Evaluation and Treatment of Injuries of the Ulnar Collateral Ligament of the Thumb Metacarpophalangeal Joint

Michael A. Baskies, M.D., and Steve K. Lee, M.D.

Abstract

Injuries of the ulnar collateral ligament of the metacarpophalangeal joint of the thumb are very common. A review of the literature regarding the pertinent anatomy, injury mechanism, diagnostic modalities, and treatment options may yield a better understanding for future management.

Injuries of the ulnar collateral ligament of the metacarpophalangeal joint of the thumb are encountered frequently. In one review of 1,000 thumb metacarpophalangeal injuries, trauma to the ulnar collateral ligament was most common and accounted for approximately 86% of the injuries. The most common mechanism for ligament injury is excessive radial deviation of the thumb proximal phalanx. Pathologic entities result from acute trauma and recurrent incidents.

Campbell coined the eponym, gamekeeper’s thumb, in 1955, to describe chronic laxity of the ulnar collateral ligament. The name was derived from a commonly observed condition in European gamekeepers of the period. Gamekeepers repetitively killed their game by grasping the heads of the animals, for example, hares, between the thumb and index finger to break the animals’ necks. For the gamekeeper, these acts resulted in a chronic attenuation pattern of injury to the ulnar collateral ligament.

Stener later described a lesion observed in many cases of complete rupture of the ulnar collateral ligament of the thumb metacarpophalangeal joint. A Stener lesion is an adductor aponeurosis interpositioned between the distally avulsed ulnar collateral ligament and the ligament’s insertion into the base of the proximal phalanx of the thumb. Stener predicted that a lack of contact at the site of ligament rupture would result in a failure of ligament healing. Thus, he deduced that such complete ruptures necessitated surgical repair.

More recently, Gerber and colleagues utilized the term, “skier’s thumb,” to describe an acute tear of the ulnar collateral ligament. This term was appropriate due to the high prevalence of this injury seen in participants of the sport; up to 32% of all ski injuries may involve the thumb. When a skier falls with his or her hand caught in a ski pole, the ulnar collateral ligament of the metacarpophalangeal joint of the thumb may sustain significant stresses.

In light of current studies investigating the validity of diagnostic modalities and the utility of various surgical techniques, it is useful to review the pertinent anatomy and pathology of the ulnar collateral ligament of the thumb metacarpophalangeal joint. Moreover, a reproducible clinical examination often yields a reliable treatment algorithm. An analysis of previous work in this area can elucidate a plan for intervention, and may allow surgeons to develop and employ future modalities in the management of this injury.

Anatomic Concepts

The metacarpophalangeal joint of the thumb is a diarthrodial joint, reinforced by a capsule and by other soft tissue structures. Opposing surfaces of the metacarpal and proximal phalanx are covered with articular cartilage, with the joint itself situated within a cavity containing synovial fluid. The surfaces of the metacarpal and proximal phalanx articulate...
and allow for a degree of free movement. The range of motion is highly variable at the thumb metacarpophalangeal joint with regard to flexion-extension arcs and the degree of valgus laxity.

Anatomic structures confer stability of the thumb metacarpophalangeal joint in response to valgus loading. The proper collateral ligament, accessory collateral ligament, volar plate, and dorsal capsule comprise the static stabilizers to valgus stress. The proper collateral ligament extends from a point slightly dorsal to the mid-axis of the metacarpal head to the palmar aspect of the proximal phalanx (Fig. 1). The proper collateral ligament prevents palmar subluxation of the proximal phalanx and serves as the primary restraint to valgus stress with the metacarpophalangeal joint in flexion. The accessory collateral ligament courses palmarly to insert onto the volar plate. The accessory collateral ligament is contiguous with the proper collateral ligament proximally. The volar plate and the accessory collateral ligament function as the principal restraints to valgus stress with the metacarpophalangeal joint in extension.

