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ORIGINAL ARTICLE

Reefing procedure for lateral collateral ligament attenuation during ligamentous repair for elbow trauma

Matthew L. Ramsey[‡], Benjamin W. Sears*, Grant E. Garrigues[†], Dan Witmer[‡]
*Synergy Orthopaedics, St Anthony's North Hospital, Westminster, CO, USA
[†]Department of Orthopaedic Surgery, Duke University Medical Center, Durham, NC, USA
[‡]Division of Shoulder and Elbow Surgery, Department of Orthopaedic Surgery, Rothman Institute, Thomas Jefferson University Medical Center, Philadelphia, PA, USA

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Conflicts of Interest
None declared.

Correspondence
Benjamin W. Sears, Synergy Orthopaedics, St Anthony's North Hospital, 2551 West 84th Avenue, Westminster, CO 80031-3887, USA.
Tel.: +1 303 423 2000.
Fax: +1 303-430-6420.
E-mail: bwsears@gmail.com

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ABSTRACT

Background Injury to the lateral soft tissue structures is common after complex elbow trauma and instability. Typically, this consists of lateral collateral ligamentous complex avulsion from the lateral distal humeral condyle. However, in some cases, attenuation of the ligament midsubstance may also occur, potentially resulting in residual ligamentous laxity after repair.

Methods From 2007 to 2011, 37 patients were identified through a current procedural terminology code search as having undergone lateral ulnar collateral ligament (LUCL) repair during surgery for trauma to their elbow and were retrospectively reviewed.

Results Attenuation of the ligament midsubstance was found in 19% (seven of 37) patients who underwent surgical repair of the LUCL for injuries to the elbow. In these patients, direct repair of the ligament with additional reefing of the ligament midsubstance was performed. Retrospective review of this population revealed no postsurgical instability or need for subsequent stabilizing procedures.

Conclusions These findings demonstrate that, in select patients, repair with reefing of an attenuated LUCL ligament promotes stability to the elbow.

INTRODUCTION

The lateral collateral ligament complex is a primary stabilizer of the elbow joint [1–3]. This ligamentous complex comprises the anular ligament, the radial collateral ligament and the lateral ulnar collateral ligament (LUCL), which originates on the distal humeral lateral condyle and inserts on the crista supinatoris of the ulna [3]. Integrity of the LUCL complex is a critical component of elbow varus stability and resistance to posterolateral rotation forces [1,4,5].

Injury to lateral soft tissue structures is a typical finding after complex elbow trauma and instability, and restoration of the lateral ligamentous complex is a critical aspect of surgical reconstruction [4–7]. The most common method of repair of an avulsed ligament is placement of a suture anchor or bone tunnel at the ligamentous center of rotation on the humeral lateral condyle [6–9]. However, in some cases, attenuation of the ligament midsubstance has been shown to occur in addition to disruption of the ligament origin [9]. In these patients, direct repair to the lateral condyle may be inadequate to address elbow stability. If direct repair does not sufficiently address ligamentous injury, the surgeon may consider either reconstruction of the ligament with allograft or autograft, or placement of an external fixator. Both of these surgical options are associated with additional complications including donor site pain, infection, and elbow stiffness.

In the present study, we describe a previously undescribed ligament reefing technique that we utilize if the LUCL substance is found to be attenuated. We report a series of seven patients who underwent reefing of an attenuated ligament by the senior author (M.L.R.) for attenuated LUCL tissue identified at time of surgery for elbow trauma. In these instances, we treated these patients with direct repair of the disrupted LUCL to its ligamentous insertion along with reefing of ligament midsubstance with a non-absorbable suture to address lateral laxity. Retrospective evaluation of these patients was conducted to review postoperative stability and assess outcome associated with this surgical technique.

