Nonoperative Treatment of Medial Ulnar Collateral Ligament Injuries in the Throwing Athlete

Indications, Evaluation, and Management

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Abstract

» Ulnar collateral ligament (UCL) injuries are common in overhead throwing athletes, particularly baseball players. Appropriate diagnosis, treatment, and rehabilitation are important in order for athletes to return to their preinjury condition.

» Many patients, including the noncompetitive athletes and those with partial ligament tears, benefit from nonoperative treatment. Elite athletes desiring a return to play benefit from UCL reconstruction.

» Rest, anti-inflammatory drugs, focused physical therapy, and biologic adjuncts are options that may allow athletes to return to play while avoiding the morbidity associated with operative treatment.

Medial ulnar collateral ligament (UCL) injuries present frequently in overhead throwing athletes as a result of repetitive valgus stresses to the elbow. Dr. Frank Jobe performed the first UCL reconstruction (UCLR) on Los Angeles Dodgers pitcher Tommy John in 1974[1]. Although Tommy John took 18 months to return to play, he was able to pitch for 15 more seasons after the reconstruction. Subsequent studies[1-3] have shown that UCLR is an effective procedure for return to play and restored performance in professional baseball players. Partly as a result of John's success following UCLR, the public has misperceptions regarding the indications, expectations, and outcomes associated with UCLR[4].

More recently, there has been a marked increase in the incidence of UCL injuries in professional and amateur athletes as well as an increase in UCLR procedures. Between 2010 and 2015, at least 113 Major League Baseball (MLB) pitchers underwent UCLR, compared with 33 during the 1990s[5]. Although previous literature has demonstrated good outcomes following UCLR[1-3], several studies have shown good success following nonoperative treatment in certain populations of patients[2,6,7].

Nonoperative treatment of UCL injuries is a viable option in the appropriate clinical situation, particularly for patients with partial tears, adolescent or aging athletes, or patients who do not wish to return to competitive play. The purposes of the present article are to review the current knowledge of UCL injuries, to provide an update regarding the relevant clinical and diagnostic evaluation, to describe the indications for treatment, and to provide the reader with nonoperative treatment options for UCL injuries.

History and Differential Diagnosis

The diagnosis of UCL injury requires a thorough history and physical examination. Correct diagnosis and treatment must

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take into account a wide range of differential diagnoses that can cause medial elbow pain (Table I). Concomitant evaluation of the common flexor-pronator mass, olecranon, trochlea, coronoid, and ulnar nerve is necessary.

When obtaining the history, it is important to note when and how the injury occurred and to review the history of symptoms, previous treatments, and current alleviating or aggravating factors. In addition, a change in training regimen, the timing of onset, and a sudden (as opposed to gradual) loss of velocity[8] can be important in differentiating between acute and chronic UCL injury. Patients with an acute UCL injury often report having heard or felt a "pop" during the throwing motion, with subsequent swelling. In many cases, the throwing athlete can relate his or her symptoms to an exact pitch[3]. Conversely, patients with chronic UCL insufficiency will report pain with throwing and a gradual decrease in throwing velocity and accuracy, which may be due decreased flexor-pronator muscle activity in UCL-deficient elbows[9]. Athletes with chronic UCL injuries also may complain of instability while throwing or during valgus stress-testing[10]. Patients also can present with ulnar neuritis due to chronic valgus stress at the elbow. Ulnar neuritis manifests as sensory loss, paresthesias, and, rarely, weakness and may present in as many as 40% of patients with a UCL injury[11].

When evaluating the elbow for UCL injury, the examiner must rule out other potential causes of medial-sided elbow pain. Patients with acute or chronic strains of the flexor-pronator mass typically present with worsening pain if not treated, stiffness, and a decrease in pain following a warm-up period[8]. A snapping triceps can present similarly to ulnar neuritis. The distal part of the medial triceps subluxates over the medial epicondyle with elbow flexion and displaces the ulnar nerve anteriorly[11]. Patients typically present with a snapping sensation (with or without pain) and ulnar nerve symptoms during elbow flexion. Valgus extension overload syndrome can present in younger athletes undergoing repetitive valgus stresses. This syndrome can result in osteophyte formation and eventually impingement symptoms, which typically have a posterior element of pain. Finally, cubital tunnel syndrome, a compressive neuropathy of the ulnar nerve as it passes through the cubital tunnel of the medial aspect of the elbow, can be a source of medial elbow pain[12]. It is also important to consider "Little League elbow," a traction apophysitis of the medial epicondyle, which can be a source of medial elbow pain in the skeletally immature patient[11].

