the usual balance of multiple anatomic structures that allow for optimal pitching performance, including achieving maximum cocking, is disrupted, resulting in in a pathologic state.[12] Anatomically, the superior labrum is more loosely attached off the face of the glenoid, while the inferior labrum is more firmly attached on the face of inferior glenoid.[22] The more mobile superior biceps-labral complex serves to tension the humeral head during throwing and works in conjunction with the more immobile inferior labrum, which provides a static bumper effect to compress the humeral head into the glenoid during the throwing motion.[12,22] When these two segments are functioning appropriately, the shoulder is balanced and stabilized during overhead throwing such that humeral head translation is minimized, the glenoid is deepened as a result of the labrum, and the PIGHL provides tension posteriorly. Because the superior labrum is inherently more mobile, throwing athletes can tolerate some degree of separation of the superior labrum from the glenoid, such as in the presence of a small SLAP tear. The superior biceps-labral complex is still able to provide tension in this setting despite some detachment of the superior labrum. Some have even referred to this as a "good" SLAP tear which may facilitate achieving maximal abduction/external rotation in late cocking due to its adaptive nature among elite throwing athletes.[12]

This balance is maintained as long as the bumper effect of the inferior labrum is still intact.[12] As the labrum extends from the superior aspect of the glenoid more posteriorly and inferiorly, the posterior labrum is less mobile and more adhered to the glenoid like the inferior labrum.[22] Once a SLAP tear extends more posteriorly and inferiorly, such as into the PIGHL, there is loss of compression along the posteroinferior aspect of the shoulder.[12] Anatomically, the posterior and posteroinferior labrum then frequently becomes flattened and/or undergoes intrasubstance delamination.[12] With these pathologic changes, a cascade of events occurs consisting of an incompetent superior biceps-label complex, which no longer serves to tension the humeral head during throwing, a decrease of the bumper effect of the posteroinferior capsulolabral complex, and decreased tension in the PIGHL. This results in increased contact between the posterosuperior glenoid labrum and the rotator cuff, leading to the so-called "kissing lesion" between a partial-thickness infraspinatus tear and posterosuperior labral tear.

The dynamic peel-back mechanism of the biceps anchor[18] on the posterosuperior labrum also comes into play when evaluating the balance between normal, or adaptive, biomechanics of throwing and pathology. A milder peel-back mechanism may be present in normal throwing shoulders as an adaptive mechanism

to allow for greater external rotation and abduction in the setting of a more mobile superior biceps-labral complex without loss of stability.[12] Alternatively, in the presence of a pathologic SLAP lesion and posterior labral tear, the peel-back mechanism results in a more forceful and sudden snapping of the posterosuperior labrum due a decoupling effect of the superior and posterior aspects of the labrum, leading to the loss of their stabilization function.[12]

Clinical Evaluation

Presentation

Although symptoms of posterior labral injuries and posterior instability can present acutely following a single traumatic event, more often these present insidiously with vague posterior shoulder pain or generalized shoulder discomfort with activity, weakness, and decreased athletic performance.[12-14] Patients can also have mechanical symptoms associated with their posterior shoulder pain, including clicking and popping, which creates a ratcheting-type sensation.[12,14] However, these mechanical symptoms are often present without a sense of subluxation or apprehension as with anterior shoulder instability. In a case series of 32 male baseball players who underwent posterior labral repairs by the senior author of this current review, 25 (78%) reported pain as their chief complaint, 6 (18.8%) indicated a combination of pain and instability symptoms preoperatively, while only 1 athlete (3.1%) reported isolated instability symptoms prior to surgery.[10] Patient complaints of vague pain rather than instability may be part of the reason for the suspected underdiagnosis of posterior labral pathology. Pitchers may experience difficulty with warming up, a decline in throwing accuracy and velocity, decreased pitching endurance, shoulder soreness, and the need for longer recovery time between pitching sessions.[12] Pain tends to start during the mid-to-late acceleration phase and continues through ball release.[12]

Other portions of the history that should be elucidated include history of prior shoulder injuries, details about previous nonoperative interventions including specific physical therapy regimens, the types and locations of any previous injections, and any previous shoulder surgeries.[12] A history of injury to other areas, such as the legs or low back that may have disrupted the kinetic chain of throwing and led to increased stress on the shoulder, or a sudden increase in the volume of throwing which may have led to fatigue should also be explored. In addition, it is important to keep in mind that posterior shoulder instability is rare in isolation and is frequently associated with other conditions, including subacromial bursitis, biceps tendinopathy, partial articular-sided rotator cuff tears, and internal impingement.[12,18,23]

