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Thumb collateral ligament injuries in the athlete

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Abstract
Purpose of review The purpose of this review is to identify current principles in the diagnosis and treatment of collateral ligament injuries of the thumb in the athlete.
Recent findings Cadaver studies have clearly identified the ulnar and radial collateral ligaments origin and insertion footprints for repair or reconstruction.
Summary Ulnar and radial collateral ligament injuries are common in athletics. History and physical examination are paramount in determining partial versus complete tear. When surgical treatment is indicated, placing the repair/reconstruction in the anatomic footprint restores stability while maintaining motion. The senior author's preferred techniques are reported.

Keywords Ulnar collateral ligament · Radial collateral ligament · Thumb · Ligament tear · Athlete · Sport

Introduction

Skier's thumb originally described a common injury to the thumb ulnar collateral ligament (UCL) of the metacarpophalangeal joint (MCPJ) in recreational skiers. They are approximately 10 times more common than their radial counterparts [1]. UCL injuries occur in many sports, besides skiing, in which a fall occurs on an outstretched hand. This injury can be critical for an elite athlete because of its effect on grip and pinch due to a lack of a stable thumb base. Special consideration in treatment should be given for timing in season, position, and throwing versus non-throwing hand. The following review characterizes the anatomy, mechanism of injury, diagnosis, and treatment of acute or chronic injuries.

This article is part of the Topical Collection on *Hand and Wrist Sports Medicine*

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Ulnar collateral ligament

UCL injuries are among the most common injuries to the hand and the most common injury to the thumb MCPJ [2, 3]. Acute injuries have been characterized in various sports [3]. Incidence has been documented as high as 50 per 100,000 [1] and as being involved in 86% of thumb MCPJ injuries, in one study [4]. Even in their partial form, participation in athletics is compromised by pain and weakness.

Anatomy

The thumb MCPJ is a diarthrodial joint with variably flattened condyles allowing principally flexion and extension but also abduction, adduction, and rotation for circumduction to a lesser extent [5••, 6]. Stability to this joint is provided by static and dynamic restraints. Static stabilization is inferred by the collateral ligaments, volar plate, and dorsal capsule, while the extrinsic and intrinsic musculature provide dynamic stabilization [3, 7].

Measuring 4–8 mm in width and 12–14 mm in length, the UCL is a thick band composed of two distinct structures [8] resisting valgus stress at the thumb MCPJ [9, 10]. These two bundles, proper and accessory UCL, run in a dorsal to palmar direction conferring stability in different degrees of flexion.

The proper UCL originates from the dorsal aspect of the metacarpal head and inserts into the volar base of the proximal phalanx giving maximum valgus stability at 30° of flexion [11]. The accessory UCL, lying superficial and volar, originates at the metacarpal head and inserts into the proximal phalanx blending with the volar plate imparting valgus restraint in full extension [12] (Fig. 1). Anatomic study of the UCL has determined the center of origin to be 4.2 mm from the dorsal surface and 5.3 mm proximal to the articular surface of the metacarpal head and inserting 2.8 mm from the volar surface and 3.4 mm distal to the phalangeal base [13].

Mechanism of injury

Valgus- or radial-directed loads produce hyperabduction moments about the MCPJ leading to UCL injury. This mechanism was originally noted in high incidence among skier's during a fall in with their pole causing the radial-directed force [12]. Commonly, this mechanism is now seen in falls onto an abducted thumb or when a ball or racquet strikes the ulnar aspect of the thumb [3]. Injury can result in partial or complete rupture of the ligament but can also extend to the dorsal capsule and volar plate [6, 14] stretching the adductor expansion.

Diagnosis

History and physical examination

Evaluation begins with a thorough history. Patients will usually describe injury during one of the above events with ensuing pain and swelling. Ecchymosis and swelling are typically evident. Depending on the extent of injury, radial deviation and volar subluxation of proximal phalanx on the metacarpal head may be noted. Tenderness is encountered along the ulnar aspect of the MCPJ and occasionally a palpable mass representing a Stener lesion [15].