MATERIALS AND METHODS

Patient analysis

The present investigation was approved by the institution internal review board. From 2007 to 2011, 37 patients were identified through a current procedural terminology code search as having undergone LUCL repair during surgery for trauma to their elbow by the senior author (M.L.R.). Seven (19%) of these patients were noted during surgery to have attenuation of the lateral collateral ligament with avulsion of the complex origin that required reefing ligament repair technique. These select patients were retrospectively evaluated for perioperative demographics and intraoperative findings. Postoperative range of motion, pain scores and functional status were evaluated through chart review, which allowed for calculation of the Mayo Elbow Performance Score.

Surgical procedure

Patients were positioned supine with the arm extended on a radiolucent hand table. A nonsterile tourniquet was placed and the arm prepped and draped in normal sterile fashion. Typically, approach to the lateral aspect of the elbow was made through a skin incision overlying Kocher's interval, extending approximately 6 cm from the lateral epicondyle to the supinator crest on the ulna. After continuing the incision to the level of the fasica, the lateral soft tissues were evaluated. If a rent in the lateral tissue was created by the injury, it was typically utilized to obtain access to the bony structures of the elbow. Care was taken at this time to maintain any existing integrity of the LUCL, particularly if the origin and insertion of the ligament remained intact. The ligament is routinely isolated during this approach.

After completing fixation or reconstruction of bony injuries, attention was turned to the lateral ligamentous complex (Fig. 1). If the LUCL was avulsed from the bony lateral epicondyle, it was repaired with either a 5.5-mm metal corkscrew anchor or bone tunnels at the centre of rotation. The joint was then taken through a full range of motion and stressed in varus to assess residual laxity of the soft tissue. The ligament was also visually assessed for diminution or midsubstance lesions.

If the substance of the ligament appeared to be attenuated, a reefing technique was performed during ligament repair. This was performed with a fibrewire locking Krakow stitch placed into the proximal third of the collateral ligament. Next, bone tunnels were created at the level of the ulnar insertion with a 2.4-mm drill bit. A second fibrewire was placed through the ulnar tunnels and