Physical Examination

Physical examination should begin with general inspection of the athlete including scapular positioning. Next, an overall assessment of the thrower's kinetic chain should be evaluated to identify potentially contributing deficits in the proximal part of the kinetic chain. Deficits in the lower extremity and trunk can lead to lower ball velocity, resulting in overexertion and subsequent breakdown of the arm in an attempt to compensate for it. Deficits that affect the pitcher's ability to generate force include reduced hip range of motion,[24] limited lower extremity motion,[25] and hip adductor and core weakness.[26] Overall dynamic lower extremity, hip abduction, and proximal core strength should be assessed with a standing single-leg balance test and a single-leg squat.[27]

Inspection of the scapula while at rest in a throwing athlete is important to note as the scapula on the throwing side is generally more protracted. Dynamic evaluation of scapulothoracic motion is an essential portion of the physical examination as scapular dyskinesis frequently contributes to shoulder pain and dysfunction.[28] Additionally, scapular winging may or may not be related to posterior instability,[14] so it is important to perform a thorough examination of both the shoulder and the scapula.

Bilateral shoulder internal and external rotation must be measured to determine the total arc of motion as well as to evaluate for any internal rotation deficits. GIRD is one of the most common findings in pitchers with a painful shoulder and should be eliminated from the differential diagnosis. Shoulder strength should also be evaluated, which is typically normal and symmetric. Weakness of external rotation at the side has been associated with SLAP lesions and associated ganglion cysts with suprascapular nerve compression.[29] Posterior glenohumeral joint line tenderness may be an occasional finding. A thorough neurovascular examination should also be conducted. In addition, patients should be evaluated for hypermobility and overall ligamentous laxity with assessment of their Beighton criteria and evaluation of their sulcus sign.[30]

There are multiple provocative shoulder examination maneuvers to identify posterior instability and posterior capsulolabral injuries. These include the posterior stress test, jerk test, Kim test, posterior load-and-shift test, modified-dynamic labral shear (M-DLS) test, and circumduction test.[12,14,31,32] These tests are all designed to either subluxate the shoulder posteriorly or pinch torn labral structures posteriorly to recreate the patient's symptoms. There is no definitive physical exam test, however, for posterior instability. Combination of both the Jerk and Kim tests has been shown to result in 97% sensitivity in detecting injury to the posteroinferior labrum, which is higher than when each test is used individually.[31] The M-DLS test is an examination maneuver that places shear stress along the shoulder while it is placed into a position that is similar to the cocking phase of the throwing cycle. The M-DLS test is reported to have a sensitivity of 72% and specificity of 98%[33] (Fig. 1). More recently, the dynamic posterior instability test (DPIT) and the modified dynamic posterior instability test (mDPIT) have been developed as additional provocative maneuvers to elicit posterior shoulder instability.[12] The DPIT is a throwing-specific examination maneuver that evaluates for posterior instability as a result of imbalances in the latissimus dorsi and pectoralis major. Imbalances of these dynamic stabilizers can generate a

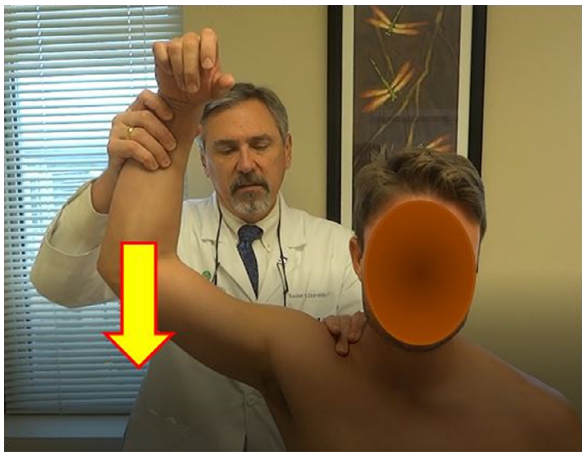

Figure 1 In the M-DLS test, the patient's arm is placed in the throwing position at 120 degrees and lowered to 60 degrees while applying a hyperextension force on the arm. A positive test consists of a sharp pain at the joint line during this maneuver.

posteroinferior translation of the shoulder reproducing a player's posterior shoulder pain.[12] The mDPIT is an assisted variation of the DPIT, with improved symptoms compared to the DPIT indicating a positive exam.[12]

Due to the frequent presence of concomitant shoulder pathology, other examination maneuvers should also be performed, including evaluation of the biceps tendon and superior labrum-biceps complex. Pennington et al[34] reported that one the most useful clinical exam findings in the setting of posterior label tears was pain and weakness with active compression test.

