Rehabilitation and Return to Sport in Athletes

Rehabilitation and Return to Play of the Athlete after an Upper Extremity Injury

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Shoulder and elbow injuries during athletic participation are very common and may require operative intervention if refractory to conservative care. In recovering from these upper extremity injuries, proper postoperative rehabilitation and setting reasonable expectations regarding return to play are very important. This review article focuses on the most common surgically treated shoulder and elbow injuries, including rotator cuff tears, SLAP tears, anterior and posterior shoulder instability, and elbow ulnar collateral ligament tears. Rates of return to play after surgical intervention are encouraging in most professional and recreational athletes but are highly dependent on the severity of injury, as well as the demands and position in sport. Real-world strategies for staged successful rehabilitation are presented and discussed.

Upper extremity sports injuries are exceedingly common and can have a large impact on athletic participation and performance. It is estimated that almost one third of shoulder injuries are sports related, with a high proportion in young males.1 In a recent systematic review, the estimated incidence of shoulder pain in sports is high: up to 32% for baseball, 47% for basketball, 63% for handball, and 52% for volleyball.2 Overhead and throwing athletes place an especially large stress on their shoulders and elbows, with professional pitchers having 58 activity-related shoulder injuries per 100 players annually.3 In recovering from these upper extremity injuries, proper postoperative rehabilitation and setting reasonable expectations regarding return to play are very important.

This review article focuses on the most common surgically treated shoulder and elbow injuries, including rotator cuff tears, SLAP tears, anterior and posterior shoulder instability, and elbow ulnar collateral ligament (UCL) tears. This article will aim to summarize the overhead athlete rehabilitation process after surgery and discuss return-to-play (RTP) criteria for athletes after surgery.

General Shoulder Rehabilitation Progression

The rehabilitation process after shoulder surgery in the overhead athlete will vary depending on the specific injury and surgery performed. In addition to eliminating pain and inflammation, the rehabilitation process for throwing athletes must include the restoration of motion, strength, and endurance, as well as restoration of proprioception, dynamic stability, and neuromuscular control. As the athlete progresses in rehabilitation, sport-specific drills are added to prepare for a gradual return to competition. Neuromuscular control drills are performed throughout recovery and are advanced to provide a continuous challenge to the neuromuscular control system. Proper communication between the surgical and rehabilitation teams must be used to determine specific timelines. Regardless of specific injury, several general principles must be followed with 4 phases: the acute phase, the intermediate
phase, the advanced strengthening phase, and the return to activity phase (Table 1).

**Acute Phase**

The acute phase of rehabilitation begins immediately after surgery and is characterized by a period of predominantly rest and protection. The duration of the acute phase is dependent on the healing constraints of the involved tissues. Range of motion (ROM) exercises are performed immediately in a restricted range beginning with gentle passive and active-assisted ROM. The rehabilitation specialist should be aware that full glenohumeral ROM is often asymmetric in the throwing athlete. These asymmetries are partly due to bony adaptations in the dominant arm. The dominant humerus often has greater retroversion, which allows greater glenohumeral external rotation (ER) while decreasing internal rotation (IR). Thus comparing total arc of rotational motion (TRM) between shoulders is necessary to assess ROM deficits. TRM is the sum of glenohumeral ER and IR when measured at 90° elevation in the scapular plane. TRM should be equal between shoulders, although the rotational arc is shifted into ER in the dominant shoulder. During this initial protection phase, passive ROM in external rotation and the plane of the scapula is initiated within limits dictated by the surgical procedure to prevent significant capsular contracture.

Deficits in shoulder TRM and pathological loss of ROM can be the result of soft tissue adaptations. Soft tissue and flexibility exercises for the posterior shoulder musculature are performed early in the rehabilitation process to address these deficits. The posterior shoulder is subjected to extreme repetitive eccentric contractions during throwing, which may result in soft tissue adaptations and loss of IR ROM. Thus this loss of IR is likely due to posterior muscular stiffness, not posterior capsule tightness. Conversely, it appears that most throwers exhibit significant posterior laxity when evaluated. Common techniques performed include soft tissue mobilization of the posterior musculature (Fig 1), horizontal adduction across the body, and IR stretching at 90° of abduction.

