Abstract

The ulnar collateral ligament, specifically the anterior bundle, resists valgus force on the elbow. Individuals, but most typically overhead athletes may injure this ligament, causing decreased stability and joint laxity. Palpation, stress tests, and imaging are used to diagnose a UCL tear. Determining the need for surgery depends on current and desired level of functioning, and should be discussed with the surgeon initially.

The most common surgical method for this type of injury is the well known Tommy John Surgery. This method published by Dr. Frank Jobe in 1986 was the first to successfully return overhead throwing athletes to their previous level of competition or higher. Since the widespread popularization of the Jobe technique, there have been many modifications suggested to improve surgical outcomes and patient function post-operatively. Some of these methods include the ZipLoop, docking, and ulnar nerve transposition techniques. As with any surgical procedure, limitations still exist which ought to eventually be attenuated with additional exploration of surgical methods.

A successful rehabilitation is dependent upon close supervision by the physical therapist to facilitate slow and gradual progression of the recently repaired tissues. Most athletes return to sport about a year post-surgery and often see similar if not better physical function at that time.
Introduction

The ulnar collateral ligament (UCL) provides elbow stability by resisting valgus stress placed on the medial aspect of the humeroulnar joint. Injury often occurs in the athletic population, since the unique force required to cause microtears is much greater than in normal functional activity. Baseball and javelin throwers comprise the most common population in which UCL injury occurs, but injury may also occur in many other sports such as soccer and tennis.

The UCL is made up of three portions – anterior, posterior, and transverse. These combine to make a triangular complex with its role of medial elbow stability. The anterior bundle acts as the primary stabilizer against valgus forces. Repeated tensile trauma to the anterior bundle can lead to partial or complete tear of the ligament, which may cause elbow instability. Acute disruption of UCL is typically what causes patients to seek medical attention and potential surgery. Posterior dislocation may also occur due to acute loss of stability during a powerful overhead throw.

Injury to the UCL can occur three ways: chronic microtears without complete disruption, an acute tear of the UCL without prior injury, or chronic microtears, which weaken the tissue enough for an acute disruption to occur. The last of the three is the most common, but it is not impossible to see the others, as well.

The typical force that may lead to UCL injury has three components: rapid shoulder medial rotation, near forearm full supination, and elbow flexion from approximately 90° to 125°. This phase from arm-cocking to arm acceleration places the maximum load on UCL throughout a complete pitch. It has been reported that the UCL
can resist a maximum valgus torque of 33 Newton meters while pitching can produce an external torque of up to 64 Newton meters in professional pitchers\(^1\). Since the external torque produced is greater than the maximum internal tensile force of the UCL, small tears in the ligament can result. The ulna and humerus have increased movement due to disruption of the UCL\(^2\). The excess movement can cause the development of painful calcifications along the ulna and humerus\(^6\).

**Diagnosis**

Diagnosis for UCL tear is often inaccurate, and may require multiple examinations and thorough history-taking. Primary symptoms include joint laxity and pain caused by improper articulation. Initially after an acute rupture, pain and swelling occur, but tends to subside within four to five days of rest\(^6\). If the patient also reports hearing a “pop” at the onset of injury, it is likely the UCL was ruptured. The patient may also report a decrease in throwing velocity, distance, or accuracy; compensatory change in biomechanics or throwing; or inability to throw due to pain. These symptoms are also likely to occur in an athlete who has repeated chronic injury to the UCL without a complete disruption. Palpation of the UCL may aid in diagnosis. Although it is not always associated with UCL injury, the patient may also experience neuropathy of the ulnar nerve, and distinguishing between the two is important for accurate diagnosis. Valgus stress test or moving valgus stress test can be performed on the affected elbow of the patient to test medial instability. A positive test result is reproduction of the pain or joint laxity increased \(>1\ mm\)^\(^5\). Contralateral comparison can help determine significant joint laxity. Diminished sensitivity of the special tests also limits the ability to accurately diagnose an individual. One study reported that the anterior bundle had to be
completely disrupted in order to test positive for 1-2mm of laxity\(^c\). Since manual testing can be unreliable, proper diagnosis should include a stress radiograph, where the examiner applies a valgus stress to the elbow while being radiographed\(^d\). Additional images may be taken using MRI, computer tomography arthrogram, and ultrasound\(^4\). Injection of a dye prior to an MRI or adding contrast to the image increases the sensitivity\(^e\).

Determining whether or not the patient requires surgery is dependent on current and desired level of function. Ulnar collateral ligament repair aims to restore valgus stability lost due to injury by replacing the deteriorated ligament. Athletes comprise the majority population to receive ulnar collateral ligament repair surgery. Overhead athletes of any age may desire the surgery if their performance has declined significantly due to pain or instability. 83% of patients return to previous, or higher, level of performance within 11.5 months, but there is no guarantee the surgery is successful for every individual\(^1\). However, athletes may also choose not to have the surgery if they decide not to return to play, or if the ligamentous injury does not affect the level or performance. All of these factors must be discussed between the patient, the surgeon, and any other figures, such as parents or coaches. For the non-athlete, surgery is only required if the patient feels that the ligamentous injury disrupts daily function enough to withstand surgery and rehabilitation.

