Clinical outcomes of arthroscopic lateral ulnar collateral ligament repair with or without intra-articular fracture

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Abstract

Background: The pathoanatomy and biomechanics of elbow instability have been previously reported; however, few researchers have dealt with the operative management and clinical consequence of recurrent elbow instability. Recent studies on arthroscopic lateral collateral ligament (LCL) complex repair have reported successful outcomes similar to those achieved by open repair. We aimed to determine the validity of arthroscopic repair of the LCL complex in elbows with unstable dislocation with or without intra-articular fracture. Methods: Eighteen consecutive patients who had undergone arthroscopic repair of the LCL complex for unstable dislocation of the elbow with or without intra-articular fracture and who were followed for at least 12 months were included in the study. Ligament injury combined with coronoid and/or radial head fractures were treated with arthroscopic technique. Pain, range of motion, clinical outcomes based on the Mayo Elbow Performance Score (MEPS), and surgical complications were evaluated. Results: At 12 months follow-up, all 18 patients demonstrated complete settlement of the instability and mean (and standard deviation) extension of 1.7 ± 3.8°, flexion of 138.3 ± 3.8°, supination of 88.6 ± 5.3°, and pronation of 88.2 ± 5.6°. The average MEPS was 97.7 ± 3.9 points and according to this validated outcome score. However, slight widening (2 mm) of the radiocapitellar joint space was accompanied in one patient, although the varus stress test and pivot shift test were not observed. One patient showed delayed union of the anteromedial facet fracture, and two patients showed pin site irritation, which was a complication of arthroscopic coronoid fracture fixation and was fully resolved after pin removal. Conclusion: In patients with unstable elbow dislocation, with or without an intra-articular fracture, arthroscopic repair of the LCL complex is an effective and alternative treatment option that can restore elbow stability and have satisfactory clinical and radiographic results.

Keywords

arthroscopy, elbow instability, lateral collateral ligament, lateral ulna collateral ligament

Introduction

There are four major components that form the lateral collateral ligament (LCL) complex of the elbow: radial collateral ligament, lateral ulnar collateral ligament (LUCL), annular ligament, and accessory LCL.1 LUCL injury is a crucial factor in acute dislocation of the elbow and can give rise to posterolateral rotatory instability (PLRI).2 O’Driscoll et al.3 in 1992 described the pathoanatomy of elbow dislocation and were the first to verify the
PLRI of the elbow following injury to the LUCL. Soft-tissue injury originates at the medial side due to rupture of the medial ulnar collateral ligament and then progresses across the anterior capsule to the lateral side by causing injury to the radial ulnohumeral ligament and lateral capsule as the elbow dislocates posterolaterally. Rupture of both the medial and lateral ligamentous structures may be caused by complete elbow dislocation. Josefsson et al.4 studied 31 complete elbow dislocations and verified that the complete rupture of both ligaments was found in each case, especially from the humeral origin.

The pathoanatomy and biomechanics of elbow instability have been previously reported. However, studies reported that the surgical approach and clinical outcomes of recurrent elbow instability are limited.4–8 Recent studies have demonstrated the similarity in the outcomes of LCL complex repair using the arthroscopic and open approach.7–9 The purpose of performing arthroscopic LCL complex repair is to restore the tension, strength, and anatomic attachment sites of the native LCL, with the intention of decreasing morbidity.10,11 The aim of this study is to analyze the effects of arthroscopic LCL complex repair in patients with unstable elbow dislocation.

Methods
This study was conducted with the approval from our institutional review board and informed consent was obtained from all patients. A total of 18 patients who had an LUCL injury caused by an unstable elbow dislocation were enrolled. Unstable dislocation was defined by Kim et al.11 as follows: (1) a concentric reduction that was not seen on radiographs after reduction (a positive drop sign), (2) reduction that was not maintained on flexion of <30°, and (3) a positive lateral pivot shift test conducted on a patient under anesthesia.

The diagnosis was confirmed by computed tomography (CT), magnetic resonance imaging (MRI), and physical examination conducted by orthopedic surgeons. The surgery was performed arthroscopically between June 2017 and August 2018, at a mean of 7.1 days (range 1–21 days) after the injury. All operations were performed by the same surgeon (a shoulder and elbow surgeon with 5 years of experience) in the same medical institution. Before the surgery, all patients were evaluated by standard simple radiography, CT, and MRI for more accurate fracture pattern analysis and assessment of soft-tissue comorbidities. Before and during surgery, stability tests such as lateral pivot shift test and varus stress test were performed on all patients to confirm the instability of the elbow joint.

