REVIEW ARTICLE

Injury to Ulnar Collateral Ligament of Thumb

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Injury of the ulnar collateral ligament (UCL) of thumb can be incapacitating if untreated or not treated properly. This injury is notorious for frequently being missed by inexperienced health care personnel in emergency departments. It has frequently been described in skiers, but also occurs in other sports such as rugby, soccer, handball, basketball, volleyball and even after a handshake. The UCL of the thumb acts as a primary restraint to valgus stress and is injured if hyperabduction and hyperextension forces are applied to the first metacarpophalangeal joint. The diagnosis is best established clinically, though MRI is the imaging modality of choice. Many treatment options exist, surgical treatment being offered depending on various factors, including timing of presentation (acute or chronic), grade (severity of injury), displacement (Stener lesion), location of tear (mid-substance or peripheral), associated or concomitant surrounding tissue injury (bone, volar plate, etc.), and patient-related factors (occupational demands, etc.). This review aims to identify the optimal diagnostic techniques and management options for UCL injury available thus far.

Key words: Gamekeeper's thumb; Skier's thumb; Thumb injury; Ulnar collateral ligament

Introduction

Collateral ligament injuries have been noted in all digits of the hand, but occur more commonly in the ulnar and radial collateral ligaments of the thumb[1]. Campbell coined the term "Gamekeeper's thumb"[2], having noticed this injury in gamekeepers who sustained chronic valgus strain injury of their thumbs when breaking rabbit necks. However, Gerber et al. popularized the term "skier's thumb" for the acute counterpart of this injury because it is prevalent among skiers[3]. Injury of the ulnar collateral ligament (UCL) of the thumb can be incapacitating if untreated or not treated properly. It is notorious for being frequently missed by inexperienced health care personnel in emergency departments[3]. Furthermore, there is no consensus on diagnosis and management of this injury. This review aims to determine the optimal diagnostic techniques and management options for UCL injury available thus far.

Anatomy

The metacarpophalangeal (MCP) joint is a diarthrodial joint, permitting predominantly flexion-extension movements. The varus-valgus laxity at this joint varies among normal thumbs and also with the arc of flexion-extension. The collateral ligaments, UCL, and radial collateral ligament (RCL) (Fig. 1), provide stability against valgus and varus stress, respectively. The UCL, a proper collateral ligament, is the chief restraint to valgus stress during MCP joint flexion[4] and an accessory collateral ligament[5], which along with the volar plate serves as the primary valgus restraint during MCP joint extension. In addition to these static stabilizers of the MCP of thumb, restraint to valgus stress is imparted by extrinsic and intrinsic muscles that act as dynamic stabilizers. These extrinsic muscles include the extensor pollicis brevis, extensor pollicis longus, and flexor pollicis longus. The intrinsic muscles include the adductor pollicis, abductor pollicis brevis, and the flexor pollicis brevis.

Mechanism of Injury and Epidemiology

As mentioned in the anatomy section, the UCL is the primary restraint to valgus stress. Hyperabduction and hyperextension forces applied to the MCP joint are the usual causes of this stress. Such forces occur, for example, in a fall on an outstretched hand or when trying to grasp an object during a fall, leading to UCL tears. This injury has been noted most often in skiers[2], but also occurs in other sports such as rugby, soccer, handball, basketball, volleyball, and even after a handshake[6–8]. A video analysis study found that most injuries
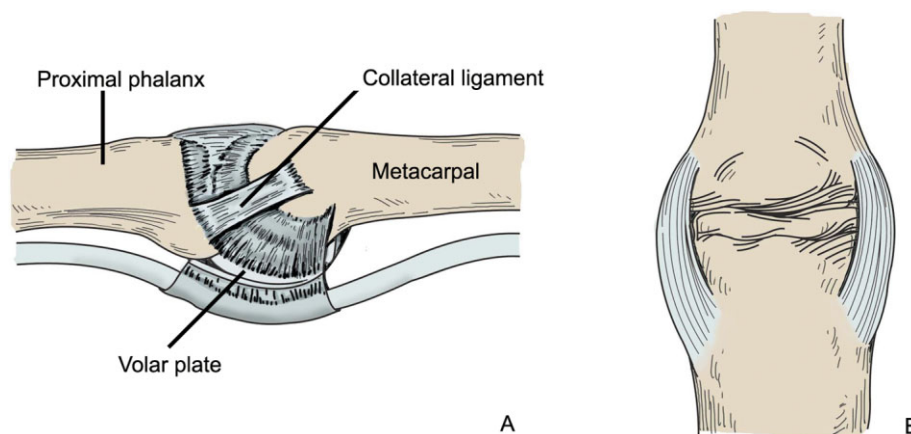
Fig. 1 Diagrammatic representation of (A) lateral and (B) anteroposterior projections illustrating the ulnar collateral ligament attachments across the metacarpophalangeal joint.