The most important aspect of physical examination is stress testing of the MCPJ with comparison to the contralateral side [2, 14]. Proper stress examination should stabilize the metacarpal neck while producing a radial-directed force on the proximal phalanx, being careful to control rotation. Local anesthetic injection can provide comfort in those with significant guarding increasing the accuracy of exam [16]. Parameters to record are the degrees of valgus laxity in full extension and 30° flexion, injured and contralateral, and presence of an end point. Laxity of 30°, increased laxity of 15° compared to the contralateral side, or lack of endpoint signify injury [17–19]. Laxity in full extension indicates accessory UCL or volar plate tear and in 30° flexion, tear of the proper UCL.

Diagnostic studies

Posteroanterior and lateral radiographs should be obtained with suspected injury. Instability is strongly suggested with radial or volar subluxation of the proximal phalanx, or a supination deforming relative to the metacarpal head called the "Sag sign" [20]. Radiographic assessment can also identify avulsion injuries or associated fractures of the metacarpal.

Stress radiography is controversial. While measurable angulation with radial-directed force on the distal phalanx can help identify complete tears, there is concern for displacement of previous nondisplaced ligaments or fractures. Proponents contend that if the initial force was not significant enough to produce displacement, then controlled stress examination is unlikely to change its position [21]. Recently, stress radiography has demonstrated the ability to differentiate between tears of the proper UCL alone and those with accessory UCL tears. In their cadaveric study, McKeon et al. [22••] found that while valgus angulation increases with proper UCL alone or combined accessory UCL transection, only radial translation of the proximal phalanx on metacarpal head was seen in combined proper and accessory UCL transection.

Magnetic resonance imaging (MRI) and ultrasound (US) are common additional imaging modalities. While noninvasive and cost effective, US results have varied widely with an accuracy of 40–92% likely owing to dependence on the operator [23, 24]. Results of MRI are more consistent, especially with dedicated extremity coils, and have been suggested to be more accurate when combined with arthrography [25, 26]. Hergan et al. [26] compared US and MRI showing 100% sensitivity and specificity of MRI compared to 88% sensitivity and 83% specificity of US (Fig. 2).

Fig. 1 Ulnar collateral ligaments (*accessory and proper*). The proper collateral ligament is shown at **a** lax in extension (*wavy lines*) and **b** tight in flexion (*straight lines*). The accessory ligament is **a** tight in extension (*straight lines*) and **b** lax in flexion (*wavy lines*). (*Reproduced* with permission and copyright © of Elsevier. *From* Avery DM 3rd, Caggiano NM, Matullo KS, Ulnar collateral ligament injuries of the thumb: a comprehensive review. Orthop Clin North Am. 2015:46:281–92)

Fig. 2 Coronal MRI of the thumb metacarpophalangeal joint showing an avulsion of the UCL from the base of the proximal phalanx, with a Stener lesion (*asterisk*). The UCL is proximal to the adductor aponeurosis (*yellow arrow*)

Classification

Tears of UCL are commonly graded into three tiers based on stability. Grade 1 injuries are associated with pain but without instability. Grade 2 signifies partial tears in which laxity is asymmetric but there is a firm endpoint. Grade 3 injuries are a complete tear with laxity and no discernable endpoint.

Non-operative treatment

Non-operative treatment is widely accepted for grade 1 and 2 injuries. These in general do well without residual pain or disability [10, 27–29]. Participation can be limited by need for immobilization and protection from radial-directed forces for which the clinician should be familiar with sports specific regulations of the region. Immobilization is needed for 4–6 weeks, followed by mobilization, and strengthening by 6–8 weeks.

Grade 3 tears are commonly treated with surgery despite few reports of successful non-operative course [30, 31]. The presence of a Stener lesion denotes a complete tear in which the distal aspect of the ligament is trapped proximal to the adductor aponeurosis with a low likelihood to result in stability with non-operative treatment. Avulsion fractures present an area of controversy. Kutz et al. [32] reported on 30 patients with bony lesions treated with spica cast or splints and found satisfactory results despite a 25% nonunion rate. Another retrospective review identified 28 patients treated non-operatively and found no instability despite a 60% nonunion rate [33]. To the contrary, Dinowitz et al. [34] showed failure in nine patients with minimally displaced avulsion fractures treated conservatively owing continued disability to rotation of the fracture fragment preventing healing. Operative treatment in these patients lead to increased pinch strength, 36–89%, and grip, 77–93%.