**Surgical Methods**

**The Jobe Technique**

In 1986, Dr. Frank Jobe published an article outlining a surgical technique for UCL reconstruction. Jobe’s technique became known as the Tommy John Surgery, and
was the first to successfully return overhead throwing athletes to previous level of competition or higher. In this surgery, the torn or ruptured UCL is reconstructed using a tendon graft from the patient's own body, called an autograft. The palmaris longus tendon is the most common used, but the gracilis or plantaris tendons, or even a section of the achilles tendon, may also be used.

To begin the surgical procedure, the medial aspect of the elbow is opened and the fascia divided longitudinally. A second longitudinal cut is made in the flexor and pronator muscles from their attachment on the medial epicondyle of the humerus. The muscle fibers are then elevated from the medial epicondyle, leaving only a small portion of the tendon on the epicondyle for reattachment. Once these steps are completed, the anterior portion of the UCL is exposed adequately for the procedure to progress.

Bone tunnels are created by drilling three holes in the medial epicondyle, and two holes centered at the sublime tubercle of the ulna. A bone bridge of 1 cm or greater is created between the drilled holes, with bone tunnels placed in order to approximate the insertion sites of the anterior band. Two divergent tunnels on the medial epicondyle are created for insertion of the graft. The posterior cortex of the humerus is also penetrated to allow for suturing of the graft.

Once the bone tunnels are drilled, the graft is then looped through the holes in a figure-of-eight pattern, pulled taut and sutured to itself with the elbow placed at 45° of flexion. If there are any remaining fibers from the native UCL, it is recommended that they be sutured over the graft for added strength.

Complications and failures exist with the original Jobe technique. As a result, some alternative options are available in attempt to eliminate or at least minimize post-
operative complications. Some issues most commonly discovered include fractures in the ulnar and/or medial epicondylar bone tunnels, difficulty in proper tensioning of the tendon graft, and ulnar nerve disruption. Alternative methods such as the Docking and ZipLoop techniques, as well as ulnar nerve transposition methods, attempt to address some of these failures.

**Zip-Loop Technique**

The ZipLoop is a suspensory device that allows tensioning of the graft after cortical fixation of the grafts within the bone tunnels. This mechanism provides the first opportunity for re-tensioning the graft after ulnar and humeral fixation has been secured. In addition, the single-tunnel configuration of the ZipLoop also allows for more isometric insertion of the graft in the ulnar tunnel. Therefore, the risk of ulnar bone bridge fracture becomes greatly minimized if not eliminated.

To perform the surgery using the ZipLoop device, the single ulnar tunnel is drilled at the center of the attachment of the anterior bundle on the sublime tubercle. The ZipLoop device is then attached to the tendon graft; the middle portion of the graft is placed in the loop of the ZipLoop and the loop is shortened to match the total length of the ulnar tunnel. The ZipLoop is then passed through the ulnar tunnel for cortical fixation.

**Ulnar Nerve Transposition**

Since ulnar nerve symptoms were one of the most common complications with the original Jobe technique, there was interest in developing methods to more adequately address the nerve. The anterior subcutaneous ulnar nerve transposition (UNT) involves rerouting the nerve to run anteriorly across the cubital fossa, rather than
through the cubital tunnel at the posterior elbow. The Anterior FCU Retraction suggests muscle splitting of the flexor/pronator mass through the posterior third of the common flexor bundle, which ultimately transects the anterior-most fibers of the flexor carpi ulnaris. This method does not require transposition of the ulnar nerve unless the patient was experiencing pre-operative impingement symptoms. Ultimately, these methods decrease the amount of handling of the nerve and subsequently decrease the chances of post-operative neuropraxic symptoms.

Docking Technique

The docking technique was designed as a slight alteration on the original Jobe technique in order to minimize chances of bone tunnel fracture when valgus stresses are placed on the reconstructed UCL. The bone tunnels are drilled in a way so that the tendon can pulled through in a triangular configuration. The ends are tied over the humeral bone bridge to secure and tension the graft.

According to a study conducted by Ciccotti et al., both the docking and the original Jobe techniques closely approximate valgus stability provided by the native UCL at higher flexion angles, ranging from 90 to 110 degrees. However, neither technique was able to restore full valgus stability at lower elbow flexion angles, especially around 30°. Thus, post-operative patients should exercise great caution when completing activities that induce valgus stresses at minimal elbow flexion, such as side-arm throwing.