The rehabilitation specialist should assess the resting position and mobility of the scapula. Frequently, throwers exhibit a posture of rounded shoulders and a forward head. This posture is associated with muscle weakness of the scapular retractors and deep neck flexor muscles because of prolonged elongation or sustained stretches. In addition, the scapula may appear protracted and anteriorly tilted. Increased anterior tilt of the scapula has been associated with a loss of glenohumeral IR in throwers. Muscle weakness may result in improper mechanics or shoulder symptoms. Stretching, soft tissue mobilization, deep tissue lengthening, muscle-energy, and other manual techniques may be needed in these athletes.

Depending on the severity of the injury, strengthening can be performed in the acute phase and often begins with submaximal, pain-free isometrics for all shoulder and scapular movements. Isometrics should be performed at multiple angles throughout the available ROM, with particular emphasis on contraction at the end of the available ROM. Manual rhythmic stabilization drills are performed for internal and external rotators with the arm in the scapular plane at 30° and 90° of abduction (Fig 2). Alternating isometric contractions facilitate co-contraction of the anterior and posterior rotator cuff musculature. Rhythmic stabilization drills may also be performed with the patient supine and arm elevated to approximately 90° to 100° and 10° of horizontal abduction (Fig 3). This position is chosen for the initiation of these drills because of the combined centralization of action of both the rotator cuff and deltoid musculature, generating a humeral head compressive force during muscle contraction.

The rehabilitation specialist uses alternating isometric contractions in the flexion, extension, horizontal abduction, and horizontal adduction planes of motion. Active ROM activities are permitted when adequate muscle strength and balance have been achieved. With the athlete’s eyes closed, the rehabilitation specialist passively moves the upper extremity in the planes of flexion, ER, and IR, pauses, and then returns the extremity to the starting position. The patient is then instructed to actively reposition the upper extremity to the previous location. The rehabilitation specialist may perform these joint repositioning activities throughout the available ROM.

Basic closed kinetic chain exercises are also performed during the acute phase. Exercises are initially performed below shoulder level. The athlete may perform weight shifts in the anterior/posterior and medial/lateral directions. Rhythmic stabilizations may also be performed during weight shifting. As the athlete progresses, a medium-sized ball may be placed on the table, and weight shifts may be performed on the ball. Load bearing exercises can be advanced from the table to the quadruped position. Criteria to progress to the intermediate phase included minimal pain or inflammation and normalized TRM.

**Intermediate Phase**

The intermediate phase begins once the athlete has regained near-normal passive ROM and sufficient shoulder strength balance. Any immobilization is discontinued. Lower extremity, core, and trunk strength and stability are critical to efficiently perform overhead activities by transferring and dissipating forces in a coordinated fashion. Therefore full lower extremity strengthening and core stabilization activities are also performed during the intermediate phase. Emphasis will now be placed on regaining proprioception,
kinesthesia, and dynamic stabilization throughout the athlete’s full ROM, particularly at end range. The goals of the intermediate phase are to enhance functional dynamic stability, re-establish neuromuscular control, restore muscular strength and balance, and regain full ROM for throwing.

During this phase, the rehabilitation program progresses to isotonic strengthening activities with emphasis on restoration of muscle balance. Selective muscle activation is also used to restore muscle balance and symmetry. The shoulder external rotator muscles and scapular retractor, protractor and depressor muscles are isolated through a fundamental exercise program for the overhead thrower.11,17-19 This exercise program is based on the collective information derived from electromyographic research of numerous investigators.11,20-26 These patients
frequently exhibit ER weakness and benefit from side lying ER and prone rowing into ER. Both exercises elicit high levels of muscular activity in the posterior cuff muscles.24

Drills performed in the acute phase may be progressed to include stabilization at end ranges of motion with the patient’s eyes closed. Rhythmic stabilization exercises are performed during the early part of the intermediate phase. Proprioceptive neuromuscular facilitation exercises are performed in the athlete’s available ROM and progressed to include full arcs of motion. Rhythmic stabilizations may be incorporated in various degrees of elevation during the proprioceptive neuromuscular facilitation patterns to promote dynamic stabilization.