Imaging

Imaging of the throwing shoulder begins with a standard shoulder series of plain radiographs, including anteroposterior (AP), true AP (Grashey), axillary lateral, and scapular-Y, although these are typically normal in posterior instability.[14] The axillary lateral view can assist with evaluating glenoid anatomy, including the presence of hypoplasia, fracture, or loss of the posterior glenoid rim, but posterior bone loss is uncommon in the throwing athlete.[12] Reverse Hill-Sachs lesions may also be identified on plain radiographs.

Advanced imaging consisting of magnetic resonance imaging (MRI) and/or computed tomography (CT) are helpful for evaluation of glenoid anatomy, the posterior capsule, and posterior labrum. Assessment of glenoid anatomy, including version, width, and bone loss, is important as glenoid retroversion and dysplasia may be associated with posterior shoulder instability.[35,36] Generally, glenoid retroversion and humeral retrotorsion are greater in the throwing shoulder as compared to the non-throwing shoulder.[37] Ultrasonography can also be utilized to quickly evaluate humeral retrotorsion.[12] Although there is greater glenoid retroversion in the throwing shoulder,[37] the amount of glenoid version has not been shown to affect outcomes following posterior capsulolabral repair.[8] Decreased glenoid bony width, but not bone loss, has been associated with worse postoperative outcomes.[8] Bone loss in posterior instability, especially in throwers, is uncommon and less frequent than bone loss seen in recurrent anterior instability. The pattern of posterior glenoid bone loss in posterior shoulder instability is characterized by loss of bony concavity along the posterior aspect of the glenoid, increased anterior-to-posterior slope, and increased posterior glenoid version.[38] This type of bone loss is different than the more abrupt and steep transition of bone loss along the anteroinferior glenoid seen in anterior instability.[38]

The addition of an arthrogram to either a CT or MRI improves the ability to evaluate the capsule and posterior labrum.[39] A magnetic resonance arthrogram (MRA) is useful to identify more subtle lesions of the posterior labrum, such as Kim lesions, which are incomplete and concealed avulsions of the posteroinferior labrum that are often difficult to visualize on standard MRI[40] (Fig. 2). On MRA, a Kim lesion can be seen as a marginal crack in the posterior labrum, characterized by a loss of posterior labral height and partial extravasation of contrast into the junction between the posterior labrum and glenoid rim.[7] Increased posterior capsular volume on MRA has been shown to be an independent risk for posterior labral tears and symptomatic posterior instability.[36]

Overall, both MRI and MRA have been shown to identify labral tears with greater sensitivity than CT arthrography, with MRA being the most sensitive to detect detached labral fragments and labral degeneration.[41] It is important to note that standard MRI can underestimate the size and extent of labral tears.[42] MRI findings in the setting of posterior instability are often limited and incomplete, correlating to arthroscopic findings only 68% of the time.[6] More recently, MRA sequences with the arm in certain positions have been suggested to be useful for identifying specific labral pathology.[12] The authors favor the use of MRA in evaluation of patients

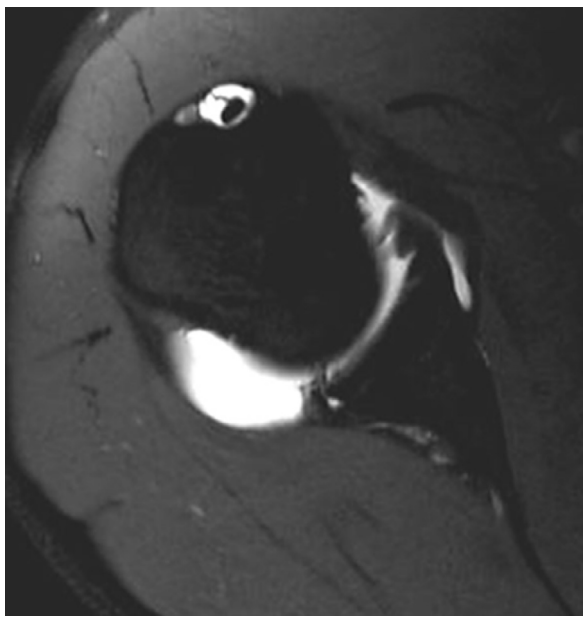

Figure 2 MRA of a posterior labral tear.

with suspected posterior instability and limit CT arthrograms to cases with suspected bony deficiency.