Acute repair

Many techniques have been described for repair of acute UCL tears, including pullout sutures over bone tunnels [10, 28, 35, 36], suture buttons [10, 36], suture anchors [37–40], interference docking screws [41], condylar shaving with suture anchors [42], and arthroscopic repair [43]. Katolik et al. [35] compared two groups of 30 patients treated with bone tunnels with pullout sutures and suture anchors. Patients in the suture anchor group had shorter tourniquet times, were mobilized earlier, and had greater range of motion (ROM) and pinch strength at average 29 month follow up. Despite the method of treatment, when anatomic reduction is achieved, clinical results have consistently shown good results in pain reduction, maintenance of motion, and return of strength and stability.

Nonanatomic repair has been shown to alter joint biomechanics [44]. Careful review of imaging for location and extent of tear along with chronicity should be considered when approaching surgical repair. Granulation tissue and early scarring of Stener lesions can make delineation of the native proper and accessory ligaments difficult.

Author's preferred technique

The senior author prefers to use a double loaded suture anchor for acute UCL repairs. The approach involves a straight midaxial incision centered on the ulnar aspect of the thumb MCPJ. As dissection is carried down to the adductor aponeurosis, care is taken to preserve and protect the dorsal cutaneous branch of the radial nerve which is typically in the dorsal half of the incision. The adductor aponeurosis is then incised sharply leaving the distal aspect intact and allowing a 2-mm cuff along its insertion for later repair. Careful mobilization of the aponeurosis will allow determination of the integrity of the accessory UCL at deepest (palmar) aspect of the dissection. The junction of the dorsal capsule and proper UCL is then sharply incised in a dorsoulnar longitudinal oblique fashion. This inside out perspective allows visualization of the site and extent of rupture whether on the metacarpal head or base of the proximal phalanx. The ligaments should be carefully dissected from any granulation tissue and the site of insertion should be denuded using a small curette or #69 blade.

Since failure always occurs at the suture-ligament interface and never from the anchor pulling out of the bone, another 2–0 nonabsorbable suture is added to the prepackaged eyelet to allow a double row mattress repair (Fig. 3). The anchor is inserted into the center of the footprint (Fig. 4), as previously described, and both limbs are passed in a mattress fashion through the ligament. If the accessory UCL is ruptured from the volar plate, it is repaired with a 4–0 nonabsorbable suture. Stability of the MCPJ should then be evaluated for endpoint with radial-directed force and maintenance of flexion.

After thorough irrigation to remove residual debris, the dorsal capsule and adductor aponeurosis are closed in distinct layers with 4–0 nonabsorbable suture. If the athlete requires early return to play, the MCPJ can be pinned in slight flexion to protect the repair. A 1.14 mm (0.045-in.) Kirschner wire is advanced from the ulnar proximal phalanx in a retrograde fashion through the MCPJ and out of the radial metacarpal cortex. While the pin does not exit through the skin, it is important to have to pin protruding through both cortices to allow retrieval on either end in case of pin breakage.

Postoperative rehabilitation requires 6 weeks in a hand-based thumb spica splint with the interphalangeal (IP) joint free (Fig. 5). Finger and thumb IP motion are encourage immediately. Active thumb MCPJ motion is allowed at 6 weeks. Formal hand therapy is infrequent. The player should protect the thumb in the hand-based spica splint during sports for 3 months.