Manual resistance external rotation is also performed during the intermediate phase. By applying manual resistance during specific exercises, the rehabilitation specialist can vary the amount of resistance throughout the ROM and incorporate concentric and eccentric contractions, as well as rhythmic stabilizations at end range (Fig 4). As the athlete regains strength and neuromuscular control, ER and IR with tubing may be performed at 90° of abduction.

Closed kinetic chain exercises are advanced during the intermediate phase. Weight shifting on a ball progresses to a push-up on a ball or unstable surface on a tabletop. Rhythmic stabilizations of the upper extremity, uninvolved shoulder, and trunk are performed with the rehabilitation specialist (Fig 5). Wall stabilization drills can be performed with the athlete’s hand on a small ball (Fig 6). Additional axial compression exercises include table and quadruped using a towel around the hand, slide board, or unstable surface. Criteria to enter the advanced phase includes full pain-free ROM and full strength with no fatigue.

**Advanced Phase**

The third phase of the rehabilitation program prepares the athlete to return to athletic activity. Full ROM and posterior shoulder muscle flexibility should be maintained throughout this phase. Progressive strengthening of the upper body is also be initiated depending on the needs of the individual patient. Strength needs should be assessed objectively, that is, through handheld or isokinetic dynamometry, because shoulder strength deficits have been prospectively linked with throwing arm injuries.27 Exercises such as IR and ER with exercise tubing at 90° of abduction should be progressed to incorporate eccentric and high-speed contractions.

Plyometrics for the upper extremity may be initiated during this phase to train the upper extremity to dissipate forces. The chest pass, overhead throw, and alternating side-to-side throw with a 4- to 8-pound medicine ball are initially performed with 2 hands. Two-hand drills are progressed to 1-hand drills over 10 to 14 days. One-hand plyometrics include baseball style throws in the 90/90 position with a 1- to 2-pound ball, reverse throws, and stationary and semicircle wall dribbles. They are beneficial for upper extremity endurance while overhead.

Dynamic stabilization and neuromuscular control drills should be reactive, functional, and in sport-specific positions. Concentric and eccentric manual resistance may be applied as the athlete performs external rotation with exercise tubing with the arm at 0° abduction. Rhythmic stabilizations may be included at end range to challenge the athlete to stabilize against the force of the tubing and progressed to the 90/90 position (Fig 7). Rhythmic stabilizations may be applied at end range during the 90/90 wall dribble exercise. These drills are designed to impart a sudden
perturbation to the throwing shoulder near end range to develop the athlete’s ability to dynamically stabilize the shoulder.

Muscle endurance exercises should be emphasized because the overhead athlete is at greater risk for shoulder or elbow injuries when fatigued. Endurance drills include wall dribbling, ball flips, wall arm circles, or isotonic exercises using lower weights for higher repetitions. The predisposing factor that correlated best with shoulder injuries in Little League pitchers was muscle fatigue. Thus endurance drills appear critical for the overhead thrower. Criteria to move to the next phase include minimal pain or tenderness, full ROM and strength, adequate proprioception, and dynamic stabilization.

Return-to-Activity Phase

The previously mentioned strengthening and neuromuscular training program of the shoulder and total body is maintained and gradually progressed during this phase, with the addition of an interval throwing program, which starts with a long toss program designed to gradually increase distance and number of throws. Athletes typically begin at 30 to 45 feet and gradually progress to 120 feet. The number of throws, distance, and intensity all gradually increase through this phase. Pitchers begin a mound throwing, whereas positional players progress to greater distances of long toss and positional drills. Throwing off the mound includes a gradual increase in the number and intensity of effort, and finally type of pitch. The duration of a throwing program and rate of progression is individualized depending on the injury and nature of a surgical procedure. Although return to play is not evidence based, the general guidelines for decision making for athletes include a holistic approach assessing duration after surgery, ROM progress, overall strength, and their supervised performance program.