TABLE I Differential Diagnosis and Physical Examination of the Medial Elbow

Diagnosis	Physical Examination
Soft-tissue injuries	
Ulnar collateral ligament	Moving valgus stress test, milking maneuver
Flexor-pronator tendinitis	Tenderness at flexor-pronator mass, stiffness, pain with resisted flexion and pronation
Ulnar neuritis or subluxation	Ulnar distribution paresthesias, snapping sensation over medial epicondyle, hand weakness
Medial triceps subluxation	Snapping sensation over medial epicondyle during elbow flexion
Osseous injuries	
Loose bodies	Loss of terminal extension, crepitus
Olecranon stress fracture	Pain with throwing, localized tenderness
Medial epicondyle avulsion	Skeletally immature, tenderness to palpation, pain with valgus stress

Physical Examination

Once a thorough history is gathered, physical examination of the patient can help the clinician to differentiate between the various conditions that may affect the medial aspect of the elbow. The examination begins with visual inspection of the extremity for swelling, muscle atrophy, and previous surgical incisions. Focused palpation of the medial epicondyle, flexor pronator mass, and olecranon should be done to assess for point tenderness. Special attention should be paid to any tenderness at the sublime tubercle as this structure is the insertion of the anterior oblique ligament of the UCL[8]. A full neurovascular examination should be performed, with particular attention to the ulnar nerve.

Examination with the patient supine may assist in identifying flexion contractures of the elbow as well as in minimizing scapular motion during testing. Stability of the UCL should be tested with a valgus force through the elbow in 25° of flexion[13]. The UCL can be palpated directly with the elbow in this position while blocking external rotation of the humerus. The amount of joint-space widening and the firmness of the end point should be compared with those in the contralateral extremity. Excessive widening may indicate UCL insufficiency.

The milking maneuver is used to test the posterior portion of the anterior oblique ligament. The examiner generates a valgus force by pulling the patient's thumb while the shoulder is extended, the elbow is flexed beyond 90°, and the forearm is supinated. Patients with UCL injury will experience a reproduction of symptoms, including pain, apprehension, and/or instability. Hariri and Safran described a modification of the milking maneuver to remove external rotation of the shoulder as a confounding variable[14]. The patient's arm is held with the shoulder in adduction and maximum external rotation, and the elbow is flexed to 70°, which has been identified as the position of greatest valgus laxity when the UCL has been sectioned in cadavers[14].

O'Driscoll et al. described the moving valgus stress test in 2005[15]. The maneuver begins with the patient upright, the shoulder abducted to 90°, and the arm in full flexion (Fig. 1). The examiner applies a valgus torque to the elbow and then extends the elbow to 30°. A positive test requires that a patient experience reproduction of maximum symptoms as the elbow passes from 120° of flexion to 70° of extension, corresponding with the positions of late cocking and early acceleration, respectively. The authors reported that the moving valgus stress test had a sensitivity of 100% and a specificity of 75% when compared with assessment of the UCL by surgical exploration or arthroscopic valgus stress-testing. This test also can be positive in patients with subluxation of the ulnar nerve secondary to triceps snapping[8].

Other causes of medial elbow pain can be differentiated from UCL injury by performing simple maneuvers. Injury to the flexor-pronator mass will cause pain with resisted flexion and pronation. Patients with such an injury often present with tenderness to palpation distal to the medial epicondyle at the origin of the flexor-pronator mass. In addition, an elbow extension test can be used to rule out an elbow effusion, fracture, or posterior impingement. The test is positive if the patient is unable to fully extend the elbow. Other physical examination findings are listed in Table I.

Fig. 1

Photograph showing the starting position for the moving valgus test. The patient is upright, with the shoulder abducted to 90° and the arm in full flexion. The examiner then applies a valgus torque to the elbow and extends the elbow to 30°. A positive test requires a reproduction of maximum symptoms as the elbow passes from 120° of flexion to 70° of extension.