Patients fulfilling one or more of the following criteria were excluded from the study: (1) another fracture in the ipsilateral upper extremity (n = 9), (2) surgical history of open reduction and internal fixation for radial head or coronoid process fracture because it was inappropriate for the arthroscopic procedure (n = 2), (3) previous history of LUCL surgery or chronic PLRI which needed LUCL repair (n = 4), (4) an immature skeleton (n = 3), or (5) loss to follow-up before 12 months of enrollment (n = 3).

Surgical technique
Under general anesthesia, the patients were placed in the lateral decubitus position and sterile pneumatic tourniquet was applied to the upper arm. The accompanying intra-articular fractures were operated using an arthroscope before the LCL complex repair. Five coronoid fractures were fixed with pull-out suture repair using Ethibond No. 2 (Ethicon Inc. Somerville, New Jersey, USA; Figure 1(a)) or with Kirschner wire (Figure 1(b) and (c)), and two radial head fractures were fixed with Acutrak headless screw (Acumed, Hillsboro, Oregon, USA; Figure 1(d)), through the proximal anteromedial and proximal anterolateral portal.

For the LCL complex repair, the viewing portal was made at the soft spot and the working portal was established at the direct lateral portal (Figure 2). Significant ruptures of LCL were observed (Figure 3(a)), and by advancing the arthroscope on the lateral side of the radiocapitellar joint, disruption of the LCL humeral attachment of the lateral epicondyle was identified, which was more evident when performing the varus stress on the elbow. Firstly, in the lateral epicondyle, the LCL insertion site was debrided using a shaver to remove scar tissue and any remnant debris. To enhance the ligament to bone healing, gentle burring of the lateral epicondyle was performed at the subchondral bone. A 1.8-mm Y-Knot (ConMed Linvatec, Largo, Florida, USA) was inserted into the LCL complex footprint of the humeral attachment (Figure 3(b)). Via a spinal needle, 2-0 polydioxanone (PDS; Ethicon) was passed, and using a grasper, sutures were pulled out through the direct lateral portal (Figure 3(c)). The PDS was connected with a FiberWire for shuttle relay. The first pass was placed on the radiocapitellar joint line under the annular ligament for plication of LCL component and the second pass was placed at 45° posterior to the radiocapitellar line under the annular ligament for plication of the LUCL component (Figure 3(d)). A suture retriever was passed through the incision and was used to collect the sutures subcutaneously, pulling them out through the direct lateral portal. Before tying the sutures, we found that removing any subcutaneous adipose tissue had favorable results when laying the ties directly on the capsule. Surgical knots were made and tensioned for each suture set, and the suture ends were cut. The radiocapitellar joint was then reassessed, and if the LCL was adequately repaired, the drive-through test was not required (Figure 3(e)).

The medial collateral ligament (MCL) was not repaired in any cases. Despite cases of medial-side instability, MCL injury was managed by conservative treatments such as maintaining a protected range of motion (ROM) through hinged elbow brace.
Postoperative management

After the operation, splints were applied to all patients immediately at the forearm in full pronation and the elbow in approximately 90° flexion to relieve tension from the repair site. The first postoperative visit usually takes place within 1 week after the surgery, and a hinged elbow brace was applied to allow comfortable movement. Physical therapy which was focused on elbow ROM in a pain-free range was started at the first postoperative visit. The exercises involved a full passive ROM after 3–6 weeks and an active ROM and strengthening exercises 6 weeks thereafter. The patient gained full activity at 3 months although it depended on the type of activity.

Statistical analysis

Statistical analysis was done using SPSS for Windows, version 25.0. The nonparametric Shapiro–Wilk test was conducted because of the small study population. To evaluate the significant differences (at a 95% confidence level) of the elbow ROM, the Wilcoxon signed-rank test was used, and to compare the contralateral elbow at the time of final follow-up, Mayo Elbow Performance Score (MEPS) was used.

Results

A total of 18 consecutive patients who had undergone an arthroscopic LCL complex repair for elbow dislocation and PLRI between May 2017 and August 2018 were retrospectively reviewed. Eleven men and seven women, with an average age of 39.9 years (range 19–64 years), were estimated. At the final follow-up assessment, all 18 patients showed complete recovery of the elbow instability and negative results of the lateral pivot shift test were shown (Table 1).