Asymptomatic labral findings are common in throwing athletes.[43,44] Therefore, it is important to correlate imaging findings to clinical signs and symptoms. In a study of 14 asymptomatic professional baseball pitchers, labral abnormalities were identified on MRI in 79% of the 28 shoulders.[44] In a cohort of 21 Major League pitchers without any shoulder symptoms, 10 (48%) were found to have SLAP tears and 13 (62%) had either anterior or posterior labral tears on preseason screening MRI.[43] These studies underscore that in elite throwing athletes, MRI will often reveal labral changes that may not be clinically relevant or are subclinical such that they are not yet pathologic from a functional standpoint. These findings emphasize the fact that conservative treatment is initially indicated in these athletes and that not all labral pathology identified on MRI requires surgery.

Treatment

Nonsurgical Treatment

The initial management of posterior instability consists of nonsurgical intervention with a prolonged course of physical therapy, which is successful in the majority of patients.[14] Emphasis is placed on posterior capsular stretching, proprioceptive training, plyometrics, core strengthening, balance, and a structured throwing program for baseball players directed by a physical therapist and/or certified athletic trainer who specializes in working with throwers.[10] Treatment begins by addressing any lower extremity or core issues identified on examination. One main focus of therapy consists of strengthening the dynamic stabilizers of the shoulder, including the posterior deltoid, external rotators, rotator cuff, and periscapular muscles to compensate for the deficient labrum and posterior capsule.[10,14] Because of the prevalence of scapular dyskinesis and scapular protraction in the throwing athlete, improving scapular dynamics is a key component of nonsurgical management. The success of nonoperative management varies in the literature from studies with lower rates of 40%-50%[12,45,46] to more optimistic studies with 63%-91% success.[14,47,48]

Therapy for a throwing athlete with posterior instability should consist of a phased-approach that also addresses concomitant abnormalities within the entire kinetic chain.[12,49,50] As recently outlined in a sample phased protocol by Sheean et al[12], the first phase of rehabilitation focuses on obtaining pain-free ROM and working on posterior capsular stretching, including with the sleeper stretch. The second phase consists of restoring neuromuscular control and muscle balance of the upper extremity, especially focusing on strengthening the periscapular stabilizers. Phase 3 then incorporates advanced strength training and plyometrics. Not until all of these goals have been achieved should the program advance to the fourth phase, which includes throwing. If a player breaks down again during the throwing portion of the program and all of the other phases were carried out successfully, a repeat of the conservative program is generally not successful and operative treatment may be considered.

Intra-articular ropivacaine and/or corticosteroid can be both diagnostic and therapeutic for players with intra-articular pathology including posterior shoulder instability. The literature on the use of biologics in shoulder pathology is still mixed with regards to the effectiveness of intra-articular injections, and therefore cannot specifically be recommended at this time.[51]

A recent study of active duty military service members with posterior labral tears on MRI found that patients who presented with a primary complaint of pain rather than instability were more likely to succeed with nonoperative management.[52] Poor prognostic indicators included a history of a single specific injury, a chief complaint of instability rather than pain, history of subluxation, inability to trust the shoulder with overhead activities, decreased strength during weight lifting, signs of instability during physical examination including positive posterior load-and-shift test and positive anterior apprehension, and imaging findings including increased glenoid retroversion, increased posterior humeral head subluxation, and anterior labral height.[52]

Surgical Treatment

Surgical treatment becomes an option when an exhaustive course of conservative management fails to return the athlete to their necessary level of competition. Surgical repair of posterior instability should achieve a balanced tension of capsulolabral tissues without overtightening the overhead athlete's shoulder, especially baseball players who rely on their adaptive biomechanics for throwing. Some posterior capsulolabral tears may only require debridement,[12] such as in cases of labral flap tears with a stable labral rim attached to the glenoid. However, even relatively small fissures in the posterior labrum may represent a significant lesion associated with posterior instability and require repair. Examination under anesthesia (EUA) is helpful in identifying the degree of instability associated with each particular lesion. More extensive tears and tears in symptomatic athletes will typically require repair.[12] The standard of care for surgical management in a throwing athlete with posterior shoulder instability consists of arthroscopic posterior labral repair. More aggressive posterior capsulolabral repair with imbrication may be appropriate in a contact athlete who is not a thrower. It is important to avoid over-constraint of the posterior capsule in the labral repair of an overhead throwing athlete to minimize the risk of stiffness, which could limit their ability to throw.[12] Open surgical repair was previously the method of choice for the surgical management of posterior shoulder instability, but has fallen out of favor due to better outcomes with arthroscopic repairs as a result of improved techniques.[13,14] The advantages of an arthroscopic approach include improved perioperative morbidity, better range of motion, shorter surgical time, improved cosmesis, reduced recurrence and revision rates, better patient satisfaction, and increased rates of return to sport and return to sports at the same

