SURGICAL TECHNIQUES

SURGICAL TECHNIQUE FOR ARTHROSCOPIC
LATERAL COLLATERAL LIGAMENT REPAIR

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Introduction

Arthroscopic repair of the lateral collateral ligament (LCL) complex in patients who have posterolateral rotatory instability after an unstable elbow dislocation, with or without an intra-articular fracture, is an alternative treatment for restoring stability of the elbow and obtaining successful clinical and radiographic results.

Posterolateral rotatory instability of the elbow has been described as a pattern of ligamentous instability that results from insufficiency of the LCL complex¹. Many biomechanical studies on the effects of sequential sectioning of the lateral soft-tissue stabilizers have confirmed that the lateral ulnar collateral ligament (LUCL) is critical in preventing transient rotatory subluxation of the ulnohumeral joint along with secondary subluxation or dislocation of the radiohumeral joint². The posterolateral aspect of the joint capsule, common extensor origin, and capsular insertion to the annular ligament have been identified as key secondary stabilizers³⁻⁶. Lateral soft-tissue injury, specifically laxity or avulsion of the LUCL, is a consistent finding in posterolateral rotatory instability, and functional restoration of the LUCL through repair is an integral component of operative management⁷.

Recent investigations of arthroscopic repair of the LCL complex have shown satisfactory results that were as good as those achieved with open repair⁸⁻¹¹. The aims of arthroscopic LCL-complex repair are to reliably regenerate the tension, strength, and anatomic attachment sites of the native LCL so that the risk of morbidity is minimized as much as possible². Arthroscopic surgery for acute LCL-complex repair applied from the humeral side can, in many patients, identify and treat a concomitant intra-articular coronoid fracture, with or without a radial head fracture, and help to minimize complications such as infection, stiffness, and scar formation, which can develop after open repair.

Indications & Contraindications

Indications

- Patients who have acute posterolateral rotatory instability after an unstable elbow dislocation. A dislocation is considered to be unstable when (1) a concentric reduction is not seen on radiographs after

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reduction, i.e., a positive drop sign^{12,13}; (2) reduction is not maintained on flexion of $<30^\circ$, i.e., the elbow subluxates at $<30^\circ$ during range of motion; or (3) a lateral pivot-shift test performed with the patient under anesthesia has a positive result.

Contraindications

- Another fracture in the ipsilateral or contralateral upper extremity.
- Open reduction and internal fixation of a fracture of the radial head or coronoid process, if not amenable to arthroscopic management.
- A coronoid fracture that involves the medial facet or is not able to be reduced; such fractures are treated with open surgery.
- As arthroscopic reduction of a radial head fracture is done by probe with the lever arm method, a completely displaced fracture that is not able to be reduced is treated with open surgery (when the fracture fragment involves more than half of the articular surface) or by arthroscopic fracture fragment excision (when the fracture fragment involves less than half of the articular surface).
- Chronic posterolateral rotatory instability (>3 months).
- Previous LCL surgery with the need for LUCL reconstruction.

Step 1: Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Preoperative Planning

Obtain radiographs and CT and MRI scans to make an accurate analysis of the fracture patterns and develop an understanding of soft-tissue comorbidities.

- Radiographs should be made to determine if there are any degenerative or osseous changes and to evaluate the osseous alignment of the elbow joint.
- Confirm the diagnosis with CT, MRI, and physical examination.
- Assess the stability of the elbow joint in every patient, after induction of anesthesia, with use of valgus stress and lateral pivot-shift tests to confirm the unstable elbow joint¹⁴.

Step 2: Position the Patient and Place the Portals

Place the patient in the lateral decubitus position and create proximal anteromedial, proximal anterolateral, anterolateral, and radial head portals as working portals and a posterior soft-spot portal as a viewing portal for the repair of the LCL complex.

- Place the patient in the lateral decubitus position, under both general anesthesia and a brachial plexus block.
- Apply a pneumatic tourniquet around the upper arm at a pressure of 250 mm Hg with a 1-hour time limit.
- Make the anteromedial, proximal anterolateral, anterolateral, and radial head portals as working portals, and a posterior soft-spot portal as a viewing portal (Fig. 1).
- The radial head portal as a working portal is located 0.5 cm posterior to a point 1 to 1.5 cm distal to the lateral epicondyle, just proximal to the radial head with the elbow in 90° of flexion (Fig. 1).

Fig. 1

Fig. 1 Portals used in arthroscopy for LCL-complex repair in a right elbow. **Fig. 1-A** Proximal anterolateral (PAL), soft-spot, and radial head (RH) portals. **Fig. 1-B** Anterolateral portal. **Fig. 1-C** Illustration demonstrating the anatomic positioning of the radial head (RH) portal.