Dynamic stabilizers to valgus stress consist of the intrinsic and extrinsic muscles of the thumb. The extensor pollicis brevis, extensor pollicis longus, and flexor pollicis longus are extrinsic muscles that provide stability in response to valgus loads. The adductor pollicis and the flexor pollicis brevis are intrinsic muscles, imparting valgus stability. The adductor mechanism presents as an aponeurosis superficial to the metacarpophalangeal joint capsule and ulnar collateral ligament. The adductor mechanism maintains dual insertions. The superficial insertion of the adductor mechanism is the extensor expansion via the adductor aponeurosis; the deep insertion extends to the palmar aspect of the proximal phalanx via the ulnar sesamoid of the metacarpophalangeal joint.

**Biomechanics**

Recent literature has focused on the biomechanical properties of the ulnar collateral ligament. Firoozbakhsh and associates reported on the properties of the native ulnar collateral ligament in cadaveric specimens. In this study, the failure load, maximum stress, and Young’s modulus of an intact ulnar collateral ligament of the metacarpophalangeal joint of the thumb were 294.3 ± 28.2 N, 11.4 ± 1.2 MPa, and 37.3 ± 5.1 MPa, respectively.

In patients with suspected ulnar collateral ligament pathology, evaluation of the appropriate range of motion relies on the precedent of previous literature regarding the arc of motion observed in normal cadaveric specimens. Thumb metacarpophalangeal joints may display arcs ranging from 5° to 115° of total motion in flexion. Valgus stability was examined with the metacarpophalangeal joint in various degrees of flexion; full flexion was the position of greatest stability. The level of valgus stability was variable; however, valgus laxity averaged 12° with the native metacarpophalangeal joint in 15° of flexion.

Analyses of the static stabilizers of the thumb metacarpophalangeal joint have been undertaken. Minami and coworkers utilized cadavers and biplanar radiographs to demonstrate that the proper collateral ligament provided joint constraint in flexion and that the accessory collateral ligament imparted stability in extension. Validating this analysis, Heyman and colleagues sacrificed the proper collateral ligament in autopsy specimens and found increased valgus instability of the flexed metacarpophalangeal joint. Furthermore, accessory and proper collateral ligament division resulted in valgus instability in flexion and extension. Transection of all static stabilizing structures resulted in volar translation of the metacarpophalangeal joint at 45° and 60° of flexion. Complementing work on the static stabilizing structures, reports on the dynamic stabilizers of the metacarpophalangeal joint have received more recent attention.

**Mechanism of Injury**

Injury to the ulnar collateral ligament of the metacarpophalangeal joint of the thumb most often results from valgus load. A commonly reported cause is a fall onto an abducted thumb. Acute thumb metacarpophalangeal injuries may be observed in association with participation in many sports, including skiing, volleyball, soccer, handball, basketball, and rugby. Several theories exist regarding the mechanism of injury demonstrated by skiers, and these hypotheses include...
falls onto the hand or inadvertent stress applied by the ski pole.  
Pathology of the ulnar collateral ligament also may represent a consequence of chronic attritional trauma.  Case reports of children presenting with ruptures of the ulnar collateral ligament of the metacarpophalangeal joint of the thumb have been reported; however, these injuries are rare in the pediatric population.  

Pathology  
Ulnar collateral ligament injury of the metacarpophalangeal joint of the thumb may represent one of several different pathologic entities. In a study that included 66 patients, Smith reported that the majority of these injuries involved the ulnar collateral ligament or its attachment.  Other associated injuries included tearing of the dorsal metacarpophalangeal joint capsule, stretching of the adductor expansion, and rupture of the extensor pollicis brevis.  

Rupture of the proper ulnar collateral ligament most often occurs at the ligament’s distal insertion on the base of the proximal phalanx.  Tears have also been reported as located midsubstance within the ligament or more proximal in the course of the ligament.  Ligament ruptures may be associated with an avulsion fracture from the ulnar aspect of the base of the proximal phalanx. Tearing of both the accessory and proper ulnar collateral ligaments is a complete ulnar collateral ligament tear. Complete tears may be associated with Stener lesions in 64% to 87% of cases.  Stener lesions are defined as displacement of the distal end of ruptured ulnar collateral ligament so that it lies superficial and proximal to the adductor aponeurosis.  An intact accessory ligament may prevent Stener lesions from occurring.  