level.[13,14,23,53] Performing the procedure arthroscopically has the added benefit to allow surgeons to address concomitant intra-articular pathology including partial rotator cuff tears, SLAP tears, capsular tears including humeral avulsions of the glenohumeral ligament (HAGL) and posterior HAGL lesions.

Arthroscopic posterior labral repair can be performed in either the lateral decubitus or beach-chair position, depending on the comfort level, training, and preference of the surgeon. A recent systematic review demonstrated low rates of recurrent shoulder instability and high rates of return to sport following arthroscopic posterior shoulder stabilization in either position.[54] Proponents of the lateral position feel that this allows for better visualization of the posterior and inferior quadrants of the shoulder, resulting in better access to the entire glenohumeral joint.[7,12] Following appropriate positioning, performing an EUA is important to obtain a true examination of the shoulder uninhibited by patient guarding. This helps to better understand the degree of shoulder laxity and to identify any concomitant instability not previously appreciated. Because posterior shoulder instability can often present with the chief complaint of pain rather than frank dislocations or clinical instability, the EUA can more readily demonstrate and diagnose instability.[55] The degree of instability noted on EUA can help guide the surgeon as to the amount of tightening required and gauge the significance of labral tears identified at surgery in terms of their treatment by debridement versus repair. The EUA is a critical step in the treatment of patients with posterior labral tears.

The senior author's preferred technique[10] for a throwing athlete includes the beach-chair position and the use of a regional nerve block and general anesthesia. Standard arthroscopic portals are utilized with a posterior portal in the soft spot and a standard anterior portal through the rotator interval. Diagnostic arthroscopy is used to assess the extent of posterior capsulolabral pathology, as there can be a large variety of tear patterns. The posterior labrum should be visualized from both the anterior and posterior portals for a full appreciation of the tear pattern (Fig. 3). In a case series of 32 baseball players who underwent posterior labral repairs by the senior author, 32% of cases consisted of tears involving 90 degrees of the posterior superior labrum, 35% had tears involving the posterior 180 degrees of the labrum, and 32% involved 90 degrees of the posterior inferior labrum.[10] In addition, surgeons must look for Kim lesions, which are more discrete and may be more difficult to identify.[40,56] After performing a diagnostic arthroscopy, the arthroscope is placed into the anterior portal for viewing of the posterior labrum and a 5-mm working cannula is placed into the posterior portal over a switching stick. One technical factor that improves surgeon proprioception is to move the screen behind the shoulder and to face in that direction instead of trying to look backwards while operating (Fig. 4). A posterolateral trans-rotator cuff portal near the Portal of Wilmington off the posterolateral corner of the acromion is established to allow for inferior and posteroinferior suture anchor placement after localization with a spinal needle, and a second 5-mm working cannula is placed. While there are many variations of where to place the posterolateral portal, an alternative method involves placing it 2 cm inferior and 1 cm lateral to the previously established posterior portal.[12]

Any nonviable and degenerative portion of the labrum is debrided with a shaver via the posterolateral portal while viewing from anteriorly. The edge of the glenoid and glenoid neck are prepared to bleeding bone with a rasp and/or shaver. Suture anchors are placed along the glenoid rim at the location of the labral tear. A tissue penetrator through the posterior portal is used to pass a limb of the suture anchor through the labrum (Fig. 5). This suture limb is then retrieved out of the posterolateral portal. In a throwing athlete, care is taken to limit capsular plication to minimize the risk of overtightening a thrower's shoulder[12] (Fig. 6). In a nonthrowing athlete, such as a collision athlete, imbricating a small portion of the posterior capsule in the repair with the labrum is appropriate. Sliding knots are utilized to tie down the labrum, ensuring the knots are posterior and off the labral and articular surfaces. These steps are sequentially repeated until the labrum is repaired (Figs. 7 and 8). The number of anchors used and location of placement are