Rotator Cuff Repair

Rehabilitation Timeline

Rehabilitation protocols after rotator cuff repair vary throughout the current literature, with a paucity of evidence-based guidelines. Many rehabilitation protocols after rotator cuff repair recommend a period of 3 to 4 weeks of immobilization in a sling postoperatively. However duration of immobilization is controversial and some studies indicate early mobilization can be associated with improved outcomes. During this phase, there is significant heterogeneity in the level of movement recommended by authors in the literature with varying degrees of passive mobilization of the shoulder. Athletes will progress through the rehabilitation protocol; further ROM and muscular strengthening will progress between 6 to 12 weeks after surgery and progression to sport specific activities will range from 3 to 6 months.

Return to Play

Return to play is permitted after the athlete regains full pain-free shoulder ROM, preinjury shoulder strength and clinical/sport-specific testing. Percentage of players returning to play after rotator cuff repair varies based on the level of athlete, severity of injury, and the sport-specific activity and demand. Elite overhead athletes more dependent on optimal shoulder function had lower RTP after surgery. In a study of 21 professional baseball players, Erickson et al reported only 33.3% of players were able to RTP. Overall, 14.3% of these players returned to a same or higher level, but 19% returned at a lower level. When performing a mini-open rotator cuff repair on professional pitchers, only 1 of 12 (8%) was able to return to a competitive level of baseball.
In contrast, nonoverhead athletes and recreational athletes were able to RTP after rotator cuff repair more frequently than overhead throwers. In a study of 33 middle-aged and elderly swimmers, Shimada et al. found that 97% were able to return to swimming at a mean of 8 months after surgery. In the study of 22 CrossFit athletes, 100% of patients returned to training after a mean of 8.7 months. A study of 12 rock climbers undergoing rotator cuff repair showed all 12 returned, but 7 of 12 did not regain their initial climbing level. A retrospective study of 76 recreational athletes found that 88% were able to return to sports activity at a similar level a mean of 6 months after surgery. Athletes younger than 30 years of age who underwent rotator cuff repair showed a high RTP of 85% a mean of 5.8 months after surgery.

Rates of returning to play are also encouraging in the adolescent patient, and for athletes with partial rotator cuff tears. A study of 27 adolescent athletes with an average age of 16 years who underwent rotator cuff repair found that 93% were able to return to sport at the same level or higher. However, 9 of the 14 athletes (64%) who played baseball or softball had to switch positions because of a loss of throwing velocity or distance. Another study of adolescent athletes by Weiss et al. showed 6/7 patients were able to return to their pre-injury level of sport. Studying repair of partial rotator cuff tears, Rossi et al. found that 87% of patients (61/72) were able to return to sports and 56 patients (80%) returned to same level they had before injury. Overhead athletes took significantly longer to return, with a mean time of 6.4 months versus 3.6 months for noncollision, nonoverhead athletes. Last, Klouche et al. performed a meta-analysis including 25 studies and 859 patients and found that the overall rate of RTP is 84.7%, with 65.9% returning to preinjury level of play after a range of 4 to 17 months.

## SLAP Tears

### Rehabilitation Timeline

Postoperative therapy protocols after SLAP repair, like the general rehabilitation protocol, have heterogeneity in timelines for progression in the literature. Neri et al. immobilized overhead athletes' shoulders for 7 to 10 days semioperatively, with active-assisted exercises initiated at 4 weeks. Rotator cuff and periscapular strengthening was started at 6 weeks, and an individualized throwing program was initiated at 12 to 16 weeks. Brockmeier et al. kept patients in a sling for the first 4 to 6 weeks after surgery and then progressed to functional exercises, proprioceptive training, and sport-specific exercises gradually over 8, 12, and 16 weeks, respectively.