Diagnostic Evaluation  
Diagnosis of an ulnar collateral ligament injury depends on an accurate patient history and a comprehensive physical examination. Patients with ulnar collateral ligament injuries occasionally report sustaining a valgus injury to the thumb; however, many do not recall the exact direction of force to the thumb. They complain of subsequent pain, swelling, and ecchymosis that is localized to the ulnar aspect of the metacarpophalangeal joint of the thumb. Many patients sustain these injuries during participation in athletic activities, with a higher prevalence reported in particular sports.  

For a patient with a suspected ulnar collateral ligament injury, physical examination should commence with observation of the thumb metacarpophalangeal joint for deformities, including apex ulnar deviation and palmar subluxation of the proximal phalanx. Next, the examiner should palpate the metacarpophalangeal joint. Stener confirmed in his seminal work that a protuberance palpated on the ulnar aspect of the joint was suggestive of an underlying Stener lesion.  However, later work showed that the absence of a palpated mass did not rule out the presence of a Stener lesion.  

Following palpation of the metacarpophalageal joint, anteroposterior and lateral radiographs of the thumb are obtained to evaluate for instability and concomitant injury. Apex ulnar deviation and palmar subluxation of the metacarpophalangeal joints are indicators of instability. Concomitant injuries may include avulsion fractures of the base of the proximal phalanx, metacarpal fractures, and simultaneous instability of the metacarpophalangeal and carpometacarpal joints.  

After a review of adequate radiographs, the patient should undergo valgus stress testing of the thumb metacarpophalangeal joint. Patients with acute injuries may demonstrate profound guarding; local anesthesia increases the accuracy of assessment of ulnar collateral ligament injuries, as the patient may comply more comfortably during the examination.  Valgus laxity signifying complete tear (both proper and accessory collateral ligaments) has been defined previously as greater than 30° of deviation or 15° greater than the normal extremity.  Ulnar collateral ligament tenderness with less than those amounts of laxity is indicative of a partial tear.  

A complete valgus stress examination initially involves evaluating the proper collateral ligament. Position of the metacarpophalangeal joint of the thumb in 30° of flexion, with rotational control of the joint via a firm grasp of the metacarpal, yields a reliable stress examination of the proper collateral ligament. Greater than 30° of valgus laxity in flexion is consistent with probable rupture of the proper collateral ligament.  Next, the examiner may place and hold the metacarpophalangeal joint in 0° of extension to assess the accessory collateral ligament. Greater than 30° of valgus laxity during this component of the stress test correlates with complete rupture of both the proper and accessory collateral ligaments.  Pearls of the evaluation are to perform the examination with the metacarpophalangeal joint at 0° using a firm grip of the metacarpal to avoid rotation of the joint. Rotation may give a false impression of instability.  

More recently, ancillary examinations have been reported to aid in the diagnosis of ulnar collateral ligament pathology. Stress radiography of the metacarpophalangeal joint may be used in the diagnosis of ulnar collateral ligament injuries; however, there is some controversy regarding its universal utility.  Arthrography showed ulnar extravasation in six of nine cadaveric specimens, with defects in the ulnar collateral ligament; however, arthrography is uncommonly used at present.  Several reports have demonstrated the advantages posed by obtaining magnetic resonance imaging (MRI) studies for patients with suspected ulnar collateral ligament injuries.  However, the cost-effectiveness of MRI has not been proven to date. In tests using cadaveric thumbs, MR arthrography proved the most sensitive radiologic examination in the diagnosis of ulnar collateral ligament injury when compared with conventional arthrography and MRI.  Lastly, ultrasonography has proven a useful modality in the correct diagnosis of ulnar collateral ligament pathology.  Ultrasound is promising, because it may be accurate and cost-effective. Potential drawbacks of ultrasound include the dependence of diagnostic accuracy on multiple factors,
including examiner skill, the quality of equipment, technique used, transducer position, and time elapsed from injury.\textsuperscript{43} Currently, the diagnosis is made by clinical examination, with the only additional study being plain radiographs.

**Treatment**

Treatment of valgus instability of the thumb metacarpophalangeal joint depends on clinical examination findings. Acute treatment is dependent on the presence of a partial or complete rupture of the ulnar collateral ligament. Acute presentation of a complete rupture requires surgical repair. Partial rupture of the ulnar collateral ligament warrants nonoperative management, as uneventful healing is the most likely outcome. Nonoperative management may include a short-arm thumb spica cast or a hand-based removable thumb spica orthosis for 6 weeks following the injury. Early range of motion exercises may commence after the period of immobilization, with grip strengthening exercises started 8 weeks after the injury.

