A Patient’s Guide to Elbow Medial Collateral Ligament Reconstruction
CHAPTER 5

MEDIAL COLLATERAL LIGAMENT RECONSTRUCTION

GUILLERMO GONZALEZ-LOMAS, MD
NEAL ELATTRACHE, MD
CHRISTOPHER S. AHMAD, MD

High-level athletes generate tremendous valgus stresses at the elbow during the late cocking and acceleration phases of throwing. Indeed, biomechanical studies have estimated that valgus moments during those phases attain 120 N-m. 1 The primary restraint to valgus forces at the elbow is the anterior bundle of the medial collateral ligament (MCL). As such, the large tensile forces it endures place it at risk for injury. Waris' first recognized and described MCL injuries in javelin throwers in 1946. The injury often presaged the end of a throwing career. In 1974, Jobe and associates' developed a technique for MCL reconstruction that altered this bleak outlook. The technique involved transection and reflection of the flexor-pronator mass, transposing the ulnar nerve submuscularly, and reconstructing the MCL with a tendon graft through bone holes that traversed two cortices of both the humerus and ulna. Since its inception, the technique has proven successful in restoring elite throwers to preinjury levels of performance. The procedure is, however, technically demanding and fraught with several potential complications. More recent techniques have attempted to address these shortcomings. Moreover, newer biomechanical studies have furthered our understanding of the dynamic properties of the MCL. 1 This chapter reviews the pathophysiology of MCL injuries, analyzes the available reconstruction techniques, and summarizes relevant outcome studies.

FUNCTIONAL ANATOMY AND BIOMECHANICS

Elbow stability results from a static and dynamic interplay of bony anatomy, ligamentous restraints, and surrounding musculature. Interlocking of the bony anatomy governs stability in <20° of extension and >120° of flexion (olecranon in olecranon fossa). 2 In the arc of 20° to 120°, which is the functional arc of throwing, however, ligamentous restraints provide the majority of elbow stability. 3 The MCL complex represents the ligamentous restraint to valgus force at the elbow. It is composed of three ligaments—the anterior oblique ligament (AOL), the posterior oblique ligament, and the transverse ligament. The AOL is the strongest of these and withstands the bulk of valgus force. It originates on the humerus, distal to the axis of rotation, and inserts on the ulnar side of the coronoid process near the sublime tubercle. The AOL can be further subdivided anatomically. Its anterior and posterior bands provide a reciprocal function in resisting valgus stress through the range of flexion-extension motion (ie, the anterior band is taut in extension, the posterior band in flexion.). 4 It also divides itself into intracapsular and extracapsular components. One AOL component lies within the medial capsule. The other lies on the superficial surface of the capsule that, in addition, serves as a partial origin for the flexor digitorum superficialis (FDS).

During overhead throwing sports like baseball, water polo, javelin throwing, and tennis, enormous valgus forces are generated across the elbow. The calculated valgus stress across the elbow in elite athletes has been calculated as 64 N-m in baseball pitchers 5 and 60 N-m during a tennis serve. 6,7 The static demand on the MCL in resisting valgus torque during baseball pitching has been reported at 35 N-m. 8 These forces exceed the known tensile strength of cadaveric MCL specimens, which is
The Athlete’s Elbow

33 N-m. Accordingly, the MCL is at risk for injury during repetitive throwing. The excess valgus stress is likely dissipated among a combination of the surrounding muscular, ligamentous, and osseous structures. Surrounding musculature, for example, plays a critical role in elbow stability during valgus stress. Park and Ahmad\(^1\) demonstrated in a cadaveric model that the flexor carpi ulnaris is a primary dynamic contributor to valgus stability and the FDS is a secondary stabilizer, in addition to sharing an origin with the MCL. Because there is a significant muscular contribution to elbow stability, muscle morbidity must be minimized during surgical reconstruction.