sustained during skiing were associated with "jumping", whereas thumb injuries were associated with "riding on rollers"[9]. First-day participation and age less than 16 years have also been implicated as risk factors for injuries sustained in snow sports[10]. Furthermore, a cohort study noted sex differences in the incidence of hand/wrist/finger injuries in skiers, male subjects sustaining injuries more often than their female counterparts[11]. In another study UCL injury was most commonly associated with "falls"[12].

Although UCL injury is more commonly seen than its counterpart, RCL injury[13], problematic joint arthrosis, and laxity can occur in inadequately treated cases of traumatic rupture of the RCL[14]. Most UCL tears occur at the point of distal attachment to the proximal phalanx (distal avulsion). However, proximal avulsion, proximal and distal bony avulsion, isolated mid-substance tears, and mid-substance tears with bony avulsion do also occur[15]. Heim and Kratz described a rare variation of this injury wherein the extensor pollicis longus tendon gets interposed between the torn edges of UCL (instead of the usually seen adductor aponeurosis interposition)[16].

Clinical Features

In acute cases there is history of trauma along with complaints of pain and difficulty in movement of the thumb. There may be associated bruising, swelling at the base of the thumb and rotational deformity[17]. In chronic cases there may be weakness of thumb-index pinch grip and instability. Thumb-index pinch weakness leads to marked limitation of basic activities of daily living[18]. As noted by Razza *et al.*, "Pulling with pinch grips is an action frequently used in either occupational or daily living activities, especially in situations where the object is too small, the access to the object is restricted, the use of tools is prevented and in situations such as pulling strips out of long-life packaging, removing seals from flask lids, tearing a plastic bag, etc"[19]. However, the position of the other fingers has a significant effect on the strength of this grip, for example when the other fingers are flexed; the

thumb-index pinch grip is maximal[20]. Instability or laxity of the thumb MCP joint is another feature associated with UCL injury. Such laxity or instability has frequently been used to assist diagnosis of UCL injury, as stated in the diagnosis section.

Diagnosis

Clinical Examination

In cases of acute injury, clinical examination reveals tenderness at the base of thumb. Furthermore, there may be bruising and swelling. Chronic cases usually show laxity/instability of the thumb MCP joint[21]. Patients usually complain of weakness of thumb-index pinch grip[22]. Long term laxity of the MCP joint may eventually lead to premature arthritis[23]. Occasionally the torn UCL may displace proximally to lie superficial to the overlying adductor aponeurosis and present as a tender swelling at the base of thumb on the ulnar side (Stener lesion). Another reason for such a swelling is excessive granulation tissue formation at the site of ligament injury[24]. Historically, presence of the Stener lesion has been used as a deciding factor in offering surgical treatment. The question arises: Why is differentiating displaced from non-displaced UCLs of paramount importance? As explained by Haramati *et al.*, "Since the UCL is a capsular ligament, non-displaced ligamentous rupture can often be treated conservatively, as is currently done in the treatment of medial collateral ligament tears in the knee. Therefore, the ability to distinguish between displaced and non-displaced UCL tears is of great clinical importance"[25].

Stress Test

Because abduction stress testing of the MCP joint of thumb to demonstrate its stability may be painful in cases of acute injury, use of local anesthesia is advocated[26]. After stabilizing the metacarpal, radial stress is applied to the proximal phalanx, both in 30° flexion and extension positions of the MCP, until a firm end point occurs. Complete UCL tears lack solid end

point. Partial tears usually have a firm endpoint; the resultant metacarpal-phalangeal angle can be measured and compared with that of the opposite side. A deviation of 35° on the affected side or a difference of 15° between the affected and opposite sides in flexion denotes a tear of the primary UCL and in extension a tear of the accessory part of the UCL.