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**Fig 5.** Push-ups on an unstable surface with rhythmic stabilizations applied to the arm and trunk.

**Fig 6.** Rhythmic stabilization drills in 90° of abduction and 90° of external rotation on an unstable surface in the closed kinetic chain position against the wall.
Return to Play

Elite overhead throwers have a modest rate of return to play following arthroscopic SLAP repair. Gilliam et al. looked at 133 male baseball players who required arthroscopic SLAP repair. After a return to throwing protocol, only 41% of pitchers felt that they were able to return to the same or better level at most recent follow up compared to 64% of non-pitchers. Seventy-three percent of the pitchers who were unable to return to play indicated that the reason was due to undergoing surgery, whereas 38% of nonpitchers who were unable to return attributed their situation to undergoing surgery. In another study of 68 major and minor league baseball players that underwent SLAP repair, only 18 of 45 (40%) of pitchers were able to RTP, with only 22% returning to prior performance. Van Kleunen et al. examined 17 baseball players (13 collegiate and 4 high school) who had surgical treatment of an infraspinatus tear and SLAP lesion. Only 6 patients (35%) returned to their preinjury level or better, 5 (29%) were participating at a lower level at the same position or had to switch positions because of a decline in speed of throw, and the remaining 6 (35%) patients were unable to return to play.

Return to play rates with non-throwing dependent athletes and mixed athletes are more favorable. A study of 34 professional athletes (including volleyball, football, basketball, tennis) showed 88% (30/34) returned to their preinjury levels with a mean return to play time of 6.4 month. Brockmeier et al. studied 47 patients ranging from professional to recreational playing a variety of sports and found that 74% of the athletes were able to return to their pre-injury level of competition. Friel et al. noted no statistically significant differences in postoperative subjective functional scores, ROM, and strength among various levels of athletic activity, suggesting that SLAP repair and rehabilitation may be independent of profession, sport, or competition level.

Recently, biceps tenodesis in younger athletes has been shown to be a promising alternative to SLAP repair for SLAP tears. Hurley et al. performed a retrospective study comparing isolated biceps tenodesis versus SLAP repair in patients younger than 30 years of age. They found statistically similar rates of RTP overall (76% for tenodesis vs 85% for repair), time to RTP (8.8 months for tenodesis vs 9.4 months for repair), and rate of RTP in overhead athletes (84% for tenodesis vs 83% for repair). A recent systematic review on biceps tenodesis to treat SLAP tears in overhead athletes found an overall RTP rate of 70%, a high American Shoulder and Elbow Surgeons score ranging from 81.7 to 97, and an athlete satisfaction from 80% to 87%.

Anterior and Posterior Shoulder Instability

Rehabilitation Timeline

Rehabilitation after surgical intervention for shoulder instability can be broadly characterized by a few main phases—protection, endurance, strength, then return to sport. Sling immobilization semioperatively varies significantly across the literature from 0 to 2 weeks, 3 weeks, 4 weeks, or even up to 6 weeks. After immobilization, athletes can begin active-assisted and active ROM exercises around 4 to 6 weeks semioperatively. Between 6 to 12 weeks semioperatively, strengthening and gradual progression to sport-specific exercises is initiated and can extend to 18+ weeks semioperatively.