Although soft-tissue structures act primarily as stabilizers during the functional arc of throwing, the bony anatomy of the elbow still plays an important stabilizing role during this range of motion. In particular, biomechanical evidence strongly suggests that the interlocking of the olecranon in the olecranon fossa contributes to elbow stability. The phenomenon of posteromedial olecranon impingement arises as a result of valgus stress during throwing, which drives the posteromedial edge of the olecranon into the olecranon fossa. Andrews and Timmerman\(^2\) reported that elbow valgus instability developed in 25% of professional baseball players after olecranon débridement for posteromedial impingement. Kamineni and associates\(^3\) examined the effect of resection of the posteromedial olecranon on elbow instability biomechanically. They demonstrated that stepwise resection of the olecranon leads to a stepwise increase in elbow valgus angulation. Another study concluded that strain on the AOL increased with olecranon resection greater than 3 mm.\(^4\) The suggestion was that aggressive olecranon débridement could lead to MCL instability. Ahmad and associates\(^5\) demonstrated that the converse could also occur; ie, subtle instability can lead to posteromedial olecranon impingement and eventually osteophyte formation. Other studies have provided compelling evidence that loss of valgus stability can lead to additional pathology such as ulnar neuritis, radiocapitellar arthrosis, and loose bodies.\(^6\)

HISTORY

The primary symptom in patients with MCL injuries is pain during the acceleration phase of throwing. In addition, patients may report loss of velocity, accuracy, and stamina while throwing. A complete history should document previous elbow problems, injections, and surgery. The examiner must differentiate acute injuries from chronic symptoms. Athletes with acute MCL tears will report a sudden onset of pain with or without a “popping” sensation that occurred during a particular throw. Often, they will report being unable to continue throwing. With acute MCL injuries, the resulting hemorrhage and injury can compress the neighboring ulnar nerve. As a result, symptoms of ulnar nerve irritation, including pain and numbness in the ipsilateral ring and little fingers, may present concurrently.

Complete disruption of the MCL can also lead to chronic valgus instability. In contradistinction to those with acute injuries, athletes with chronic MCL injuries report insidious pain and soreness along the inner elbow during throwing rather than recalling a specific traumatic event. Often these patients report bouts of soreness that arise during and after throwing that respond to nonsurgical management. Ultimately, most present when they can no longer throw at 75% of their baseline speed. Athletes will describe this as a loss of “zip” or “pop” in their throwing.

Occasionally a chronic injury underlies a superimposed acute injury. In these instances, the athlete will recount a chronic MCL history punctuated by a sudden, isolated giving way or medial elbow pain that prompted a visit to the clinic.

PHYSICAL EXAMINATION

The physical examination must include inspection, palpation, and examination of bilateral upper extremity range of motion and stability. Pathology in the shoulder and scapula may uncover hidden improper throwing mechanics. Examination for the presence of the palmaris is needed if an MCL reconstruction is planned. Positive findings for MCL injury include point tenderness to palpation 2 cm distal to the medial epicondyle (reported in up to 80% of athletes undergoing reconstruction)\(^7\) and painful valgus instability, as well as positive MCL-specific tests.

Several tests are available to examine the integrity of the MCL. The classic test is to stress the elbow at 30° of flexion while stabilizing the humerus, because this removes the bony interlocking effect of elbow stability. This test is positive when the patient reports pain and the medial joint space opens up in response to valgus stress. The “milking maneuver” involves having the ath-
The athlete pulls on his or her own elbow. The athlete flexes the affected elbow beyond 90°, with the hand in a "thumbs up" position, and brings the contralateral hand under the arm of the affected elbow to grab the extended thumb. While the athlete pulls on his or her own thumb, stressing the medial elbow, the examiner palpates the MCL for tenderness, joint space opening, and end point. The affected elbow is compared with the normal, contralateral side. Relative differences in laxity must be interpreted with caution because elite throwers may demonstrate relatively more laxity in the throwing elbow than in the contralateral elbow at asymptomatic baseline. Therefore, the examination should be more focused on eliciting pain and lack of an end point. In a modification of the milking maneuver illustrated in Figure 1, the surgeon performs the valgus stress by pulling on the patient’s thumb with one hand while holding the elbow with the other hand. One shortcoming of the milking maneuver is that the patient will often flex the affected elbow >120°. At this degree of flexion, the bony anatomy begins to contribute to elbow stability. To address this, O’Driscoll and associates recently described another test, the moving valgus stress test. In this test, the examiner places the athlete’s shoulder in abduction and external rotation. The examiner holds the athlete’s forearm with one hand and the humerus with the other while flexing and extending the elbow and applying a valgus stress, as shown in Figure 2. If the MCL is injured, the athlete will experience pain in the arc of 80° to 120°. One advantage of this technique is that the examiner can also control external rotation of the shoulder, which has classically been a confounding factor in tests of elbow stability. Additionally, the test more accurately mimics the position of the elbow during throwing. Two points should be emphasized concerning this maneuver: First, cadaveric studies have verified that the best position to demonstrate valgus laxity is with the forearm in neutral rotation during testing; second, the expected amount of laxity in an elbow with complete MCL disruption will be subtle, at most a few millimeters.