Chronic reconstruction

Acute repair in season may not be feasible. Immobilization and protection may allow continued participation. Tears of UCL are generally considered chronic after 3–4 months. Instability may cause significant pain and weakness with pinch and grip. Primary repair of chronic tears have not shown

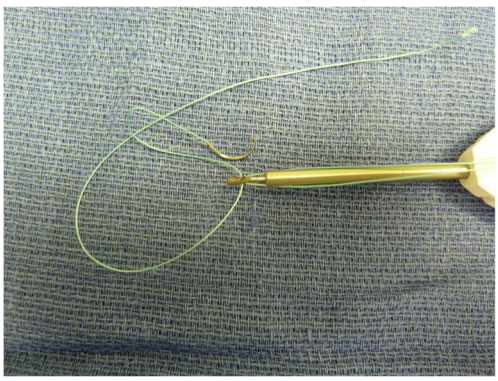

Fig. 3 Image showing the bone anchor with extra nonabsorbable suture added to the eyelet before insertion to allow for a double row repair of the UCL. (*Reproduced* with permission and copyright © of Elsevier. *From* Lee AT, Carlson MG. Thumb metacarpophalangeal joint collateral ligament injury management. Hand Clin. 2012:28:361–70.)

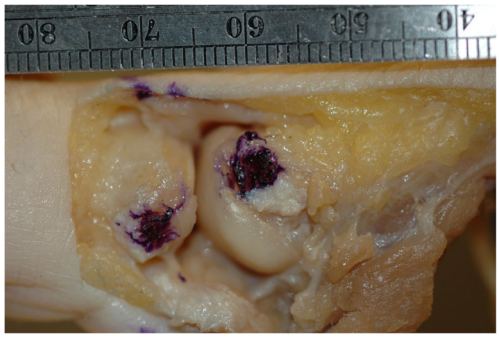

Fig. 4 Gross specimen showing the center of the UCL footprints on the metacarpal head (*right side*) and base of the proximal phalanx (*left side*). *Reproduced* with permission and copyright © of Elsevier. *From* Carlson MG. Commentary on RCL/UCL injury in basketball. Hand Clin. 2012:28:373–5)

the same success of acute injuries [10, 45]. In a systematic review, Samora et al. [46] showed that UCL reconstruction with or without tendon transfers have enjoyed similar good clinical outcomes as acute repair. Reconstructive options include dynamic stabilization with tendon transfers, ligament reconstruction with transosseous tunnels, and bone tendon grafts.

McCue et al. [47] described an adductor advancement with ligament reattachment in 25 athletes allowing eventual return to sport participation for all patients. Neviaser et al. [48] performed a MCPJ capsulorrhaphy with adductor aponeurosis advancement to the proximal phalanx base showing stable, pain-free thumbs at 1 year. Kaplan [49] and Sakellarides and DeWeese [50] both described tendon transfers with repair using the extensor indicis proprius and split or full extensor pollicis brevis (EPB), respectively.

A variety of tendon grafts have been used for reconstruction, utilizing techniques of anatomic reconstruction, figure-of-eight weaves, and fixation through bone tunnels or biointerference screws. Common grafts choices include palmaris longus [10], split EPB [51], full thickness EPB [52], slip of the abductor pollicis longus [53], second extensor

Fig. 5 Example of the hand-based thumb spica splint used during the rehabilitation period. (*Reproduced* with permission and copyright © of Elsevier. *From* Lee AT, Carlson MG. Thumb metacarpophalangeal joint collateral ligament injury management. Hand Clin. 2012:28:361–70)

compartment retinaculum [54] and fourth toe extensor digitorum [55].

Author's preferred technique

The senior author prefers to use a ligament reconstruction technique fixated with interference screws. One concern with reconstruction techniques is loss of MCPJ flexion particularly with nonanatomic reconstructions. Previous biomechanical research has demonstrated this technique to have no significant difference with regard to flexion or radial deviation when compared to its native state [56].

Dissection is carried out similar to that of that acute repair. The chronically scarred ligament is debrided to allow full visualization of the anatomic footprints of the ligament on the metacarpal head and proximal phalanx. Using the identifiable remnants and previously described measurements for the centers of each footprint, 3.2 mm bicortical drill holes are made in the origin and insertion. A harvested palmaris longus autograft cut to 4 cm, with whip-stitched passing sutures, is loaded on two Keith needles to advance them through the bone tunnels. The graft is first secured at the proximal phalanx with an interference screw. The MCPJ is then reduced at 30° flexion making sure to engage the volar rim of the proximal phalanx on the metacarpal head. The graft is tensioned as tight as possible and fixated with a second interference screw (Fig. 6). The reconstructed ligament is then attached to the volar plate using a 4–0 nonabsorbable suture. Excess passing suture material is cut at the level of the skin on the radial side of the thumb. Closure is conducted in a layered fashion as described above and the MP joint is held in 20° of flexion with a 0.045 kirschner wire.