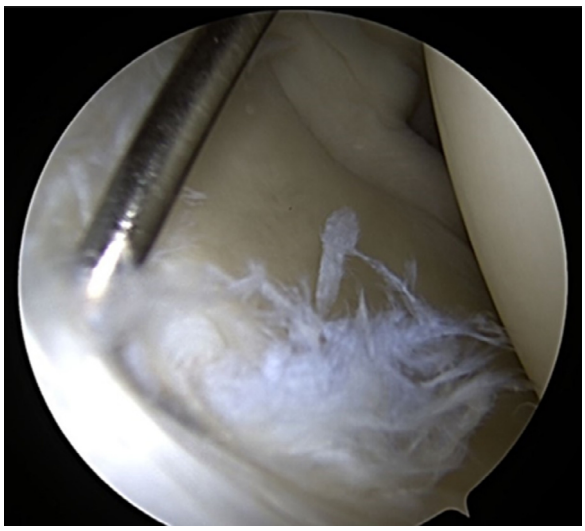

Figure 3 A posteroinferior labral tear seen from the posterior viewing portal.

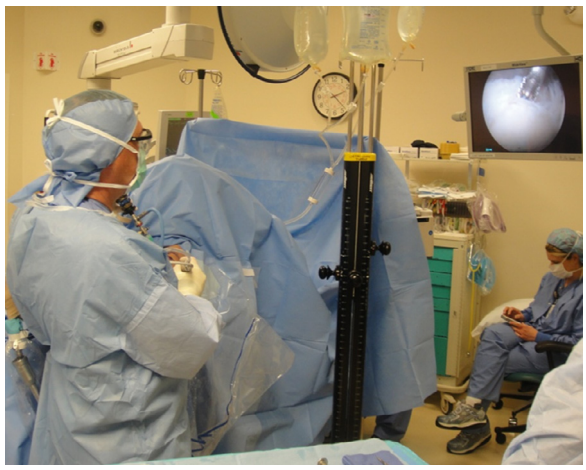

Figure 4 Looking posteriorly while repairing a posterior labrum improves the surgeon's proprioceptive abilities.

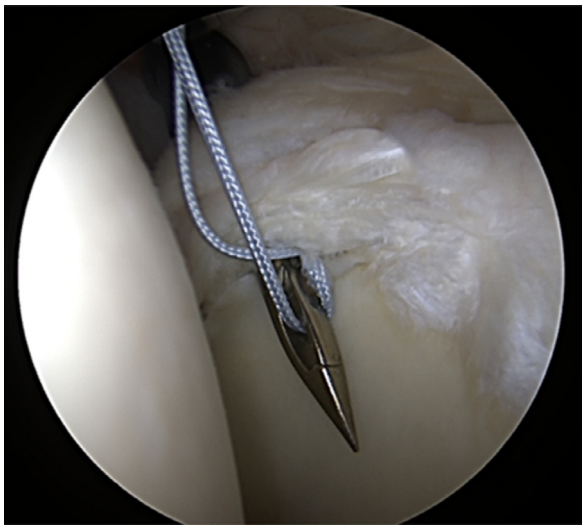

Figure 5 After insertion of the suture anchor on the glenoid rim via the posterolateral portal, a tissue penetrator is passed via the posterior portal through the detached labrum to retrieve one suture limb.

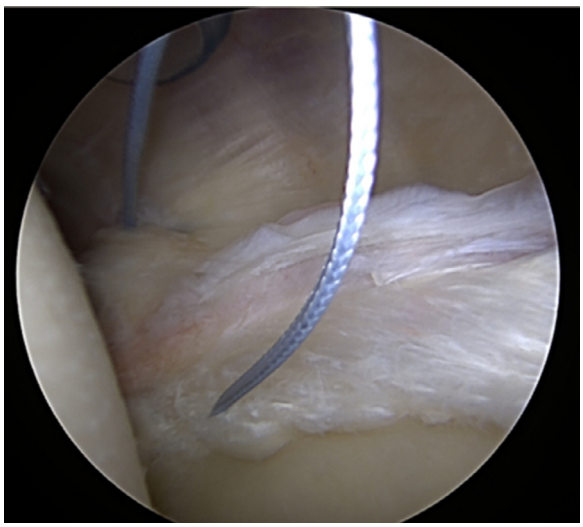

Figure 6 The suture has been passed through the detached labrum.