The mean ROM values (and standard deviation) at the final follow-up were flexion of 138.3 ± 3.8°, extension of 1.7 ± 3.8°, supination of 88.6 ± 5.3°, and pronation of 88.2°.
A surgical technique for arthroscopic repair of the LUCL was described by Smith et al.\textsuperscript{9} and Savoie et al.\textsuperscript{7} who performed a study comparing both open and arthroscopic methods. Savoie et al.\textsuperscript{13} reported that arthroscopic application of the LUCL was safe and effective for the treatment of chronic PLRI, and the results were comparable to those of open repair. We also preferred the arthroscopic application technique of Savoie et al.\textsuperscript{13} and Arrigoni et al.\textsuperscript{14} to avoid sutures from ripping out and to increase suture strength. Savoie et al.\textsuperscript{13} and Arrigoni et al.\textsuperscript{14} passed the suture through the annular ligament. It is possible to use a rip-stop stitch because the direction of annular ligament fibers is perpendicular to the direction of the LCL complex fibers.

Conventionally, orthopedic surgeons prefer the conservative treatment in a simple elbow dislocation. However, in a study published by Anakwe et al.\textsuperscript{15} of the 110 patients managed with conservative treatment for a simple dislocation, followed for a mean of 88 months, 56\% suffered from residual stiffness and 62\% showed residual pain. In 2017, Arrigoni et al.\textsuperscript{16} reported that over 85\% of patients suffering from recalcitrant lateral epicondyritis demonstrate at least one pathologic intra-articular finding, and almost 50\% presented with at least one sign of lateral ligamentous patholaxity. O’Brien et al.\textsuperscript{8} argued that acute or subacute arthroscopic repair of the LUCL is a safe and effective treatment after elbow dislocation in high-demand patients. Out of all patients in that study, 3 showed serious unstable elbow dislocation accompanied by multiple ligament injuries, and 10 had a complex elbow dislocation with intra-articular fracture. During the acute period, all surgeries were performed using the arthroscopic approach for LCL complex repair and associated fractures. Nevertheless, satisfactory results were achieved. In 2016, Kim et al.\textsuperscript{11} also reported satisfactory outcomes with a mean MEPS of 92 points, mean extension of $3 \pm 1^\circ$, mean flexion of $138 \pm 6^\circ$, mean supination of $88 \pm 5^\circ$, and mean pronation of $87 \pm 6^\circ$ following arthroscopic LCL repair in patients with PLRI, with or without intra-articular fractures.

In our study, repair of the LCL complex during the acute or subacute period both performed well, with excellent MEPS results in all patients. More importantly, all patients were able to gain their previous level of activity without recurrent instability. Complications such as nerve injuries or infections were not reported in our study. The average final ROM showed 1.7 of extension to 138.3 of flexion. Although Josefsson et al.\textsuperscript{4} showed that there were no statistically meaningful benefits in the early surgical approach, it may let patients return to their normal activities more quickly without complications. The average period of returning to normal activities in a brace showed on average 3.6 weeks and the acute group (2.7 weeks) exhibited a faster recovery period in comparison to the subacute group (4.6 weeks). These results reveal better outcomes than the 6 weeks demonstrated by Protzman\textsuperscript{17} in a military population, as well as Rettig\textsuperscript{18} and Parsons and Ramsey\textsuperscript{19} in athletes, returning to full activities...
after conservative treatment by applying a brace. Kenter et al. reported that after an acute elbow injury, National Football League professional football players missed an average of 0.64 games (range 0–4 games). Therefore, O’Brien et al. proposed that certain high-demand patients may benefit greatly from a more aggressive approach and

Figure 3. Intraoperative arthroscopic images. (a) Ruptured LCL complex (asterisk) with an arthroscopic soft-spot portal established as the viewing portal. (b) A double-loaded suture anchor has been placed through direct lateral portal into the humerus at the site of origin of the LCL complex of the lateral epicondyle. (c) A spinal needle is passed percutaneously to penetrate the LCL complex stump. (d) The first pass was placed on the radiocapitellar joint line for suturing LCL component and the second pass was placed on the \(45^\circ\) posterior of the radiocapitellar line for suturing LUCL component. (e) Arthroscopic view through the soft spot portal showing the left LCL being tightened onto the lateral epicondyle (arrowhead). H: humerus; RH: radial head; LCL: lateral collateral ligament; LUCL: lateral ulnar collateral ligament.
maybe candidates of acute arthroscopic surgery. In our series, almost all patients obtained functional ROM 6 weeks after surgery, and there was no significant limitation of motion 12 months after surgery.