Care must be taken to rule out associated injuries, in particular flexor-pronator mass avulsions. Several authors have reported significant coexistence of flexor-pronator ruptures with acute MCL tears. Athletes with these combined injuries will have tenderness at the medial epicondyle origin that worsens with resisted wrist flexion. The ulnar nerve should also be examined for concurrent neuritis by attempting to elicit a Tinel sign.
IMAGING STUDIES

Imaging modalities can help in delineating the diagnosis of MCL tears. AP, lateral, and axillary radiographs without valgus stress can be obtained to rule out the presence of osteochondral lesions, loose bodies, and osteophytes. Stress radiographs can assess instability in the case of an acute MCL tear. Significant radiographic elbow valgus laxity can exist in the dominant, asymptomatic throwing arm of pitchers: up to 0.5 mm of laxity has been measured in professional baseball pitchers. Conversely available stress devices are available that boast a reported 94% sensitivity and 100% specificity for MCL tears. Nevertheless, even in the normal, nonthrowing population, the difference in elbow valgus laxity between normal elbows can be up to 0.5 mm. Therefore, diagnosing MCL injury based on laxity may not be reliable. Although some authors have found that ~2 mm of increased relative valgus laxity denotes an MCL tear, others have reported that ≤50% of athletes who underwent warranted MCL reconstruction had positive stress radiographs.

MRI may help define the extent of MCL injury (Figure 3). It visualizes the ligament directly and can help identify coexisting pathology such as in the radiocapitellar joint. MRI sensitivity has been reported to be between 57% and 79%, whereas specificity has been found to range from 79% to 100%. MR arthrography has more reliable sensitivity (92%) and specificity (100%). MRI using a high-field closed magnet, thin-slice images, and enhanced with intra-articular gadolinium contrast appears to have dependable diagnostic value.

Dynamic ultrasonography has also been studied as a diagnostic tool for MCL tears. Although this modality is noninvasive and inexpensive, accurate diagnosis is operator-dependent.

INDICATIONS/CONTRAINDICATIONS

In deciding whether to operate on an athlete, the surgeon must consider the athlete’s individual demands, goals, and expectations along with the degree of MCL injury. Initial nonsurgical treatment should consist of 6 weeks of complete rest from throwing while undergoing a flexor-pronator strengthening program. If after 6 weeks the patient is asymptomatic and has a normal examination, then a gradual return to throwing is begun. At this point, patients can also benefit from a structured throwing mechanics optimization program. Rettig and associates demonstrated a 42% return to preinjury level of play with nonsurgical management lasting an average of 24.5 weeks.

The primary indication for surgical MCL reconstruction is a diagnosis of MCL insufficiency that has failed nonsurgical treatment. The diagnosis of MCL insufficiency is arrived at from a thorough history, physical examination, and interpretation of imaging as outlined above. Patients who meet these criteria and who would like to undergo reconstruction must be informed of and prepared to undergo extensive and lengthy postoperative rehabilitation.