Treatment of a patient with an avulsion fracture associated with an ulnar collateral ligament injury is a source of controversy in the literature. Dinowitz and associates\textsuperscript{44} recommend surgery for avulsion fractures\textsuperscript{44} and Kuz and coworkers\textsuperscript{45} and Sorene and Goodwin\textsuperscript{46} reported good results with nonoperative treatment. Sorene and Goodwin stress that the metacarpophalangeal joint must be stable on examination for nonoperative treatment to be successful.

**Surgical Repair**

Operative treatment of acute ulnar collateral ligament injuries is performed with administration of regional or general anesthesia and sterile preparation of the extremity. Exsanguination of the extremity and application of a pneumatic tourniquet for hemostasis should be employed in appropriate cases, as indicated by the surgeon. Skin incision may be curvilinear or longitudinal and centered over the ulnar aspect of the metacarpophalangeal joint. During dissection through the superficial subcutaneous tissues, care should be taken to identify and protect the sensory branches of the radial nerve. Accurate identification of the proximal edge of the adductor aponeurosis is followed by incision through the aponeurosis, in a manner that is parallel and palmar to the course of the extensor pollicis longus. Retraction of the aponeurosis distally allows for assessment of the dorsal capsule as well as the proper and accessory collateral ligaments. Determination of the most appropriate repair technique may be made at that point.

Regardless of the approach utilized, the primary objective of surgical repair is maintenance of an anatomic reduction of the metacarpophalangeal joint of the thumb. An acceptable surgical result depends on restoration of normal ulnar collateral ligament orientation. Furthermore, changes in ligament orientation may result in changes in joint kinematics or alterations in ligament tensile properties.\textsuperscript{47}

When primary repair of the ulnar collateral ligament is indicated, the location and nature of ligament pathology may influence the surgical technique used. In cases with bony fragment avulsions, the size of the fracture fragment guides primary treatment. Small pieces are typically excised; larger fragments may be retained and incorporated into the repair. Several techniques have been described to achieve successful ligament repair. Transosseous non-absorbable sutures have proven a valuable component of surgical repair.\textsuperscript{4,19,48} The suture deployed may be tied over a bone tunnel or over a button on the radial aspect of the metacarpophalangeal joint.\textsuperscript{4,19,49} The ulnar collateral ligament may also undergo direct repair to the periosteal tissues at the base of the proximal phalanx of the thumb.\textsuperscript{5,50-52} Many surgeons currently perform acute surgical repair using a proximal phalanx suture anchor (Fig. 2).\textsuperscript{53} The surgeon should take care to restore the proper collateral ligament to its anatomic position, and disruptions of the accessory collateral ligament may be addressed with suture repair to the volar plate. Tears in the volar plate and dorsal capsule are repaired, if present. Our preferred method is to pin the metacarpophalangeal joint with a 0.045 inch Kirschner wire, with the joint reduced and flexed 10° to 20°. The ligament is repaired to bone with a bone suture anchor.

Postoperative protocols include 6 weeks of cast immobilization, followed by cast and pin removal and initiation of range of motion exercises with progression to strengthening. Return to activity without restrictions may be prescribed.
approximately 3 months following surgical repair. Recent biomechanical literature indicated the potential safety of enlisting a controlled active motion protocol after suture anchor repair.54

**Results of Surgical Repair**
Several factors influence treatment outcome in patients who have sustained ulnar collateral ligament injuries. Accurate, early diagnosis and management is paramount. Ulnar collateral ligament injuries are frequently missed on initial presentation, and this may compromise the restoration of valgus stability of the metacarpophalangeal joint and the timely return to activities.55 An early repair in appropriately indicated patients with ulnar collateral ligament injuries is advantageous. In several reports, complete rupture of the ulnar collateral ligament treated with primary repair within 3 weeks following injury yielded good-to-excellent results in greater than 90% of patients, regardless of repair technique.4,7,15,19,53