X-ray films

Anteroposterior and lateral X-ray films of the thumb are taken to rule out any associated bony injuries. Associated bony avulsion fractures are seen in 20%–30% of UCL ruptures[15]. The position of an avulsed bony fragment usually indicates the position of the distal end of the UCL[27]. Indications for surgical treatment based on imaging include avulsion fractures with displacement of greater than 5 mm or any fracture involving 25% or more of the MCP joint surface[28]. Stress X-ray films of the thumb MCP joint have also been used for diagnosis[29,30]. However, there is concern that this maneuver can further damage the already injured UCL and create difficulties in interpretation of these films. Some authors consider the presence of bony avulsion a contraindication to valgus stress testing and hence recommend taking X-rays prior to performing this maneuver for fear of displacement[31,32]. Other authors argue that, in the case of associated undisplaced fractures, the injury force is always greater than the force applied during clinical testing, thus allaying any fear of displacement[15,33]. A recent cadaver study concluded that correctly performed stress test examinations do not cause Stener lesions[34]. Thirkannad and Wolff described the "Two Fleck Sign", wherein two bony fragments are present: one of them is usually obvious and denotes an undisplaced avulsion fracture whereas the other, which is frequently missed during initial X-ray evaluation, denotes a Stener lesion[27]. These authors emphasize the "need to look for a second fragment of bone in every instance where an apparently undisplaced fracture is noted at the base of the proximal phalanx". They believe that this second fragment probably indicates the whereabouts of the distal end of the ulnar collateral ligament and may identify Stener lesions. Gurdezi and Mokdescribed the "sag sign", which is visible on lateral X-ray films in cases of UCL tears and denotes a "volar subluxation of the proximal phalanx in relation to the metacarpal at the metacarpophalangeal joint"[35]. A recent study found that the presence of an exostosis at the metacarpal neck is a useful sign for differentiating chronic from acute UCL tears in the absence of a conclusive history and examination[36].

Ultrasound

Ultrasound (US) is an excellent and cost-effective modality for diagnosing UCL tears because it allows direct visualization of the entire UCL and surrounding structures. It locates the torn end of the UCL in almost 90% of cases[37]. A normal UCL shows an echolucent, convex-shaped appearance extending from the metacarpal head to the base of proximal phalanx[37]. As described by Hergan et al., the sonographic picture in cases of undisplaced UCL tears shows a "normal-positioned UCL surrounded by inhomogeneous or echolucent areas due to

hematoma, effusion, and edema. In the displaced type, the UCL cannot be seen in its normal position. Usually, an ill-defined echolucent area close to the head/neck of the first metacarpal bone represents the displaced UCL"[37]. Identification of a tadpole image during US suggests a displaced UCL, which requires surgical management[38]. Based on subsequent surgical findings, US reportedly has 94% positive predictive value (80%), sensitivity of 83%, and specificity of 75%[39]. These authors reported that US performed soon after presentation is a valuable adjunct to clinical examination in differentiating displaced from non-displaced UCL tears. Another study by Schnur et al. found a positive predictive value of 87.5% for US diagnosis of UCL injury in patients who underwent surgical exploration[32]. Measuring on US, Koslowsky et al. found a difference of 2.25 ± 0.46 mm between normal and injury groups in the distance between the innominate tubercle of the first metacarpal and the base of the proximal phalanx of the MCP joint and opined that this may be sufficient to diagnose a UCL tear without direct observation of the UCL[40]. However, Susic et al. reported that US is inadequate for identifying dislocated UCL tears and advised exploration in cases with clinical instability[41]. A recent retrospective review found that non-visualization of UCL fibers and presence of a heterogeneous mass proximal to MCP joint on ultrasound were 100% accurate in differentiating displaced from non-displaced full-thickness UCL tears[42]. The advantages of US are that it is dynamic, safe, and quick and can be readily performed in the emergency department[43]. Its drawbacks include patient discomfort in acute cases[35] and difficulty in locating the torn UCL when it is thin or in cases more than one week old where scar tissue or ligament shrinkage pose difficulties[37]. Furthermore it requires an experienced sonographer with sound knowledge of hand anatomy and pathology[32].

MRI

MRI is considered by some as the best modality for evaluating UCL injuries[44]. Like US, MRI allows direct visualization of the UCL and surrounding structures and is safe and non-invasive; however, it is more costly and less readily available. One study reported that MRI has a sensitivity of 96% and specificity of 95% in diagnosing UCL tears[45]. Modern MR scanners and appropriate MR coils are now available for evaluating small structures such as the UCL[46]. The MRI findings of normal and torn UCLs as described by Lohman et al.[44] are shown in Table 1. The authors also noted that MRI coronal sequences are optimal for viewing the UCL; however, differentiating Stener from non-Stener lesions is not always possible by MRI in chronic UCL rupture with excessive scarring. Stener lesions typically have a "yo-yo on a string" appearance[47]. MRI has been recommended for assessing graft integrity in cases of suspected post-operative graft failure[48].