Patients contraindicated for surgical MCL reconstruction include those with asymptomatic tears and those who do not wish to continue throwing at a high level or who cannot participate in the significant postoperative rehabilitation required. Patients with coexisting ulnohumeral or radiocapitellar arthritis should be informed of the possibility of continued or worsening pain following reconstruction.
RECONSTRUCTION TECHNIQUES

Modified Jobe Technique

This technique is usually done using a sterile tourniquet on the upper arm. A 10-cm incision centered over the medial epicondyle is made. Care is taken to protect the sensory branches of the medial antebrachial cutaneous nerve, just anterior to the medial epicondyle. The flexor-pronator mass is then divided longitudinally along its fibers by incising the raphe from the medial epicondyle to the sublime tubercle (Figure 4, A). The flexor-pronator muscle mass is separated from the MCL with an elevator. At this point, the ligament can be inspected and examined by stressing the elbow in valgus at 30° of elbow flexion. The ligament is split longitudinally to visualize the ulnohumeral joint (Figure 4, B and C). If the MCL is insufficient, the ulnohumeral articulation will open. Converging 3.2-mm drill holes are made in the ulna anterior and posterior to the sublime tubercle, leaving at least 5 mm of bone bridge between the holes (Figure 4, D and E). The drill holes are connected with an angled curette.

A 4.5-mm drill hole is made on the medial epicondyle, at the site of the anatomic origin of the anterior bundle of the MCL. The hole is made in the anterior cortex and does not penetrate the posterior cortex of the humerus (Figure 4, F). The fascia over the anterior aspect of the epicondyle is split superior to the last hole to expose the broad, flat surface of the anterosuperior epicondyle. Two 3.2-mm drill holes are then made. The first is drilled just anterior to the epicondylar attachment of the medial intermuscular septum (superior and anterior to the 4.5-mm hole) and directed to communicate with the 4.5-mm drill hole in the medial epicondyle. The second 3.2-mm drill hole is made in the anterosuperior surface of the epicondyle, approximately 1 cm posterior to the previous 3.2-mm hole.

The palmaris longus from the ipsilateral arm is harvested through a series of small transverse incisions beginning at the distal flexor crease of the wrist. Additional skin incisions are made 7.5 and 15 cm from the wrist, exposing the entire length of the tendon. Alternatively, the palmaris longus may be harvested with a tendon stripper and a single incision in the flexor crease of the wrist. A No. 2 nonabsorbable suture is cross-stitched at each end of the graft. The graft is passed through the proximal ulnar bone tunnel and medial epicondyle in a figure-of-8 configuration. With the elbow placed in varus stress and 60° of flexion, and the forearm in supination, tension is applied to the graft. The ulnar side of the graft is sutured to the remnants of the MCL adjacent to the sublime tubercle. The proximal limb of the graft is sutured to the medial intermuscular septum outside the drill hole on the superior surface of the epicondyle. Simple sutures are placed in the crossing limbs of the graft, further tensioning the graft and enhancing fixation. The native ligament is then repaired over the graft with simple sutures placed. Figure 4, G illustrates the final construct. The muscle fascia is repaired, and the skin is closed.

Docking Technique

The docking technique modifies the Jobe technique further, simplifying graft passage, tensioning, and fixation (Figure 5, A). The initial approach to the ulna closely parallels the Jobe technique. The flexor-pronator mass is split and elevated from the MCL and the ulnar tunnel is made in the fashion described above. The humeral tunnel position is located in the anterior half of the medial epicondyle at the anatomic insertion of the native MCL, similar to the Jobe technique. This tunnel is created to a depth of 15 mm using a 4-mm burr or drill. The upper border of the epicondyle is exposed by excising the fascia there. Two small exit tunnels separated by a bone bridge of 5 mm to 1 cm are created, stemming from the 4-mm primary humeral tunnel. Suture loops are then placed with a straight needle from the primary humeral tunnel through the exit tunnels to facilitate graft passage (Figure 5, B). With the elbow in forearm supination and mild varus stress, the horizontal incision in the native MCL is repaired with a No. 2.0 absorbable suture.