This study had several limitations. First, this study was performed as a nonrandomized retrospective study. Second, the follow-up period was short, and the patients had various degrees of injury as this was a consecutive series of surgically treated patients. Third, the study group was not compared with a group that had not taken the surgical approach. Finally, the number of included cases was too small for subgroup analysis of different treatment methods.

**Conclusion**

In patients with unstable elbow dislocation, with or without an intra-articular fracture, arthroscopic repair of the LCL complex is an effective and alternative treatment option that can restore elbow stability and have satisfactory clinical and radiographic results.

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### Table 1. Demographic data for 18 patients reviewed in study.

| Patient no. | Age (year) | Hand dominant | Injured elbow | Sex | Occupation activity | Injury mechanism | Combined fracture | Fixation method | Time to surgery (day) |
|-------------|------------|---------------|---------------|-----|---------------------|------------------|-------------------|------------------|------------------------|
| 1           | 22         | RHD           | Left          | Male | High                | Sports injury    | None              | –                | 2                      |
| 2           | 24         | RHD           | Left          | Male | High                | Sports injury    | Radial head       | Headless screw    | 4                      |
| 3           | 51         | RHD           | Left          | Male | High                | Fall from height | None              | –                | 14                     |
| 4           | 55         | RHD           | Right         | Male | High                | Fall from height | None              | –                | 5                      |
| 5           | 64         | RHD           | Right         | Male | High                | Traffic accident | Coronoid          | Pinning          | 7                      |
| 6           | 62         | RHD           | Left          | Female| High               | Fall from height | None              | –                | 8                      |
| 7           | 44         | LHD           | Left          | Male | Intermediate or Low | Fall from height | Coronoid          | Pull out suture   | 2                      |
| 8           | 31         | RHD           | Right         | Male | High                | Fall from height | None              | –                | 10                     |
| 9           | 64         | RHD           | Right         | Male | High                | Traffic accident | Coronoid          | Pull out suture   | 1                      |
| 10          | 38         | LHD           | Right         | Female| High               | Traffic accident | Coronoid          | Pinning          | 2                      |
| 11          | 27         | RHD           | Left          | Male | High                | Sports injury    | None              | –                | 21                     |
| 12          | 35         | RHD           | Right         | Male | Intermediate or Low | Traffic accident | Coronoid          | Pinning          | 9                      |
| 13          | 50         | RHD           | Left          | Female| High               | Fall from height | None              | –                | 1                      |
| 14          | 59         | RHD           | Right         | Female| High               | Fall from height | None              | –                | 24                     |
| 15          | 21         | RHD           | Right         | Female| Intermediate or Low | Sports injury    | None              | –                | 10                     |
| 16          | 23         | RHD           | Left          | Male | High                | Sports injury    | Radial head       | Headless screw    | 5                      |
| 17          | 19         | RHD           | Right         | Female| High               | Sports injury    | None              | –                | 3                      |
| 18          | 26         | RHD           | Left          | Female| Intermediate or Low | Fall from height | None              | –                | 2                      |

RHD: right hand dominant; LHD: left hand dominant.

### Table 2. Postoperative MEPS and ROM.

|                  | 6 Weeks | 3 Months | 6 Months | 12 Months | Contralateral elbow | p Value |
|------------------|---------|----------|----------|-----------|---------------------|---------|
| MEPS (degree)    | 87.7 ± 16.3 | 91.1 ± 12.2 | 92.2 ± 10.6 | 97.7 ± 3.9 | 100                 | 0.28    |
| ROM (degree)     |          |          |          |           |                     |         |
| Extension        | 12.2 ± 13.1 | 3.9 ± 7.0 | 3.3 ± 6.9 | 1.7 ± 3.8 | 0                   | 0.83    |
| Flexion          | 13.27 ± 11.1 | 136.1 ± 7.0 | 137.7 ± 4.3 | 138.3 ± 3.8 | 140                 | 0.74    |
| Supination       | 82.3 ± 6.2 | 86.3 ± 6.8 | 87.4 ± 5.8 | 88.6 ± 5.3 | 90                  | 0.22    |
| Pronation        | 79.8 ± 7.8 | 83.4 ± 6.3 | 86.5 ± 6.1 | 88.2 ± 5.6 | 90                  | 0.28    |

MEPS: Mayo Elbow Performance Score; ROM: range of motion.

For the difference at 12 months compared with the contralateral elbow.
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