Arthrography

Arthrography involves distension of the MCP joint by injecting contrast material and then visualizing the joint by X-ray or MRI (MR-arthrography). UCL injuries are diagnosed by direct

TABLE 1 MRI findings of normal and torn UCLs	
UCL	MRI findings
Normal	Situated immediately adjacent to the ulnar side of the metacarpophalangeal joint, smooth, homogeneous, hypointense structure extending from the distal metacarpal to proximal phalanx
Acute rupture	Gap easily identifiable, edema around the ligament and at the rupture site
Chronic rupture	Scarring looks like an irregular area of decreased signal intensity, gap between the torn ends not easily identifiable

visualization of any focal defect or by extravasation of contrast from the joint, suggesting rents in the ligaments[46]. Another indirect finding on arthrography suggestive of UCL tear is demonstration of the heads of the adductor pollicis muscle[49].

The various modalities used for diagnosis of UCL injury are presented in Table 2.

Management

Injuries of the UCL can be managed conservatively or surgically, depending on various factors that primarily include: (i) timing of presentation (acute or chronic); (ii) grade (severity of injury); (iii) displacement (Stener lesion); (iv) location of tear (mid-substance or peripheral); (v) associated or concomitant surrounding tissue injury (bone, volar plate, etc.); and (vi) patient related factors (occupational demands, etc.)

Conservative Management

The indications for conservative management include partial, non-displaced UCL tears presenting early. Associated fractures, if undisplaced, can also be managed conservatively. Non-operative treatment typically includes immobilization for 4–6 weeks in plaster or a splint. The thumb should be immobilized in a position of mild flexion and slight ulnar deviation at the MCP joint. The interphalangeal joint is usually kept free to allow movement. Physiotherapy is started as soon as the immobilization has been removed, starting with range of motion exercises followed by grip strengthening exercises. Compared to a standard thumb spica plaster cast, a splint allows some movement, such as flexion and extension, while simultaneously restricting abduction. A randomized controlled trial comparing plaster with splints in subjects with UCL tears found both modalities to be equally effective with regard to outcome measures like "stability, range of motion, strength of the injured thumb and length of sick leave"[50]. However, patients favored splint over plaster because of the former's superior comfort. In addition to standard thumb spica casts, a variety of other casts and splints for this injury have been described. These include glove spica casts[51], modified thumb spica casts[52], hinged MCP joint splints[53] and modified thumb spica splints[54]. McCue *et al.* use a taping method whereby they first immobilize the thumb MCP using a tape and then include the index finger to prevent abduction of the thumb[24]. One laboratory study cautioned that excessive strain on the UCL could be avoided by not immobilizing the MCP joint in excessive flexion or starting unrestricted early mobilization[55]. There is no consensus regarding the optimal treatment for UCL tears associated with avulsion fractures. Both operative and conservative treatments have been advocated[56,57]. Complete UCL tears are usually associated with gross instability and traditionally have been managed surgically; however, some authors have reported encouraging results with non-operative treatment[58]. In the presence of bony avulsion, we treat acute UCL injuries surgically only if they are unstable on stress testing and if there is any radiological evidence of displacement. Even minimal displacement has been associated with rotational deformity[56].

Surgical Management

Surgery is usually required for injuries of the thumb UCL characterized by: (i) Stener lesions; (ii) displaced unstable

TABLE 2 Various modalities for diagnosing UCL injury		
Modality	Advantages	Drawbacks
Plain X-ray films	Cheap, readily available, can rule out bony injury	Inability to visualize the UCL, differentiate displaced from non-displaced UCLs or grade the injury
Stress X-ray films	In evaluating joint stability, can diagnose partial tears (see text)	Uncomfortable for patient (may require local anesthesia), inherent risk of increased displacement (controversial), unable to differentiate between displaced and non-displaced UCLs
US	Simple, non-invasive, cost-effective(compared with MRI), direct visualization of UCL, less time-consuming than MRI	Somewhat uncomfortable (requires some stress to be applied to the UCL), requires experienced sonographer and optimal hardware
MRI	Non-invasive, direct visualization of UCL and surrounding structures, ability to differentiate displaced from non-displaced tears as well as grading(severity), aids in planning and selecting surgical approach, high sensitivity and specificity	Cost, availability, motion artifact (apprehensive patients with acute injury)
Arthrography	Direct visualization (by joint distension), indirect visualization (by extravasation of contrast)	Time consuming, contrast complications, invasive, does not assess surrounding structures (unlike MRI), difficulty in interpretation of results

bony avulsion; (iii) chronicity; (iv) acute tears with gross instability; and (v) associated volar plate injury. Surgical options include repair (early or late), reconstruction, arthrodesis, and arthroplasty.