Rehabilitation

The primary goals of the first phase of UCL graft recovery are to limit inflammation and pain while also initiating tissue healing, range of motion recovery and
preventing muscle atrophy. Immediately post-surgery, the patient is placed in a posterior splint to immobilize the elbow at 90 degrees of elbow flexion and in a compressive elbow sleeve. Although the splint is intended to limit movement, the patient should also be instructed to avoid active hyperextension of the wrist and external rotation of the shoulder greater than 90 degrees. However, if the modified Jobe muscle-splitting procedure was performed, the patient may be allowed to perform range of motion exercises and well as isometric exercises in these first few days post-surgery. Furthermore, if the ulnar nerve was transposed, the patient should undergo nerve testing to ensure it has maintained its integrity and is fully functioning. Along with testing its function, special care should be taken to avoid over-stretching the transposed nerve. After the first 2-3 days of recovery, the patient’s compression dressing can be removed while the hard splint is removed around day 7. It is important to be mindful that this patient may be on analgesics for pain relief and their ability to give accurate feedback on sensation and pain will be impaired.

During the first 72 hours following surgery exercise interventions are performed to improve joint and scar nutrition as well as prevent loss of range of motion. It is important to stress the importance of immobilization in this acute healing phase as many everyday motions can cause injury to the recently repaired ligament. Passive and active-assisted range of motion should be performed at the humeroulnar joint as well as the radial-ulnar joint in all planes. The intensity of this phase may vary based on the surgeon’s instructions and the method of surgery performed. As previously stated, the muscle-splitting approach allows for a more expedited return to activity. Low intensity strength exercises can be performed isometrically to ward off atrophy of the associated tissues.
Ball squeezes are often introduced immediately while bicep isometric holds are performed later in the first week. The modalities in this phase include cryotherapy, electrical stimulation and ultrasound. These are intended to primarily reduce pain and inflammation in the surgical area.

Beginning in the second week of recovery, the patient is placed in a functional brace that is adjusted to allow 30° to 100° of elbow flexion. From this point on, the brace’s range of motion is increased weekly by 5° of extension and 10° of flexion until full return to pre-surgery range of motion around week 6 when the brace can be removed. Proprioceptive stretching should be incorporated to prevent loss of kinesthetic awareness in the end range of elbow. Low intensity passive range-of-motion exercises can also be performed at the elbow and wrist to prevent elbow flexion contractions. Strength exercises at this time include elbow, wrist and shoulder isometrics as well as wrist range of motion and gripping training. As the patient progresses in this post-operative phase, light tubing resistance and light dumbbell exercises can be performed to strengthen the shoulder and actively take the joints of the arm through an increasing range of motion. The incision site should receive scar mobilization at this time as well through massage to improve collagen re-alignment and minimize scar tissue formation.

In weeks 5 and 6, the “second phase” of rehabilitation focuses primarily on increasing range of motion and improving strength. The patient should have full range of motion at all joints by this time except external rotation of the shoulder. Light resistance exercises such as wrist curls and lateral raises should be continued throughout this phase and resistance can increase slightly. Once the full range of motion requirement is met, the functional brace is removed and only re-applied when the patient feels they are at risk.
for falls. Isotonic exercises with precaution given to avoiding elbow valgus stress are performed at all joints to return patient to pre-surgical strength.

If the patient is healing sufficiently, 6 to 8 weeks post-op brings about an increase in functional full range of motion training. A comprehensive exercise program is often initiated around week 6 to re-strengthen the sport-essential muscles that have may have undergone atrophy due to the relative inactivity since the surgical procedure. Around this time the patient will begin to transition to the advanced strengthening phase that concentrates on returning the athlete to their pre-surgical functional status. Plyometrics such as medicine ball throws are extremely effective at stressing the targeted tissues while also posing no significant risk of re-injuring the ulnar collateral ligament. Throughout this period of increased intensity, it is important for the physical therapist to intuitively know when to challenge the patient’s body but also not over stress his UCL to the point of inhibited recovery.

If the initial phases of rehabilitation progress according to plan, athletes may begin to throw a ball in a gentle toss manner around month four or five. The most important concept of this phase is to progressively increase the intensity of training to allow the tissues to heal following each training session. If pain increases or range of motion is affected, the physical therapist should re-evaluate the current interventions to diagnose the cause of the negative effects. Throwing volume should begin around 25 throws per session, 3 days a week on non-consecutive days and progressively increase in distance and total volume. Special attention should be placed on proper warm-up and cool down surrounding the throwing training. A month later, pitchers can combine the wind-up into their throwing motion and can return to throwing off a mound around month 7. As
velocity approaches pre-surgical speeds, many therapists and coaches will decrease total volume to around 75 pitches not including the warm-up and cool down phase to limit total workload\textsuperscript{6}. Within the next two months, full recovery is expected and all precautions can be removed.

The prognosis following UCL surgery is extremely positive. Dr. James Andrews, the most prominent Tommy John surgeon in Major League Baseball, finds that 83\% of his patients return to activity at or above their previous playing level\textsuperscript{1}. Andrews also claims the majority of his patients return to play in less than a year, with the average time of eleven and a half months. Position players are often able to return to play around 6 months, while pitchers usually are given the “Go” around a year post-surgery.
References