Rehabilitation follows as similar course as for acute repairs. Protection in a hand-based thumb spica splint is utilized for 8 weeks. Digital motion and thumb IP motion is encouraged immediately after surgery with MCPJ motion initiated upon k-wire removal at 8 weeks. As in acute repairs, splint wear during sports should be maintained for at least 3 months.

Radial collateral ligament

Radial collateral ligament (RCL) tears are far less common than UCL tears, comprising 10–42% of collateral injuries of the thumb [55]. The RCL is the primary radial stabilizer of the MCPJ, and provides support against ulnar force in pinch and depression [56, 57]. The anatomy of the radial side of the MCPJ is distinct from that of the ulnar side, making RCL injuries different entities from UCL injuries [3, 56].

Anatomy

The radial side of the thumb MCP is not a mirror image of the ulnar side of the thumb, and these different anatomic considerations are critical when evaluating RCL and UCL injuries [57]. The musculotendinous insertions are weaker on the radial side of the thumb than on the ulnar side. There are three musculotendinous insertions on the radial side of the thumb: the two heads of the flexor pollicis brevis (FBP), and the abductor pollicis brevis (APB). The deep head of the FPB inserts onto the volar plate and the lateral sesamoid. The superficial head of the FBP inserts into the volar proximal phalanx. The most superficial layer of the radial side is the APB, which inserts broadly dorsally and distally to the FPB [58]. Stener lesions are thought to be rare on the radial side of the MCPJ because the APB aponeurosis is broader than the corresponding ulnar adductor aponeurosis, and completely overlies the RCL [59].

The RCL consists of both an accessory and a proper collateral ligament, similar to the ulnar side. Both originate from the lateral condyle of the metacarpal head and course volarly to insert on the proximal phalanx. The main static restraint in

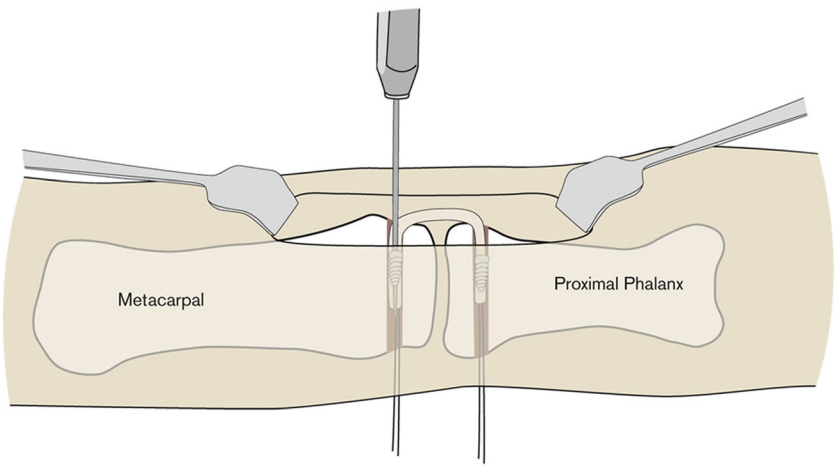

Fig. 6 An interference screw is first placed in the phalanx. The graft is then tensioned in 30° of flexion and the second interference screw is placed. Sutures emanating from the contralateral side are cut off at skin level. (*Reproduced* with permission and copyright © of Elsevier. *From* Carlson MG, Warner KK, Meyers KN, Hearns KA, Kok PL. Mechanics of an anatomical reconstruction for the thumb metacarpophalangeal collateral ligaments. J Hand Surg Am. 2013:38:117–23)

flexion is the proper collateral ligament, which is located more dorsally. The main static restraints in extension are the more volar accessory collateral ligament (ACL) and the volar plate [58]. The RCL is 4–8 mm wide and 12–14 mm long [8]. A recent anatomic study defined the center of the RCL origin at the metacarpal as 3.5 mm from the dorsal surface and 3.3 mm from the articular surface, with the center of the RCL insertion on the proximal phalanx as 2.8 mm from the volar surface and 2.6 mm from the articular surface [13]. The width of the RCL insertion may be greater than that of the RCL origin [58], which may explain why proximal tears occur more frequently than distal tears [59].