The graft is then passed through the ulnar tunnel from anterior to posterior (Figure 5, C). The posterior limb of the graft is passed into the humeral tunnel and secured. The final length of the anterior limb of the graft is determined by placing it adjacent to the humeral tunnel and visually estimating the length of the graft needed to provide adequate tension once secured in the humeral tunnel (Figure 5, D). A No. 1 braided nonabsorbable suture is placed in a Krakow fashion on the end of the anterior limb of the graft. The excess graft is excised and the graft limb is passed into the humeral tunnel with the
Modified Jobe technique. A, Drawing shows the location of the muscle split in the flexor-pronator mass. FCU = flexor carpi ulnaris. B, Drawing shows the muscle-splitting approach and unhumeral gapping demonstrated after the MCL is incised longitudinally. C, Intraoperative photograph demonstrates the muscle-splitting approach with MCL incision. The unhumeral joint, which is visible through the MCL incision, is seen inside the white oval. Intraoperative photographs show ulnar tunnels being created anterior (D) and posterior (E) to the sublime tubercle. F, Intraoperative photograph shows the inferior humeral tunnel being created at the anatomic MCL insertion. G, Drawing shows the final appearance of the original MCL reconstruction technique as described by Jobe and associates, demonstrating ulnar and humeral bone tunnels and graft figure-of-8 configuration. (Parts A and B reprinted with permission from Conway JE: The DANE TJ procedure for elbow medial ulnar collateral ligament insufficiency. Tech Shoulder Elbow Surg 2006;7:98–103.)
The docking technique. **A**, Drawing showing the position of the tunnels used in the docking technique. Exit holes are created superior to the inferior humeral tunnel for tensioning sutures stitched to graft. **B**, Intraoperative photograph showing sutures attached to graft being passed through humeral tunnels. **C**, Intraoperative photograph showing graft being passed through ulnar tunnels from anterior to posterior. **D**, Intraoperative photograph showing the posterior graft limb docked in the tunnel and the anterior graft limb being marked to appropriate length with marking pen. **E**, Intraoperative photograph showing final graft tensioning.
sutures exiting the small tunnels. Final graft tensioning is performed by ranging the elbow through full flexion, extension, supination, and pronation, with varus stress placed on the elbow (Figure 5, E). With the elbow in 60° of flexion and full supination, and with varus stress applied, the sutures are then tied over the bony bridge on the humeral epicondyle.

**Hybrid Interference Screw Fixation Technique**

Another technique of MCL reconstruction uses interference screw fixation. It achieves ulnar-sided fixation with an interference screw through a single bone tunnel and humeral fixation using the docking technique57 (Figure 6, A). This technique has several advantages. First, it is less technically demanding because fewer drill holes are required. Second, the muscle-splitting approach used requires less dissection because only a single central ulnar tunnel is required, rather than two tunnels with an intervening bony bridge. Third, because there is no need to make a posterior ulnar tunnel, which often exits close to the ulnar nerve, morbidity to the nerve is minimized. Finally, graft passage is less difficult with an interference screw in a single tunnel. In situations in which the sublime tubercle of the ulna, approximately 4.5 mm distal to the joint surface, a 5-mm-diameter tunnel is drilled and directed 45° distally to the long axis of the ulna for a depth of 20 mm (Figure 6, B). The drill is advanced with guidance of the drill sleeve that protects the soft tissue and ulnar nerve. Maintenance of a 2-mm bone bridge from the edge of the tunnel to the joint avoids possible fracture of the tunnel into the ulnohumeral joint.

The palmaris longus tendon is harvested and folded over to create a double-strand graft. A standard whipstitch using No. 2 nonabsorbable suture is placed in the folded portion of the graft. Graft fixation into the ulnar tunnel with a 4.75 or 5.5 × 15-mm interference screw is then achieved using a unique Bio-Tenodesis driver (Arthrex, Inc, Naples, FL). The driver shaft is used to guide the turning screw into the tunnel while providing constant tension on the graft. Figure 6, C shows the graft fixed to the ulnar side and the two graft limbs ready for docking.

The humeral tunnels are created as described for the docking procedure as shown in Figure 5, A. The two limbs of the graft are then prepared as described for the docking procedure, with the modification that both limbs must be accurately cut to length. The anterior graft limb sutures are then marked with ink for later identification. One suture from the anterior graft limb and one from the posterior graft limb are then passed through the anterior humeral tunnel using a free needle or suture-passing wire. The two remaining sutures from each graft limb are passed through the posterior tunnel. The graft is delivered into the humeral tunnel and the elbow is flexed and extended with tension on the sutures to eliminate any creep. The elbow is positioned at 80° of flexion, varus stress is applied, and the posterior limb sutures are tied (Figure 6, D). Then with the elbow positioned at 30° of flexion and varus stress applied, the anterior limb sutures are tied (Figure 6, E).