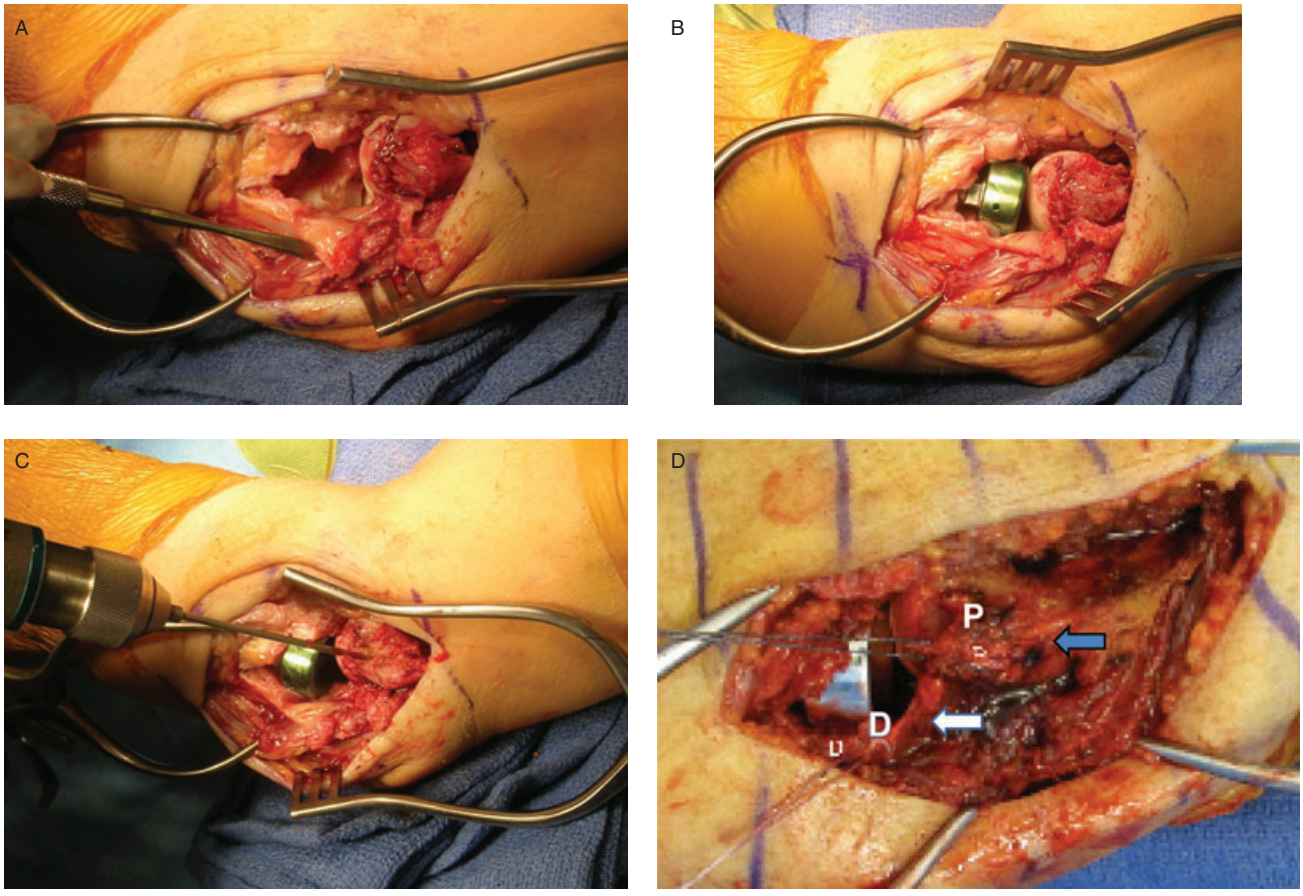

Fig. 1 A 42-year-old female who sustained a fracture dislocation to her left elbow with associated coronoid fracture and comminuted radial head fracture. She underwent open reduction and internal fixation of the coronoid with radial head replacement. Subsequent evaluation of the lateral soft tissues demonstrated avulsion of the lateral ulnar collateral ligament (LUCL) from the distal humerus lateral condyle with apparent attenuation of the ligament midsubstance. A transosseous repair of the LUCL to the distal humerus with reefing of the ligament midsubstance restored stability to the elbow. This patient did not require any subsequent operations. (A) Visual examination of the elbow joint from a lateral approach. The comminuted radial head has been excised. The white arrow indicates the origin of the LUCL complex, which has been avulsed from the distal humerus. The black arrow is pointing to the LUCL. (B) The cornoid has been fixed and the radial head replaced. (C) Drill preparing transosseous tunnels in distal humerus in preparation for placement of the proximal suture. Transosseous tunnels were created next at the level of the LUCL insertion into the ulna. (D) The proximal (P) and the distal part (D) of the LUCL are shown with an attenuated segment between (white arrow). A reefing suture has been placed in the proximal and distal portion of the LUCL utilizing osseous tunnels in the humerus and ulna. The blue arrow is pointing to two proximal drill holes in the lateral epicondyle used to anchor the proximal reefing suture through transosseous tunnels. The reefing sutures will be tied with the forearm in slight supination and 40° of flexion to avoid overtightening of the ligament substance.

carried into the distal third of the ligament with a Krackow stitch. The elbow was placed in 40° of flexion with slight supination, and the fibrewire suture ends tied together tightly at the approximate midportion of the ligament. This effectively removed laxity within the ligament and shortened the ligament to its native length. It is important that the elbow is placed into slight supination at the same time as the sutures were tied to prevent overtightening of the ligament. If the reef stitches are tightened with the forearm in pronation, anterior translation of the radial head may occur. After ligament repair, the stability of the joint was reassessed and the skin closed in normal fashion. Finally, the elbow was splinted in slight supination for approximately 1 week depending on associated injuries and quality of fixation. Patients routinely received postoperative pharmacologic heterotopic ossification prophylactic prevention consisting of oral intake of indomethacin (75 mg twice daily) for 3 weeks.