RCL injuries also affect the dorsal capsule. With tears of both the RCL and dorsal capsule, the intact adductor, which runs volar to the axis of the MCPJ, serves as a volar and ulnar deforming force [56, 57]. The MCPJ is thus often translated volarly and ulnarly with RCL tears.

Mechanism of injury

Like UCL injuries, RCL injuries are common in athletic events. RCL injuries are caused by an ulnar-directed force on the MCPJ of the thumb. Commonly, they are caused by a fall on the radial aspect of the thumb, or by a player or ball producing an ulnarly directed stress on the proximal phalanx of the thumb [3, 56]. The location of tears is more variable than UCL injuries; Coyle [59] found that the lesion was proximal in 55%, distal in 29%, and midsubstance in 16%.

Diagnosis

History and physical examination

Again, a thorough history is key to diagnosis. Patients typically complain of pain, swelling, and joint stiffness. Pain may occur with grasping objects, unscrewing jar lids, turning a key, turning a doorknob, or writing [3, 56]. In acute injuries, ecchymosis and swelling are often present over the dorsal radial MCP joint. In chronic injuries, there may be dorsoradial prominence from the exposed radial metacarpal condyle, as the proximal phalanx of the thumb is translated in a palmar and ulnar direction.

Examination should assess for tenderness over the radial aspect of the MCPJ, as well as over the dorsal radial capsule. ROM and stability in flexion and extension should be assessed. Local anesthesia can assist with guarding during stability testing. The examiner must stabilize the metacarpal neck while providing an ulnar-directed force on the proximal phalanx in both full extension (to test the ACL) as well as 30° of flexion (to test the proper collateral ligament) (Fig. 7). The degree of laxity, as well as the presence of an end-point, should be noted. Care should be taken to control rotation at

Fig. 7 Preferred technique for examination of MP joint stability, with hands on a table in front of the patient, pointing towards one another. *Reproduced* with permission and copyright © of Elsevier. *From* Carlson MG. Commentary on RCL/UCL injury in basketball. Hand Clin. 2012:28:373–5)

the MCPJ. Anterior and posterior drawer testing should also be performed to assess for palmar subluxation. The injured thumb should be compared to the contralateral uninjured thumb for an internal control. A complete tear is typically indicated by palmar subluxation of >3 mm, instability >30°, or instability >15° compared to the contralateral side [3, 56, 60].

Diagnostic studies

Radiographs should be obtained to assess for avulsion injuries, associated fractures, and for palmar MCP subluxation. Both posterioranterior and lateral radiographs are critical. In the chronic setting, MCP arthritis may be present as well [5••, 60]. Stress dynamic fluoroscopy may also assist in evaluation of instability [56].

In equivocal clinical situations, advanced imaging with ultrasonography or MRI may be useful (Fig. 8). In certain

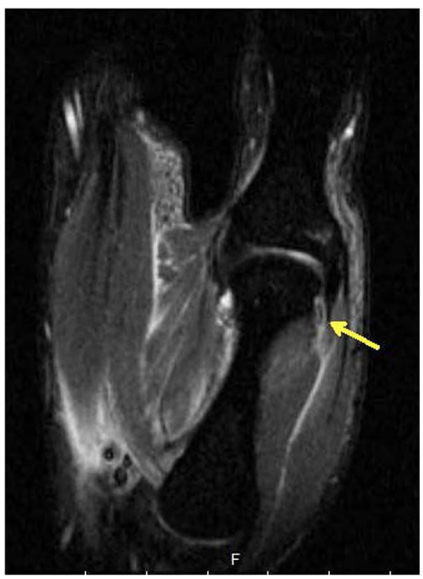

Fig. 8 T2 weighted coronal MRI of the thumb MP joint demonstrating a tear of the radial collateral ligament off the metacarpal head

centers, ultrasound can be a good test that allows for both static and dynamic assessment. MRI scan is a reliable way of assessing the integrity of the ligament, and is most accurate when performed with a 3-T machine using a dedicated extremity coil [60].