**Surgical Considerations**

The palmaris longus is the most commonly used graft choice. All surgical candidates should be assessed for the presence of the palmaris longus because it is absent in up to 25% of the population.39 If the palmaris longus is absent, the gracilis, Achilles, plantaris, or toe extensor tendon can be used. The gracilis generally has a predictable size and is easy to harvest. No determination can be made at this time as to which graft choice produces the best results.

The ulnar nerve also should be assessed prior to surgery. Ulnar neuritis commonly presents concurrently with MCL tears. In addition, ulnar nerve subluxation may occasionally also be present. In early reports of MCL reconstruction, the ulnar nerve was routinely transposed.39 More recent technique modifications, in particular splitting the flexor-pronator origin instead of taking it down, have obviated the need for nerve transposition unless specific criteria are met. If the patient reports symptoms of ulnar neuritis (pain, numbness along the fourth and fifth digits) and nerve subluxation preoperatively, ulnar nerve transposition is indicated. Symptoms of ulnar neuritis and ulnar motor deficits
Figure 6

Hybrid technique of MCL reconstruction with interference screw fixation on the ulnar side and docking fixation on the humeral side. 

A, Drawing showing the completed reconstruction. 
B, Intraoperative photograph showing the ulnar tunnel for the interference screw drilled at the sublime tubercle. 
also are an indication for transposition. Subcutaneous transposition appears to have fewer complications than submuscular transposition.

The arthroscopic valgus stress test may have some utility in assessing the competence of the MCL prior to reconstruction. In this test, the ulnoumeral joint is stressed in valgus with the forearm maximally pronated and the elbow at 90° of flexion. The ulnoumeral opening is <1 mm in most normal elbows, although this is a purely subjective observational measurement. Furthermore, a cadaveric study concluded that the anterior bundle of the MCL could not be visualized arthroscopically. Indications for surgery should be based primarily on the history and physical examination. Preoperative elbow arthroscopy seems to have more of an adjunctive diagnostic utility.

Posteromedial decompression should be considered very carefully. It should not be undertaken if the patient does not have posteromedial elbow pain in extension. In addition, isolated posteromedial debridement should not be done if MCL insufficiency is present. As noted earlier, MCL resection increases valgus angulation and strain on the MCL during valgus stress. MCL insufficiency may also lead to increased posteromedial wear and subsequent osteophytes, which may result in an artificially stable joint. Therefore, isolated posteromedial decompression may render symptomatic previously asymptomatic MCL insufficiency. One series reported MCL insufficiency requiring reconstruction after isolated posteromedial decompression. Azar and associates and Rohrbough and associates currently recommend selective minimal resection of posteromedial osteophytes in addition to MCL reconstruction.

REHABILITATION

The elbow is immobilized in a splint for 10 days to allow the skin and soft tissues to heal. Sutures are removed at that time, if necessary, and active wrist, elbow, and shoulder range-of-motion exercises are initiated. After 4 to 6 weeks, strengthening exercises are begun while avoiding valgus stress until 4 months after surgery. At 4 months, the patient begins a throwing program consisting initially of ball tosses of 30 to 40 feet for about 15 minutes two to three times a week. At 5 months, the patient may increase the tossing distance to 60 feet, and at 6 months, the patient may throw lightly from the windup. At 7 months, a graduated program of range-of-motion, strengthening, and total body conditioning exercises is undertaken. Throwners and pitchers are limited to throwing at half speed, gradually increasing the duration of the session to 25 to 30 minutes. Pitchers are permitted to throw from the pitching mound and progress to 70% of maximum velocity during the eighth or ninth month. Over the next 2 to 3 months, the duration of throwing sessions and velocity are increased incrementally to simulate a game situation. Throwing in competition is permitted at 1 year if the shoulder, elbow, and forearm are pain free while throwing and full strength and range of motion have returned. Throughout the rehabilitation phase, careful supervision and focus on body and throwing mechanics should be emphasized. Up to 18 months may be required to regain preoperative ability and competitive level with accurate ball control. Relatively shorter periods are required for other player positions or overhead sports.