Imaging

Radiography

Imaging of the extremity begins with radiographs to evaluate for avulsion fractures, osteochondral defects, ulnohumeral or radiocapitellar osteophytes secondary to valgus extension overload, or calcifications within the UCL that may denote degeneration and a possible partial tear[16]. Stress radiographs may be made to evaluate for increased medial gapping, but the findings may be difficult to interpret in baseball pitchers because of increased baseline medial laxity of the pitching elbow[17]. Bruce et al. evaluated bilateral static and stress radiographs of the elbows of baseball players and showed that increased openings of >0.6 mm can be expected with full-thickness UCL tears, with excellent interobserver and intraobserver reliability[17].

Ultrasound

Dynamic ultrasound has been used to assess for abnormalities within the UCL. Atanda et al. demonstrated that the cross-sectional area of the UCL increased with the number of years of professional experience in asymptomatic baseball players, suggesting that this finding may be one of the first changes seen in the UCL with repetitive stress[18]. Similarly, Ciccotti et al. reported that stress ultrasound demonstrated increases in baseline ligament thickness, medial joint gapping, and hypoechoic foci and calcifications in the dominant arm of pitchers[19]. UCL ruptures can be observed on ultrasound as discontinuity of the ligament with anechoic fluid or heterogeneous echogenicity in place of the ligament. Dynamic ultrasound potentially can identify patients who may be at increased risk for UCL injury and detect silent UCL injuries[20].

Magnetic Resonance Imaging

The diagnosis of UCL injury is most commonly established with use of magnetic resonance imaging (MRI) with or without arthrography. Magnetic resonance arthrography (MRA) has been shown to be more sensitive and specific for detecting UCL injuries, with sensitivities of 86% (for partial tears) and 95% (for complete tears) and a specificity of 100%[21-23]. MRA is useful for characterizing, classifying, and guiding the treatment of the injury.

The appearance of abnormality within the UCL on MRI depends on the acuity and severity of the injury. Sprains typically demonstrate ligament thickening and signal hyperintensity with no discrete areas of discontinuity[22]. Acute, complete tears demonstrate increased T2 signal within and around the ligament as well as the adjacent bone marrow; this signal represents the edema, discontinuity, irregularity, and poor definition that is present in association with UCL abnormality. Complete tears also can demonstrate extracapsular contrast extravasation on MRA[24]. Partial tears present as focal areas of disruption with increased signal. Timmerman and Andrews described an arthrographic "T-sign," in which contrast medium extends distally on the ulna, secondary to a partial tear of the deep UCL off of the sublime tubercle[25]. Chronic changes include intraligamentous calcification as well as heterotopic ossification resulting from chronic repetitive valgus loads on the UCL[26].

In addition to characterizing the injury, MRA is useful for classifying the injury. Joyner et al.[26] classified UCL injuries in 240 patients into 4 types: type I (low-grade partial tear with edema), type II (high-grade partial tear), type III (complete full-thickness tear with extravasation of fluid), and type IV (tear in >1 location). Injuries were further classified on the basis of the rupture site (humerus, ulna, and midsubstance). The majority of tears (58%) were type II, whereas 28% were type III, 9% were type I, and 5% were type IV. In contrast to historical studies, the majority of the tears were primarily at the humerus (45%) and ulna (38%); midsubstance tears were noted in 12% of the patients, and 5% of tears were in >1 location. Because of its high sensitivity, specificity, and interobserver reliability, MRA is the study of choice for the diagnosis of UCL injuries. Imaging should be performed in the plane of the anterior band of the UCL as that structure is the primary static restraint to valgus stress[8].

Arthroscopy

Arthroscopy can be used to directly visualize the UCL if an abnormality is suspected. The anterior oblique ligament of the UCL can be visualized through the anterolateral portal while a valgus stress test is performed. Medial joint-space widening and ligament integrity can be directly assessed. Field and Altchek studied 7 cadaveric elbows and found that medial joint opening was best visualized with the arm in 60° to 75° of flexion[27]. In that study, there was 1 to 2 mm of joint-space widening when the anterior oblique ligament was released and 4 to 10 mm of widening with complete release of the UCL. Some practitioners may perform diagnostic elbow arthroscopy with surgical reconstruction in order to confirm the diagnosis and address any concomitant abnormality.

Nonoperative Treatment

Indications

Physicians should begin with a frank discussion with the patient regarding treatment goals. The severity of the injury, location of the tear, timing of recovery, and tissue quality are all factors that should be considered when creating a treatment plan. There is no reliable, consensus-driven treatment algorithm for UCL injuries. In addition, to our knowledge, there have been no prospective randomized studies comparing nonoperative and operative treatment. The response to nonoperative treatment may be difficult to predict, but there is a spectrum of injury to the UCL, and treatment plans are unique to each patient.