Return to Play

Criteria for return to sports participation includes having a full functional ROM, satisfactory muscular strength and endurance, adequate static and dynamic stability, and clinical examination free of pain. Athletes typically target return to sports at around 6 to 8 months after surgery. Success in return to play after surgical treatment for anterior and posterior shoulder instability is also variable depending on the sport, position, and nature and severity of injury. In 66 collision athletes, the return to play rate after arthroscopic Bankart repair was 90.9% at a mean of 6 months. A study of martial art athletes found 95% RTP rate in 6.4 months after arthroscopic Bankart repair. After arthroscopic Bankart repair or open Latarjet reconstruction, 22 of 23 professional athletes were able to return a mean of 4.5 months after surgery. For posterior shoulder instability, arthroscopic posterior capsulolabral repair in 56 American football players was successful in returning 93% to play. In a recent systematic review of posterior shoulder stabilization procedures, 25 studies found an overall 62.7% to 100% RTP, with higher return to
preinjury level for collision athletes compared with overhead athletes.72

**UCL Tear**

**Rehabilitation Protocol and Timeline**

There exists significant variability in rehabilitation protocols after UCL reconstruction of the elbow. Despite no standard consensus on an evidence-based protocol, many studies have reviewed the available literature to identify the core principles of recovery.74-77 Current principles of UCL reconstruction (UCL-R) can be divided into 4 phases: (1) immediate postoperative, (2) intermediate strengthening, (3) advanced strengthening, and (4) return to activity.75,77

The first phase (weeks 0 to 3) is directed at protecting the healing graft and gradual restoration of elbow ROM.5,77 A systematic review by Lightsey et al.74 analyzed 30 rehabilitation protocols after UCL-R and found that most protocols recommend immediate splinting of the elbow at 90° for approximately 2 weeks, followed by a functional brace to be worn until approximately 4 to 6 weeks semioperatively. Once preinjury ROM is restored and pain has subsided, the second phase (intermediate strengthening) may be initiated.75,78,79

The intermediate strengthening phase (weeks 4 to 7) involves gradual increases in upper-extremity mobility, muscular strength, and increasing resistance to valgus stress.75,77 Once strength of the operative extremity reaches 70% of the uninjured extremity, the advanced strengthening phase is initiated.75

The advanced strengthening phase (weeks 8 to 14) is comprised of increasing muscle strength, durability, and neuromuscular control.75,77 Lightsey et al.74 described 8 different plyometric exercises that were commonly cited in protocols, including chest passes, side throw close to body, side-to-side throws, side throws, soccer throw, one-hand throws, one-hand wall dribble, and one-hand baseball throws into wall. Athletes may finally transition to the return-to-activity phase once full, painless ROM is tolerated and strength testing is satisfactory.75

During the return to activity phase (weeks 14 to 32), an Interval Throwing Program is recommended to safely reintroduce athletes back into overhead throwing through graduated throwing distances.74,75,77 Across most protocols, the average initiation of this program was reported to be approximately 16 weeks after surgery.74,76 Pitchers will be introduced into practice games as they gradually increase pitch counts to ensure readiness for return to play.75,79,80

**Return to Play**

A systematic review by Douoguih et al.77 reports a return to play target of 9-10 months and return to previous level of play as high as 81% to 90%. However, additional studies of elite baseball players suggest that this population may require longer periods of rehabilitation and gradual progression of return to minimize risk of reinjury. A systematic review comprised of 1520 pitchers by Coughlin et al.81 reported an increased mean time of return to play of 19.8 months, with a return to competition for Major League Baseball pitchers to be a mean 17.3 months. The authors also described a rate of return to any level of pitching between 79% to 100%.81 Anderson et al.76 report a rate of return to competition at the preinjury level or higher of 85.7% at an average of 12.2 months after surgery. In general, there is strong evidence to suggest that a 4-phase rehabilitation protocol after UCL-R with milestone-based progression is successful in returning young overhead athletes back to preinjury level of play.

**Conclusion**

Shoulder and elbow injuries during athletic participation are very common and may require operative intervention if refractory to a period of rest and rehabilitation. After surgery, a stepwise rehabilitation process is essential to restore shoulder and elbow motion, muscular strength, proprioception, and neuromuscular control. Rates of return to play after surgical intervention are encouraging in most professional and recreational athletes but are highly dependent on the severity of injury, as well as the demands and position in sport. Unfortunately, professional baseball pitchers have a lower rate of return to elite performance after rotator cuff repair and SLAP repair.

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