Classification

Like UCL injuries, the classic ligament injury grading system is applied to RCL injuries. Grade 1 tears are incomplete, with tenderness to palpation but no instability on examination. Grade 2 tears are partial tears with asymmetric laxity, but with a firm endpoint. Grade 3 tears are complete tears with instability and no identifiable endpoint.

Non-operative treatment

Grade 1 and grade 2 injuries are treated with immobilization [10, 49]. The treatment of grade 3 injuries is more controversial; some older literature advocates casting, while other authors favor acute surgical repair [8, 10]. Unlike the ulnar side, where formation of a Stener lesion may interfere with healing, there are few case reports of Stener-type lesions associated with RCL tears [59, 61]. Even in the absence of an interposed aponeurosis, non-operative treatment of complete RCL tears has been posited to lead to symptomatic instability and degenerative changes at the MCPJ. The palmar and ulnar pull of the adductor, as well as the ulnar pull of the extensor pollicis longus, may prevent the ligament from healing, or cause it to heal in an elongated position [62].

Acute and chronic repair

The literature surrounding RCL repair is heterogeneous. Edelstein et al. [56] succinctly comment on the challenges of critically evaluating the literature on RCL repair due to variable acuity of the injuries treated, the small sample sizes available (which often leads to combining outcomes for UCL and RCL repairs), the myriad repair techniques used (even within the same paper), as well as the lack of a comprehensive grading system for measuring outcome. Smith [10] advocated primary repair of all acute complete injuries, reconstruction for all chronic injuries, and used 3 weeks as the cutoff between acute and chronic injuries.

Durham et al. [63] investigated a group of 18 patients with RCL injuries, six of whom underwent acute repairs (within 2 months), and 12 of whom underwent late repairs (after 2 months). The early repairs included midsubstance suture repairs, reattachment to the bony metacarpal origin, and pinning of distal avulsions. The late repairs were conducted in a variety of ways, including proximal or distal reattachment as appropriate, abductor advancement, RCL imbrication, RCL imbrication with abductor advancement, and reconstruction with palmaris graft. At a follow up of a mean of 6 years, 17/18 patients were completely satisfied with their treatment, and all had a stable MCPJ. No patients had pain requiring medication, and none were limited in work or other activities. There was no significant difference between grip and pinch strength in the groups treated acutely or late. There was a slight loss of motion at the MCPJ in both groups, which was significant only in the late repair group. The acute repair group had an 11% decrease in motion at the MCPJ, while the late repair group had a 23% decrease in motion at the MCPJ [63].

Horch et al. [64] treated nine patients with chronic (>15 days) RCL injuries treated with reconstruction using redirection of the APB. A subjective grade was developed from the patient's perception of their thumb movement, MCP joint stability, quality of pain, and strength of thumb. The majority of patients were very satisfied with their surgery at an average of 39 months follow up, with an average subjective score of 1.7 (1 as the highest, 6 as the lowest). Patients had good mobility of their MCPJ, with total ROM averaging 52.2°, and all patients had full extension. They conclude the APB-plasty is safe and effective for treatment of chronic RCL instability [64].

Coyle [59] treated 38 patients with acute (less than 2 weeks from injury), chronic (6 weeks–1 year), and late (greater than 1 year) RCL injuries with soft tissue sleeve advancement with bony reattachment tied over a button. There were no patients in this series treated from 2–6 weeks. Post-operatively, the joint was immobilized with a K-wire and a thumb spica for 6 weeks. Only four patients in the cohort were treated acutely. At a mean follow-up of 3.8 years, 87% of patients were asymptomatic, 92% regained normal pinch and grip strength, 79% had full ROM at the MCPJ, and all had normal IP ROM. No patients had symptomatic MCPJ instability, although 8% had mild asymptomatic MCPJ volar subluxation [59].

In order to minimize dissection, surgical time, and graft site morbidity for treatment of chronic instability, McDermott and Levin [65] introduced the use of a suture anchor. They described five patients with chronic (greater than 2 months) RCL instability treated with a Mitek suture anchor to anatomically reattach the ligament to bone. All patients had a full return to activities by 2–3.5 months. Grip and pinch strength and ROM were normal by 6 months. At 24 months follow-up, all patients were satisfied and had clinically stable MPJs [65].