An online survey that was distributed to members of the American Shoulder and Elbow Surgeons showed general consensus among the 159 survey respondents that complete UCL tears in professional athletes should be treated operatively[28]. Opinions differed on the treatment of partial tears and tears in non-professional athletes. Professional or high-level athletes with full-thickness UCL tears who wish to return to play are candidates for UCLR. Athletes who do not wish to return to play, who are unwilling to participate in the postoperative rehabilitation program, or who have substantial ulnotrochlear or radiocapitellar arthritis may be treated nonoperatively.

A trial of nonoperative treatment is acceptable for patients with partial-thickness tears, which are associated with attritional changes such as ligament thickening and signal hyperintensity[22]. Ford et al. attempted to identify the ability of professional baseball players to return to play after nonoperative treatment of UCL injuries on the basis of MRI grade[2]. Forty-three players were diagnosed with UCL injuries, of whom 8 had full-thickness tears and required UCLR in order to return to play. Twenty-eight players (including 18 pitchers) were managed nonoperatively and had a return-to-play rate of 93%. The authors found that incomplete UCL injuries could be treated nonoperatively in the majority of cases and that MRI grading of the UCL injuries helped to predict return to play and the need for subsequent surgery. In the practice of the senior author (V.M.), the majority of partial tears undergo a period of nonoperative treatment, regardless of athletic activity.

The location of the UCL tear also be may important when considering operative versus nonoperative treatment. Frangiamore et al.[29], in a study of 32 pitchers who underwent initial nonoperative treatment of a UCL injury, found that 9 (82%) of 11 patients in whom nonoperative treatment failed had distal tears whereas 17 (81%) of 21 in whom nonoperative treatment did not fail had proximal tears. Nonoperative treatment failed in 7 (88%) of 8 patients who had a high-grade tear in a distal location. The findings of that study suggest that high-grade tears from the ulnar insertion will likely need UCLR, whereas low-grade tears from the humeral origin may be more responsive to nonoperative treatment.

The goals of treatment of any UCL injury are to decrease pain and inflammation, to restore stability, and to allow return to play if desired[30]. These goals can be achieved in many patients with nonoperative treatment. In the practice of the senior author (V.M.), professional athletes with full-thickness UCL tears who wish to return to play are managed with UCLR, whereas those with partial-thickness tears may undergo a trial of nonoperative treatment before considering surgery. Recreational athletes with partial-thickness tears initially undergo nonoperative treatment, with their response to treatment and desire to return to play dictating any subsequent surgery. Older athletes with no desire to return to competitive play also may be treated nonoperatively. The majority of pediatric patients with UCL injuries should be offered nonoperative treatment initially as most injuries are the result of poor throwing technique and overuse[31].

Initial Nonoperative Treatment

All patients initially are managed with a period of rest, ice, and anti-inflammatory drugs and are counseled to avoid stress to the medial side of the elbow in order to decrease associated inflammation and to avoid any additional stress to the ligament. Because of the potential risk of damage to articular cartilage, intra-articular steroid injections are not used[32]. A hinged elbow brace may be used initially, immobilizing the elbow in 90°

with the hand free, for 2 weeks. Bracing may protect the elbow from valgus stresses as well as prevent extension of the elbow to protect the anterior oblique ligament, which is stressed in extension[8].

The treatment algorithm in Figure 2 is based on clinical experience and is supported by previous studies in the literature[8,15,33]. Clinicians may differ with regard to the timing of diagnostic studies but, if there is high clinical suspicion of a UCL injury in an elite athlete, then such studies may be performed prior to an initial trial of nonoperative treatment. For non-elite athletes, we prefer a trial of nonoperative treatment prior to performing advanced diagnostic imaging.

Rehabilitation

Following initial treatment with rest, ice, anti-inflammatory drugs, and stretching, a graduated rehabilitation program is initiated, which includes strengthening and stretching. Depending on the sport, following successful completion of rehabilitation, the athlete can begin an interval throwing program.