**Complications**
The literature on acute ulnar collateral ligament injuries has included reports on several potential complications of treatment. Surgical management of the injury may result in radial sensory nerve neurapraxia. This nerve palsy usually results in spontaneous resolution and presumably occurs in response to traction or swelling. Several reports alluded to potential postoperative stiffness in the metacarpophalangeal and interphalangeal joints of the thumb. However, Bostock and Morris concluded that joint stiffness was not a common postoperative complication when compared with the range of motion of the uninjured thumb.56

Reporting on a large cohort, Moutet and colleagues found that 2% of patients achieved poor results from the treatment of ulnar collateral ligament injuries.1 Most of these patients presented late for evaluation and achieved good outcomes following secondary ligament reconstruction. Less than 1% of all patients achieved poor outcomes; these patients sustained ulnar collateral ligament injuries in work-related accidents or developed complex regional pain syndrome postoperatively.

Persistent valgus instability of the metacarpophalangeal joint often results in pain on pinching and grasping and in reports of thenar weakness. Chronic, untreated injury of the ulnar collateral ligament also may result in secondary osteoarthrosis.

**Chronic Valgus Instability**
Persistent instability to valgus stress is rare following a stable repair of the ulnar collateral ligament.19,57 Most commonly, chronic instability results from a failure to seek medical attention for acute injury or a missed diagnosis.1,55 As time passes from acute injury, the likelihood of achieving a successful repair is significantly diminished.4,50,51,58,59

Techniques for surgical reconstruction of the ulnar collateral ligament have varied in the literature. Neviaser and associates reported on the use of a dynamic transfer of the adductor pollicis, from the ulnar sesamoid to the base of the proximal phalanx.60 Several groups have used a free tendon graft weave.7,57,59 Glickel and coworkers presented a retrospective review of 26 patients whose surgery involved passing a free tendon graft through two gouge tracks in the proximal phalanx and one through the metacarpal (Fig. 3)57; 24 of 26 patients in this study achieved valgus stability and relief of pain.57 Alternatively, Mitsionis and colleagues employed bone suture anchors as well as a free tendon graft for reconstruction.61 By harvesting the extensor carpi radialis longus and a bone block from the base of the second metacarpal, surgeons in one group showed that all patients in a small series displayed good-to-excellent results following reconstruction.53

Surgical reconstruction recently has become the focus of several biomechanical studies. The importance of achieving a near anatomic reconstruction was confirmed, as non-anatomic reconstruction of the ulnar collateral ligament altered the normal range of motion of the metacarpophalangeal joint.57 Lee and associates showed that reconstruction tunnel positioning of a triangular configuration, with the apex proximal, was optimal for stabilization of the metacarpophalangeal joint, while preserving range of motion.63 Our preferred method is a ligament reconstruction with tendon autograft of palmaris longus or half flexor carpi radialis through bone tunnels. 3.5 mm drill holes are made in the proximal phalanx 5 mm from the joint at the 12:30 and 5:30 positions. A 5.0 mm hole is made in the metacarpal from the ligament origin point obliquely to the radial side of the bone.
The two tendon ends are tied together on the other side of the metacarpal bone after joint reduction and pinning with a 0.045 inch Kirschner wire (Fig. 3).

Unsuccessful reconstructions result in the necessity of resorting to a salvage procedure. Arthrodesis of the metacarpophalangeal joint of the thumb is reserved for cases of significant secondary osteoarthritis. Arthrodesis is also a treatment option for manual laborers.

Conclusion

Injuries of the ulnar collateral ligament of the thumb metacarpophalangeal joint are common. Knowledge of the structures imparting valgus stability to the joint is essential to make an accurate diagnosis and to execute effective treatment. A complete patient history, physical examination and radiographs comprise the diagnostic protocol. Nonoperative management is appropriate and successful in the treatment of partial tears. The presence of a complete rupture (greater than 30° instability or greater than 15° from the normal contralateral side) tested with the metacarpophalangeal at 0° is an indication for surgical intervention. Several successful techniques for ligament repair have been described. Ligation reconstruction is indicated for patients with chronic instability where there is inadequate tissue for a primary repair. Arthrodesis is reserved for cases of chronic instability with secondary symptomatic osteoarthritis.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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