RESULTS

Thirty-seven patients were identified as having undergone surgical repair of the LUCL for injuries to the elbow from 2007 to 2010 by the senior author (M.L.R.). Of these patients, seven were identified as requiring reefing with repair of the LUCL during time of surgery (19%) (Table 1). This population consisted of five males and two females, with an age range of 22 years to 56 years. Two patients required surgical intervention for simple dislocation with residual symptomatic instability after a failed trial period of non-operative management. Two patients were manual laborers and two patients were involved in a workman's compensation claim during treatment. Two patients remained out of work at the time of their final evaluation.

All patients were followed in the postoperative period to clinical discharge. The mean follow-up was 6 months (range 5 months to 9 months). No patient required subsequent reconstruction of the ligament or placement of an external fixation device. No patient demonstrated signs of instability in the operating room or during subsequent clinical visits. Two patients did require a secondary surgery, both for removal of heterotopic ossification.

Sixty-seven percent of patients reported no pain or discomfort at the conclusion of their treatment. Mean range of motion consisted of 115° of elbow flexion (range 105° to 140°) to 15° elbow extension (range 0° to 30°) and 70° of forearm rotation in pronation and supination (range 40° to 85° pronation/supination). The Mayo Elbow Performance Score for this population at the conclusion of treatment was 86.6 (range 65 to 100).

DISCUSSION

Ligamentous injuries of the elbow are associated with both simple dislocations and serious trauma. Several investigations have shown that the lateral ligamentous complex is typically disrupted in elbow trauma with concomitant instability [4–7]. Avulsion of the lateral collateral ligamentous complex and capsule from the lateral distal humeral condyle is the most common

Table 1 Seven patients required reefing with repair of the lateral ulnar collateral ligament (LUCL) for attenuation of the ligamentous midsubstance

Patient	Age	Injury	Procedure	Assessment of LUCL during surgery	LUCL managment	MEPS score	Postoperative stability
A.R.	22	Simple dislocation with no osseous injury	Arthroscopic loose body removal, open LUCL repair	Midsubstance incompetence	Reef and repair	100	Stable
L.A.	29	Coronoid fracture and LUCL disruption	ORIF coronoid, LUCL repair	Attenuated mid substance	Reef and repair	85	Stable
T.L.	46	Comminuted radial head and shaft fracture, LUCL disruption	ORIF radial head and shaft, LUCL repair	Appearance of poor tissue quality	Reef and repair	95	Stable
V.C.	26	Elbow dislocation with residual subluxation, LUCL insufficiency	Open reduction of joint, LUCL repair	Incompetent LUCL	Reef and repair	70	Stable
L.K.	56	Coronoid and radial head fracture with residual subluxation	ORIF coronoid, radial head replacement, LUCL repair	Deep tear in LUCL substance	Reef and repair	100	Stable
K.G.	33	Elbow dislocation with radial head fracture and MCL disruption	Radial head replacement, LUCL and MCL repair	Attenuated midsubstance	Reef and repair	95	Stable
L.D.	56	Left radial head FX, left olecranon FX, LUCL insufficiency	Radial head replacement, olecranon ORIF, LUCL repair	Incompetent LUCL	Reef and repair	85	Stable

This represented 19% of patients undergoing surgical repair of the LUCL for injuries to the elbow from 2007 to 2010. FX, fracture; MEPS, Mayo Elbow Performance Score; MCL, medial collateral ligament; ORIF, open reduction internal fixation.