OUTCOMES

Simple repair of the MCL does not yield reliable results. Most previous studies have reported better results with reconstruction than with repair. Reported success rates after reconstruction have improved since Jobe and associates' original article. In their original series, 62.5% of throwing athletes (10 of 16) returned to their preinjury level of competition. However, the original technique had a complication rate of 31.25% (5 of 16), primarily related to submuscular transposition of the ulnar nerve. Subsequently, Conway and associates reported a success rate of 68% with a 95% follow-up rate. They emphasized that a history of surgery on the same elbow decreased the likelihood of an excellent result. Excluding patients with a previous operation, 74% of their patients returned to their previous level of competition. The study reported a 21% ulnar nerve complication rate. After modifying their technique further (changing flexor-pronator detachment to flexor-pronator splitting and abandoning ulnar nerve transposition in favor of no transposition), the group reported excellent results in 82% of patients, with a reduced transient ulnar nerve complication rate of 20% and no permanent ulnar nerve symptoms. Results were excellent in 93% of patients undergoing primary elbow surgery. Results for the docking technique also have been promising. Rohrbough and associates reported that 92% of their patients returned to preinjury levels of...
competition. Dodson and associates\(^5\) found that 90% of their athletes undergoing MCL reconstruction using the docking technique returned to the same or a higher level of competitive throwing. Recently, in a 2-year follow-up study, Paletta and associates\(^6\) reported that 92% of elite baseball players (23 of 25) were able to return to preinjury levels of competition using the docking technique. They reported a mean time to return of 11.5 months and only two complications.

Interference screw fixation is a newer technique that has potential advantages. Ahmad and associates\(^7\) conducted a biomechanical cadaveric study demonstrating that a technique using interference screw fixation on both the ulna and the humerus restored valgus stability at all flexion angles and achieved strength of fixation to a level approaching that of an intact ligament. McAdams and associates\(^8\) compared cyclic valgus loading on reconstructions using the bioabsorbable interference screw procedure and docking procedure using cadaver elbows. The interference screw fixation resulted in less valgus angulation in response to early cyclic valgus load as compared with the docking technique.

Dines and associates\(^9\) reported the results of an initial series of 22 patients treated with the hybrid interference screw technique that has been referred to as the DANE TJ technique. At 36 months’ follow-up, 19 of 22 patients had excellent results, 2 had fair results, and there was 1 poor result, which was a revision case. The two other revision MCL reconstructions had excellent outcomes. When used in two cases of sublime tubercle avulsions, the results were excellent.

In contrast, a recent cadaveric study compared four different reconstruction methods with respect to initial fixation strength when subjected to initial peak loads and repeated valgus loading.\(^{10}\) The study evaluated the figure-of-8, docking, single-strand interference screw, and EndoButton (Smith & Nephew, Memphis, TN) techniques. The authors concluded that all reconstructions had a lower peak load to failure than the intact ligament. Furthermore, the docking and EndoButton techniques had higher peak and cyclical loading characteristics than the figure-of-8 and single-strand interference screw techniques. Large and associates\(^11\) performed a biomechanical cadaveric study comparing the strength provided by the Jobe technique and the interference screw technique with that of intact MCL. They found that, compared with the interference screw technique, the Jobe bone tunnel technique created a much stronger construct that more closely approximated the tensile properties of the intact native MCL. In general, the bone tunnel technique failed with tunnel breakage, while the interference screw technique failed with graft slippage. Long-term follow-up of these new techniques in the clinical setting has not yet been reported.

**CONCLUSIONS**

MCL reconstruction is a technically demanding procedure. The surgeon must work to perfect several factors, including graft isometry, tension, and security, while optimizing the healing environment. In properly selected patients, MCL reconstruction can be successful in returning elite athletes to their preinjury level of play. Excellent results are generally achieved with a flexor-pronator muscle-splitting approach without ulnar nerve transposition (unless indicated), using a figure-of-8 or docking technique.Transient ulnar nerve symptoms are common. Judicious concurrent posteromedial osteophyte excision may be performed if required. A history of prior elbow surgery diminishes the likelihood of an excellent result. A number of new techniques, including interference screw fixation, have yet to be validated in the clinical setting.

**REFERENCES**


*American Academy of Orthopaedic Surgeons*
The Athlete’s Elbow