Following the initial period of elbow immobilization, the brace may be unlocked and range of motion and strengthening exercises may be gradually introduced as pain decreases. Strengthening of the wrist extensors and flexors, improving shoulder motion, and periscapular strengthening are the goals for the first 4 weeks. In addition, proprioceptive training as well as lower-body and core training should be included in order to strengthen the kinetic chain, which can help to prevent future elbow and shoulder injuries[34-36]. All throwing and valgus stresses are restricted for at least 6 weeks following injury. Range of motion can be increased in an incremental fashion according to surgeon preference and clinical symptoms. Nassab and Schickendantz suggested increasing range of motion in a hinged elbow brace by 5° in both flexion and extension per week after the initial rest period[8]. At our institution, range of motion is increased 5° to 10° per week, with a goal of a full pain-free range of elbow motion at 3 to 4 weeks. Once the patient has full range of motion, including no pain on valgus stress, and adequate shoulder and elbow strength (5 of 5 on manual muscle testing), sports-related activity and an interval throwing program may be initiated. The exercises used in our throwing program typically take 4 to 6 weeks to complete (see Appendix). These exercises also should be performed by the athlete on discharge in order to continue to maintain proper muscle balance.

Special attention must be paid to clinical symptoms. If at any point the patient is in pain with range of motion, strengthening, or sports-related activity, then the elbow must be rested. Once symptoms have resolved, rehabilitation can be started again or resumed at an earlier period of the protocol according to the provider's clinical judgement. At our institution, the rehabilitation protocol does not differ for partial as

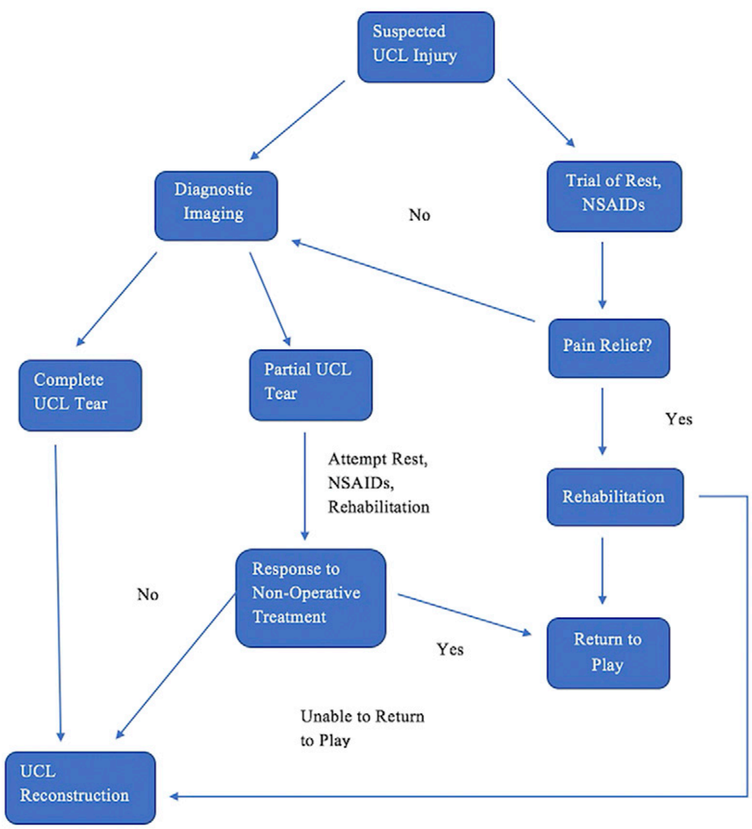

Fig. 2
UCL treatment algorithm. NSAIDs = nonsteroidal anti-inflammatory drugs.

opposed to complete UCL tears. The clinician may prefer to accelerate rehabilitation based on the patient's progression, with the goal of restoration of motion, and cessation of pain prior to muscular strengthening and return to play. If the patient continues to have symptoms during rehabilitation, then surgical intervention must be considered.

Injections and Biologic Adjuncts

Recently, there has been increased attention on the use of biologics to stimulate and enhance tissue-healing in patients with UCL injuries. Multiple studies have investigated the use of biologic adjuncts to stimulate and enhance the healing response. The ultimate goal of these agents is to initiate the molecular healing cascade and to avoid the morbidity associated with surgical intervention.