Step 3: Diagnostic Arthroscopy

Identify concomitant radial head and coronoid fractures, and confirm the LCL-complex tear intraoperatively.

- Establish a proximal anteromedial portal for diagnostic arthroscopy of the anterior compartment.
- Abundant hematoma will be encountered in the joint. A proximal anterolateral portal can be positioned to clean out the hematoma.
- After evacuating the hematoma, identify fractures of the radial head or coronoid.
- Evaluate the lateral side, the laxity of the annular ligament, and the LCL complex. With a 4.5-mm, 30° arthroscope, enter the elbow through the proximal anteromedial portal and then evaluate laxity, which is established by radiocapitellar joint widening and identification of the LCL-complex stump. In addition, identify the defect of the LCL complex at the footprint in the epicondyle through the soft-spot portal. Valgus load and forearm supination demonstrate posterolateral rotatory instability with the radial head subluxating off the capitellum, indicative of injury to the LCL complex.
- When free osteochondral fragments are seen posteriorly, extract the fragments if the fragments are not too bulky to remove.
- Evaluate the medial side. An arthroscopic valgus stress test can be performed to evaluate the incompetence of the medial ulnar collateral ligament.

Step 4: Management of Concomitant Injuries

Treat intra-articular fractures arthroscopically before the LCL-complex repair.

- Fix coronoid fractures with a Kirschner wire when the fracture fragment is large enough to penetrate with a Kirschner wire. Otherwise, fix coronoid fractures with suture repair. Typically, 2 or 3 unthreaded Kirschner wires are used for fixation of the coronoid fracture. After fixation, cut them at the level of the olecranon bone.
- Under direct arthroscopic visualization, perform a reduction and fixation with Kirschner wire. No guide is used. First, prepare the coronoid fracture site using a shaver through the proximal anterolateral portal. Then, insert 1.6-mm Kirschner wires from the posterior aspect of the ulna in an anterior direction to the radial head. Using this Kirschner wire as a guide, insert an additional Kirschner wire at 0.5 cm distally and 1 cm medially to guide the Kirschner wire in a parallel direction. Use 2 or 3 Kirschner wires, depending on the size of the fragment. Then, advance the Kirschner wire and pass it through the fragment while holding the fragment with the grasper and maintaining the reduction.
- Manage radial head fractures with partial excision or screw fixation.

Step 5: Arthroscopic LCL-Complex Repair (Video 1)

After soft-tissue debridement using the soft-spot portal as a viewing portal and the proximal anterolateral portal as a working portal, decorticate the footprint of the humeral attachment of the LCL complex with use of a shaver or burr and then make a modified Mason-Allen stitch using a needle, fixing the suture with a knotless anchor, to achieve a stable elbow joint.

- Debride soft tissue for an adequate visual field.
- Pass a spinal needle through the radial head portal to penetrate the LCL-complex stump at the joint capsule.
- Pass a polydioxanone (PDS) suture through the spinal needle and pull it out through the proximal anterolateral portal using a grasper (Figs. 2-A and 2-B).
- Make the shuttle relay by connecting the PDS suture with a FiberWire (Arthrex) or other nonabsorbable suture material and pulling it out through the proximal anterolateral portal.
- Pass a second PDS suture through the proximal anterolateral portal from the radial head portal, and connect the FiberWire with the second PDS suture.

Fig. 2-A

Fig. 2-B

Video 1 The arthroscopic LCL complex repair method used with this technique.

Figs. 2-A through 2-F Illustrations and arthroscopic views of arthroscopic lateral collateral ligament (LCL)-complex repair. **Fig. 2-A** Ruptured LCL complex with a posterior arthroscopic soft-spot portal established as the viewing portal for the LCL-complex repair. F = LCL-complex footprint of the humeral attachment, S = LCL-complex stump, and RH = radial head.

Fig. 2-B A spinal needle is passed through the radial head (RH) portal to penetrate the LCL-complex stump (S) and joint capsule. Polydioxanone suture (PDS) is then passed through the spinal needle and moved outside the proximal anterolateral (PAL) portal using a grasper. CP = capitellum.

- Move the FiberWire back to the radial head portal (Fig. 2-C).
- Repeat the sequence with a 10-mm gap left between the previous stitches.
- Knot both paired strands of FiberWire using the modified Mason-Allen method (Fig. 2-D).
- Make the anterolateral portal using a spinal needle, and then transfer the FiberWire from the radial head portal to this portal for fixation at the LCL-complex footprint.
- Gently decorticate the footprint of the humeral attachment of the LCL complex with a burr or shaver.
- Make a predrilled hole directed slightly upward with a 4.5-mm drill-bit before anchor fixation.