In a more recent series, Catalano et al. [62] evaluated 26 patients with RCL injuries. Sixteen were treated with ligament repair at an average of 2.5 weeks after injury for gross instability with stress testing. Ten were treated with reconstruction at an average of 7 months after injury for persistent pain in the setting of an unstable MCPJ despite conservative treatment. Primary repair was carried out with direct suture repair for midsubstance tears, or suture anchor repair for proximal or distal tears. Chronic injuries were reconstructed with palmaris

or flexor carpi radialis grafts anchored in bone tunnels. Patients were evaluated at an average of 5 years after repair. There was no statistically significant difference in MCP or IP motion, grip or pinch strength, or MCP stability between the acute repair and reconstruction groups. The authors created a grading system based on stability, MCP ROM, pain, activity limitations, and pinch strength. In the repair group, there were 12 excellent and three good results. In the reconstruction group, there were eight excellent and two good results. The authors recommend surgical repair of acute grade 3 RCL injuries, and reconstruction of chronic grade 3 RCL injuries [62].

Author's preferred technique

Our preferred technique for RCL repair is suture anchor repair. A straight incision is made centered over the radial aspect of the thumb MCJ. Dissection is carried out carefully to identify the abductor aponeurosis and protect branches of the dorsal radial sensory nerve. The abductor aponeurosis is divided longitudinally and elevated volarly and dorsally as a flap. A capsulotomy is then performed and the remnants of the RCL are identified. There will often be a bare area on the metacarpal head, as the tear is most commonly off the origin of the ligament. The repair site is abraded using a #69 blade or a rongeur to clear off any residual soft tissue and promote direct bone to ligament healing.

A double-loaded suture anchor is then placed at the anatomic origin of the ligament on the metacarpal condyle. A second 2–0 non-absorbable suture is passed through the suture anchor eyelet. Both limbs are passed through the RCL substance in a horizontal mattress pattern. This allows for double-row suture fixation of the RCL. The goal of the repair is to advance the palmarly displaced ligament to its dorsal anatomic position. This repair prevents palmar subluxation of the proximal phalanx. ACL tears are evaluated and repaired with 4–0 nonabsorbable suture if present. The MCP should then be tested for improvement in clinical end point with an ulnar-directed stress. A 0.045 in. Kirschner wire is then inserted from distal ulnar to proximal radial across the MCPJ. The pin should be left prominent on both ends in order to facilitate retrieval in the event of pin breakage. The pin is cut below the level of the skin.

The capsule and abductor aponeurosis are closed separately with 4–0 nonabsorbable sutures. The skin is then closed and a thumb spica splint applied.

The post-operative protocol is for 6 weeks of immobilization in a hand-based thumb spica splint with the IP joint free. After 6 weeks, the pin is removed and immobilization is discontinued. Basketball players can often return to play between weeks 6–12 in a "cone" splint, with a volar cutout (Fig. 9). Unprotected play is typically allowed at 6–12 weeks, depending on the quality of repair [66•]. For baseball injuries, Chhor and Culp recommend that nonpitchers may resume unprotected play when motion and pinch strength is 80% of the contralateral side. Pitchers need 100% pinch strength and full ROM prior to return to play [67••].

Fig. 9 Cut down "cone" splint that may be taped on for play. *Reproduced* with permission and copyright © of Elsevier. *From* Carlson MG. Commentary on RCL/UCL injury in basketball. Hand Clin. 2012:28:373–5)

Conclusion

Collateral ligament injuries to the thumb are common. History and physical examination are paramount in discerning partial versus complete tears. When in question, MRI and US can be useful adjuncts. Complete tears are best treated with repair or reconstruction with special attention given to placing the ligament in the anatomic footprint to regain stability and preserve motion. Athletes will be able to return to play but must have the thumb protected in appropriate splint wear.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Human and animal rights and informed consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines). This article does not contain any studies with human or animal subjects performed by any of the authors.

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