type of soft tissue disruption after elbow trauma [6,9]. McKee et al. reported on 62 patients who sustained elbow dislocation or fracture dislocation leading to complex elbow instability [9]. In their population, proximal soft-tissue avulsion occurred in 52% of cases, whereas midsubstance rupture of the LCL was found in 29% of patients. In 5% of cases, a combined pattern of midsubstance tearing or rupture with an associated avulsion from the lateral humeral condyle was identified [9]. Although repair techniques were not discussed, their study demonstrates that midsubstance LUCL injury is probably more commonly encountered in patients with complex elbow instability than previously assumed; however these injuries are less common than isolated avulsion of the ligament from its insertion. As with any material undergoing a load to failure, the ligament first undergoes plastic deformation after reaching its yield point followed by ultimate failure. This leaves the ligament both ruptured and in an attenuated, stretched state.

In the present study, a reefing technique was employed to augment midsubstance LUCL laxity in seven of 37 (19%) of patients undergoing lateral ligamentous complex repair. Ligament attenuation was identified inraoperatively in all cases and assessed by varus stress of the ligament and visual inspection of the ligamentous tissue quality. Even after anatomic repair of the ligament to its origin at the isometric point, these cases still had pathological laxity in the ligament. In each patient included in the present study, repair of the ligamentous origin and associated reefing of attenuated midsubstance ligament restored appropriate soft tissue stabilization, and no patient required additional stabilization, including ligament reconstruction or placement of an external fixation device.

Restoration of the lateral stabilizers is a crucial component for surgical management of the traumatized elbow [6–8,10]. Although repair of the avulsed ligament to the lateral condyle with transosseous sutures tends to provide more reliable fixation and accurate tensioning of the repair [11], a suture anchor also may be used [12]. Typically, a running, locking krackow suture is placed into a portion of the ligament to draw it back to the bone. Although this krackow suture can be continued from the lateral condyle through the entire substance of the ligament to address ligamentous midsubstance injury, we have found that the use of only one suture causes disruption of ligamentous tension, and can even damage the ligament substance further. In our experience, the reefing technique, which utilizes tensioning of two sutures that are tied at the midportion of the ligament, allows for optimal tensioning with minimal chance of ligament tearing because the burden of tensioning is borne primarily by suture.

Patients in this case series demonstrated no incidence of instability or subsequent stabilizing procedures after repair and reefing of the LUCL. Two patients did require subsequent excision of heterotopic ossification; however, this does not appear to be related to the reefing procedure and is a common occurrence after elbow trauma, despite the use of pharmacological heterotopic ossification prophylactic prevention. Also in the present series, there was no injury or diagnosis that consistently resulted in ligament laxity, thereby highlighting the importance of evaluating ligament integrity intraoperatively during repair in all patients.

It should be noted that, in the present series, two patients with an initial diagnosis of simple and reducible elbow dislocation (patients 1 and 4) required operative ligamentous reefing after a course of attempted non-operative management. Historically, and in our practice, most simple dislocations are successfully managed with non-operative treatement [13,14]. However, during the post-dislocation period, both patients complained of a continued sense of elbow 'slipping' with activity, and had a positive table top push-up test resulting in a clinical diagnosis of posterior lateral rotatory instability. This may indicate that, in the rare case of post-reduction instability after simple elbow dislocation, midsubstance attenuation of the LUCL complex should be considered and evaluated.

Our findings demonstrate that, in patients with midsubstance attenuation of the lateral ligamentous complex after serious elbow trauma, repair with reefing of an attenuated LUCL ligament restored varus stability to the elbow. This technique is not always required but, when midsubstance attenuation is identified intraoperatively (19% of patients in the current investigation), reefing improves lateral ligamentous structure competency without the need for ligament reconstruction or external fixation. Important technical points include the use of osseous tunnels in both the humeral lateral condyle and crista supinatoris, as well as tying the fibrewire with the elbow in slight supination and 40° of flexion. Ultimately, LUCL reefing is an effective technique for restoring ligament integrity for midsubstance attenuation without ligament reconstruction or external fixation.

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