Repair

The UCL is frequently avulsed from its distal attachment. Historically, securing it to its normal anatomical position at the base of proximal phalanx has been performed using wire or suture pull out techniques through a bone tunnel. The non-absorbable sutures are passed through this tunnel and then tied to the bone tunnel or over a button on the radial side. Another option is to directly suture the UCL to the periosteal tissue of the proximal phalangeal base, provided secure fixation is possible. Suture anchors as a repair fixation modality have become popular because they obviate the need for drilling a bone tunnel or exposing the suture material as required in suture/wire pull-out techniques[59]. A variety of suture anchors are commercially available. Both the primary and accessory parts of the UCL are repaired, followed by repair of the volar plate and dorsal capsule if required. For mid-substance tears direct repair using absorbable[33] or non-absorbable sutures[60] has been advocated. Some authors prefer additional repair stability in the form of k-wire passed across the MCP joint[21]. Haddock *et al.* described a new technique for repair of chronic UCL tears involving condylar shaving on the ulnar side of metacarpal and proximal phalanx along with double breasting of the UCL[61].

Reconstruction

Reconstruction of the UCL is usually performed in cases of failed primary repair or late presentation where the torn ligament ends are not identifiable or have shrunk, thus preventing a late repair. Prior radiological assessment of the MCP joint is important to identify any degenerative changes which, if present, will make the reconstruction futile. Reconstruction can be performed using a local graft or a free graft from a distant site. It can be dynamic (using a local musculotendinous unit) or static (using a local or free graft). Materials which have been used as graft materials for either dynamic or static reconstruction of the UCL include the palmaris longus[62], adductor pollicis[63], extensor pollicis brevis[23,64], bone periosteum flap[65] and bone periosteum bone (BPB) graft[66]. For static reconstruction, grafts have been used in various configurations. Arthroscopic reduction and internal fixation of UCL tears with bony avulsion has also been advocated. The procedure allows for derotation of the displaced avulsed bone fragment and anatomic restoration of the UCL. Two small cases series have reported acceptable results with this technique[67,68]. As noted by Badia, the advantages of an arthroscopic technique over open repair include faster rehabilitation, shorter surgical and tourniquet times, better cosmesis, and decreased postoperative inflammatory responses[67]. Injury to the superficial branch of radial nerve during portal placement is a potential risk[69].

Post-operative care after repair or reconstruction includes immobilization using a plaster cast or splint, depending on the physician's choice. However, removable functional splints provide for easy post-operative wound care. Immobilization is continued for 4–6 weeks and followed by staged range of motion exercises and grip strengthening exercises. Complications of surgery include neuropraxia (sensory branch of the radial nerve), stiffness, persistent pain, persistent weakness of grip, and cold intolerance. A recent study noted specific activities that may be affected, including opening jars, lifting weights in the gym, riding a motorcycle and using a tennis or badminton racket[12]. Functional outcomes that should be assessed include tip, tripod, and key pinch strength as measured by pinch gauge; power grip as measured by dynamometer; stability of MCP joint as measured by metacarpal-phalangeal angle during stress testing; and range of motion as measured by goniometer. The ultimate aim of successful treatment is improvement in quality of life (no persistent pain, instability, weakness of pinch strength, stiffness or arthritis). Many validated scales/instruments are available for assessing functional outcomes after treatment. They include DASH (Disabilities of the Arm, Shoulder and Hand) and *Quick* DASH[70], Buck–Gramko[71], Kapandji index[72] and Michigan hand outcome score[73].

Arthrodesis/Arthroplasty

Untreated or inadequately treated UCL injuries with persistent laxity usually develop progressive premature arthritis[23] with or without chronic volar subluxation. As mentioned earlier, in this situation with persistent pain and limitation of joint movement, repair, and reconstruction are not helpful. Hence some authors have advocated arthrodesis[6,24,63] or arthroplasty[60,74]. In a recent study of subjective outcomes after arthrodesis of the MCP joint, the authors concluded that arthrodesis is best reserved for elderly patients with painless instability[75].

Conclusions

Tears of the UCL of the thumb are small but incapacitating injuries. Inexperienced clinicians can easily miss them and inadequate or delayed treatment can result in chronic disability. The diagnosis is best established clinically; however, MRI is the imaging modality of choice. Many treatment options exist, surgical treatment being offered depending on various factors, including severity of injury and chronicity. The best treatment option is still not clear and requires further research.

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