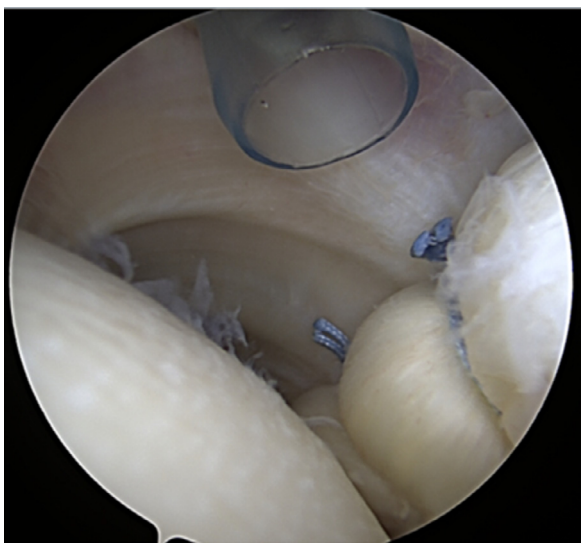

Figure 7 Labral repair viewed via the anterior portal.

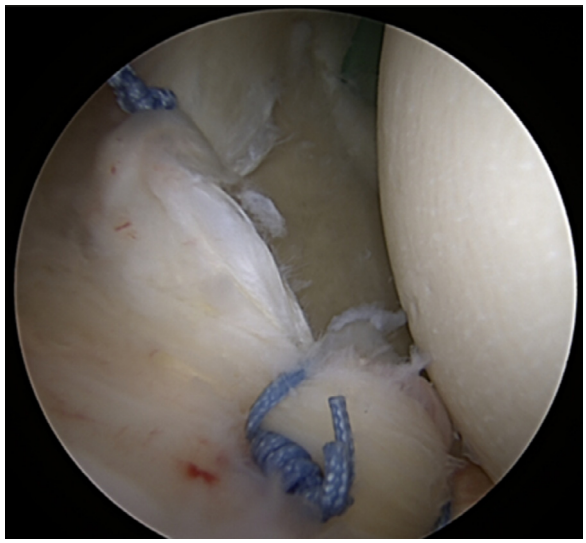

Figure 8 Labral repair viewed via the posterior portal.

dictated by tear anatomy. Along the posterosuperior labrum, knotless anchors are preferred to avoid potential impingement of overhead athletes. The posterior capsular defect may or not be repaired depending on surgeon preference.[12] The senior author of this review does not routinely do this.

Both knotted and knotless suture configuration with anchors can be utilized, as both techniques have been reported to result in equivalent patient reported outcomes[57] and similar overall outcomes.[58] In addition, both suture fixation methods are able to equally re-establish labral height.[59] A biomechanical study in a cadaveric model demonstrated a higher failure rate in knotless repairs utilizing traditional suture in type II SLAP tears compared to repairs with knot tying, with failures occurring most commonly at the suture soft tissue interface.[60] To minimize the risk of suture cutout, the use of wider sutures with knotless anchor repairs, such as with suture tape, has been suggested as an alternative.[61] Multiple studies have demonstrated benefits of the use of knotless suture anchor fixation over knot-tying, including shorter operative time,[57,58] lower profile,[62] improved pullout strength,[63] and the potential to better restore the meniscoid anatomy, especially of the superior labrum.[64] Theoretically, the use of knotless anchors decreases the possibility of knot loosening, migration, irritation, and abrasion of the articular surface as well as abrasion of the undersurface of the rotator cuff tendons with shoulder range of motion.[62,65]

The results of capsulolabral repair are improved with the use of suture anchors as compared with sutures alone, with one study demonstrating that throwers who underwent repairs with suture anchors had a 10-fold increased likelihood of return to sport compared to those who underwent repair without anchors.[66] There was no difference with regards to return to sport based on the use of anchors in the nonthrowing athletes in the same study.[66] Additionally, a systematic review and meta-analysis by DeLong et al[13] found that the use of suture anchors leads to fewer recurrence of instability and need for revisions, with more rapid return to sport when compared to anchorless repairs.