Fig. 2-C

Fig. 2-D

Fig. 2-C The FiberWire is moved back to the radial head (RH) portal. PDS = polydioxanone suture, CP = capitellum, and S = LCL-complex stump.

Fig. 2-D The sequence was repeated once with a 10-mm gap between the previous stitches. Both paired strands of FiberWire were knotted using the modified Mason-Allen method. C = capitellum and RH = radial head.

- Fix the remaining FiberWires using 1 knotless anchor suture (ReelX [Stryker Endoscopy] or PopLok [ConMed Linvatec]) on the articular side of the LCL-complex footprint of the humeral attachment, with the elbow in a valgus position, through the anterolateral portal (Figs. 2-E and 2-F).

Fig. 2-E

Fig. 2-F

Fig. 2-E An anterolateral portal was made by using a spinal needle, and then the FiberWire was transferred from the radial head portal to the anterolateral portal for fixation at the LCL-complex footprint of the humeral attachment (F) through the anterolateral portal.

Fig. 2-F Completed arthroscopic LCL-complex repair and a stable elbow joint.

Step 6: Postoperative Management

After postoperative immobilization of the elbow for 2 to 3 days, instruct the patient to perform passive exercises, returning to a full range of motion at 4 to 6 weeks after surgery, and typically returning to full activity at 3 months after the operation.

- After skin closure, immobilize the elbow joint in a posterior splint with the forearm pronated and the elbow flexed at 90° for 2 to 3 days.
- Instruct the patient to perform passive range-of-motion exercises using a hinged brace with a 30° extension block.
- Passive exercises involving a full range of motion are allowed at 4 to 6 weeks after surgery.
- Advise the patient to start active exercises with a full range of motion at 6 weeks after surgery.
- At about 8 to 10 weeks postoperatively, strengthening exercises are initiated, and the patient can typically return to full activity at 3 months after the operation.

Results

To date, arthroscopic LCL-complex repair has produced excellent results, with all 13 patients in our original study reporting complete resolution of the elbow instability and demonstrating a negative result on the lateral pivot-shift test¹⁵. Twelve patients demonstrated a satisfactory range of motion of the elbow with no significant difference compared with the contralateral elbow. The remaining patient, in whom the repair deliberately had not been over-tightened because of the degree of instability seen intraoperatively, had a decrease of 10° of flexion and 15° of extension. However, that patient did not note any functional disability. Eleven patients had no pain while performing daily activities, and 2 patients had mild pain with activity. The patients had a mean Mayo Elbow Performance Score (MEPS) of 92 points (range, 75 to 100 points). Elbow performance was rated as excellent for 12 patients and as good for 1, according to the MEPS, a validated outcome score. In addition, the results were graded as excellent for 11 patients and as good for 2, according to the Nestor grading system. On the 3-month follow-up MRI, 12 patients had complete healing (Fig. 3); however, 1 patient had incomplete healing, with mild widening of the radiocapitellar joint space, but no symptoms of instability (Fig. 4). At the 3-month follow-up with radiography and CT to evaluate intra-articular fractures, 1 patient had a delayed union and 1 had pin-site irritation, which had resulted from arthroscopic fixation of a coronoid fracture but completely resolved after the pin was removed. At the final follow-up examination, no significant difference in muscle strength was found between the involved elbow and the contralateral elbow in any patient.

Fig. 3

Fig. 4

Fig. 3 T2-weighted coronal MRI scans showing a complete tear of the LUCL (white arrows) preoperatively (**Fig. 3-A**) and complete ligament healing at 3 months postoperatively (**Fig. 3-B**).

Fig. 4 T2-weighted coronal MRI scans showing a complete tear of the LUCL (white arrows) preoperatively (**Fig. 4-A**) and incomplete ligament healing with mild widening of the radiocapitellar joint space at 3 months (**Fig. 4-B**).

Pitfalls & Challenges

- Arthroscopy of the acutely injured elbow demands speed and precision, as tearing of the capsule allows fluid extravasation and swelling. A concrete preoperative plan must be formulated and followed with adjustments made for arthroscopic findings.
- The portals are close to the neurovascular structures surrounding the elbow. It is crucial to have a thorough understanding of the anatomic structures around the elbow and for the portals to be placed precisely.
- During evacuation of the hematoma, great care is taken not to resect or damage the LCL complex.
- Intra-articular fractures should be treated arthroscopically before the LCL-complex repair because the intra-articular space becomes narrower in a stable joint after the LCL complex repair.
- It is important that the spinal needle for shuttle relay be passed through the radial head portal to penetrate the LCL-complex stump exactly.
- Fix the FiberWire using a knotless anchor at the footprint of the anatomic humeral attachment of the LCL complex after gently decorticating the footprint of the LCL complex with a burr or shaver.

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