Platelet-rich plasma (PRP) is a sample of autologous blood that contains an increased concentration of platelets above baseline. These platelets then release their contents, resulting in a 3-fold to 5-fold increase in the number of growth factors, including platelet-derived growth factor, transforming growth factor beta, and vascular endothelial growth factor, potentially stimulating endothelial growth and angiogenesis[37]. Dines et al. retrospectively studied the effect of PRP injections on partial UCL tears in high-level throwing athletes (including 6 professional, 14 college, and 24 high school athletes)[38]. Patients received 1 to 3 injections of PRP (3 mL each), prepared according to the manufacturer's guidelines. Repeat injections were considered for patients with refractory pain at 3 weeks. Following the injections, patients were started on an interval throwing program after a 2-week period of rest. The authors reported that 4 of the 6 professional athletes returned to professional play, that the overall return-to-play time for the entire study group was 12 weeks, and that there were no injection-related complications. Podesta et al.[37] studied 34 athletes with partial-thickness UCL tears in whom an initial trial of nonoperative treatment had failed. Each patient received a single ultrasound-guided autologous PRP injection, followed by a course of physical therapy. After an average duration of follow-up of 70 weeks, 30 patients (88%) had returned to play, with an average return-to-play time of 12 weeks. One player in that study had persistent UCL insufficiency and underwent UCLR 31 weeks after the PRP injection. In addition, as noted by Rebolledo et al., the leukocyte concentration within PRP injections can vary between leukocyte-rich PRP and leukocyte-poor PRP[33]. Leukocyte-poor PRP may have greater healing potential as a result of less inhibition of the repair process, but additional studies will be required to determine any utility in the treatment of UCL injuries.

Multiple systems exist to obtain autologous PRP from a patient during point of care, with preparation varying by manufacturer. The area of UCL injury can then be confirmed with ultrasound. Following sterile preparation of the elbow, the PRP can then be injected into the area of injury. Post-injection protocols vary according to provider but usually include a period of rest, followed by 4 to 6 weeks of progressive stretching and strengthening. Once the patient is asymptomatic, both subjectively and clinically (as demonstrated by a negative moving valgus test), then he or she may start sports-related activity[37,38].

The use of PRP for the nonoperative treatment of UCL injuries has shown promise and may be useful for initiating a healing response and avoiding surgery. The lack of randomized controlled trials, combined with variability in preparation and dosing, limits any definitive treatment recommendations. Additional studies are needed to determine if PRP is a viable option for the treatment of UCL injuries.

Outcomes

According to a recent meta-analysis of return to sport after UCL injury in baseball players, the overall rate of return to play was 90%, with the rates differing between MLB players (89%), Minor League players (91%), collegiate players (95%), and high school players (93%)[39]. Few studies have evaluated return to play following nonoperative treatment of UCL injuries. Rettig et al. reported a 42% rate of return to play in a study of throwing athletes with UCL injuries that were treated nonoperatively with anti-inflammatory drugs, icing, nighttime bracing, graduated physical therapy, and a throwing program[7]. The average time to return to play (among those who did so) was 24.5 weeks. The authors did not find any factors that predicted return to play, including time of symptoms, acuity of injury, or age of the patient. Barnes and Tullos, in a retrospective study of 100 symptomatic collegial and professional baseball players with either shoulder or elbow abnormality, reported a 50% return-to-play rate[40].

In contrast, studies of protocols involving the use of PRP have demonstrated return-to-play rates of 66%[38] to 88%[37] among throwing athletes with a partial-thickness tear. Kenter et al. retrospectively studied National Football League athletes with acute UCL injuries and valgus instability on examination[6]. The majority of participants were non-throwing athletes, but all returned to play, including 2 quarterbacks. That study highlights that non-throwing athletes likely have a higher rate of return to play with nonoperative treatment than throwing athletes following UCL injuries.

The majority of studies in the literature have focused on competitive athletes, but such individuals may not be the ideal candidates for nonoperative treatment. Currently, there is a lack of studies evaluating the outcomes of nonoperative treatment in recreational or low-demand athletes. Additional studies are required in order to identify the optimal nonoperative treatment protocols in these populations of patients who are less likely to undergo UCLR.

Overview

Although many high-level athletes require UCLR in order to return to play, nonoperative treatment modalities have a large role in the treatment of UCL injuries. Rest, focused physical therapy, and biologic adjuncts are options that may allow athletes to return to play while avoiding the morbidity associated with operative treatment.

Appendix

A description of the return-to-throwing program is available with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSREV/A442).

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