Postoperative Rehabilitation

According to the senior author's preferred postoperative protocol,[10] all patients are placed in a sling in neutral rotation for the first 3 weeks, During this immediate postoperative period, patients are allowed to remove the arm out of the sling for light activities of daily living. Low-impact cardiovascular exercises such as walking and stationary bicycle can be introduced at 2 weeks for athletes. ROM exercises can be started at 3 weeks after surgery with progression as tolerated unlike similar protocols following anterior labral repair. Resistance exercises are not allowed until 6 weeks following surgery. For baseball players, a throwing program is initiated at 4 months if strength and ROM have improved sufficiently to allow for this activity. Hitting off a tee is allowed at 3 months if the operative shoulder is the back shoulder but not until 4 months if it is the lead shoulder. Unrestricted activities are allowed at 6 months, including diving onto the operative arm.[10]

Outcomes

Arthroscopic posterior labral repair in throwing athletes is an effective treatment strategy for those who have failed nonsurgical management. However, the available literature on posterior instability repairs in throwing athletes has suggested that although throwers in general are able to return to play following operative repair, this is often at a rate less than that of nonthrowing athletes and frequently at a level of play less than prior to their injuries.[10,12] In a case series of baseball players managed surgically by the senior author of this review, 94% of players were able to return to baseball, while 61% of players were able to return to play at their previous level, and 6% did not return.[10] Position players were more likely to return to previous levels of play at 86%, compared to pitchers at 41%. Additionally, 73% of the players were very satisfied with their postoperative outcomes, while 21% were satisfied. In this case series, there were no significant ROM deficits following repair. Outcomes were not associated with labral tear size or number of anchors utilized. With regards to return to play, this is comparable to the 63% return to previous level of play by overhead athletes following SLAP repairs reported in the systematic review by Sayde et al.[67]

With regards to posterior labral repairs, specifically, Wanich et al[15] reported a 92% return to play among baseball players in a small series following surgery for batter's subluxation. Radkowski et al[68] reported a return to play of 55% in a group of throwers, compared to 71% for nonthrowing athletes, although both groups reported similar patient satisfaction. Other studies that have evaluated repair in elite throwers have found a return to play of approximately 30% to 60%.[23] The presence of a concomitant rotator cuff tear at the time of posterior capsulolabral repair with suture anchors does not appear to affect outcomes in throwing athletes following surgery, as 84% of the throwers were able to return to sport, while 56% were able to return to the previous level of performance.[69] These values are consistent with the return to play rates reported in the existing literature. Contact athletes, such as football linemen, appear to have better outcomes and a much higher return to sport than has been reported for throwers.[9,70] This is most likely due to the different forces placed on throwing shoulders and the need to preserve their ROM, while the primary goal in linemen is stability, even at the cost of slightly reduced ROM. This is consistent with the findings of the recent systematic review and meta-analysis by DeLong et al,[13] which found that overhead and throwing athletes have a lower return to sport compared to contact athletes and the overall athletic population.

In a retrospective cohort study of 48 overhead athletes, including 18 pitchers, undergoing posterior capsulolabral repairs who were compared to a matched cohort of nonthrowing athletes, both groups had similar American Shoulder and Elbow Surgeons (ASES) scores, stability, strength, and range of motion at a mean of 37 months after surgery.[66] Despite similar outcomes, only 60% of throwing athletes and 50% of pitchers were able to return to their preinjury level of play. This is compared to the nonthrowing athlete return to sport rate at the same level of 71%.

A recent large series by Fourman et al[71] reported on the outcomes following arthroscopic repair of type VIII SLAP tears, which are type II SLAP tears (detachment of the superior labrum-biceps complex) with posteroinferior extension, in 46 patients, which included 27 throwing athletes. Functional outcomes improved in the entire cohort, including stability, pain, ROM, Kerlan Jobe Orthopaedic Clinic (KJOC) scores, and ASES scores. However, when comparing the postoperative outcomes, throwers reported more pain, decreased ROM, lower KJOC scores, and lower ASES scores compared to nonthrowers. Overall return to play of 70.4% in throwers trended lower than the 94.7% return to play in nonthrowers, albeit not statistically significant. However, throwers were significantly less likely to return to play at the preoperative level compared to nonthrowers (37% vs 73.7%, respectively).

Summary

Posterior capsulolabral injuries are common problems encountered by throwing athletes. These usually occur as a result of a more insidious process as opposed to the traumatic events typically reported with collision athletes. Recent advances in our understanding of this pathology and improvements in diagnosis have led to an increased ability to recognize and appropriately manage this problem in throwing athletes. Posterior labral tears often occur in variable patterns, and athletes more often report shoulder pain and limited throwing ability than complaints of instability. Although most will improve with nonoperative management, surgical intervention with arthroscopic repair is a good option for those who have exhausted conservative management. Postoperative outcomes appear to have improved with arthroscopic posterior labral repairs with the use of suture anchors, with very high patient satisfaction and patient reported outcomes. However, return to play

and return to preinjury/preoperative levels are inferior to those seen in contact and collision athletes with posterior shoulder instability, most likely due to the complexity of the throwing motion.

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