Arthroscopic Reinsertion of Lateral Collateral Ligament, Anterior Capsular Plication, and Coronoid Tunneling Technique for Chronic Elbow Posterolateral Rotatory Instability

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Abstract: Posterolateral rotatory instability (PLRI) of the elbow is a chronic condition that results from lateral collateral ligament complex injury and presents with pain, clicking, and subluxation within the flexion and extension arcs of elbow motion. The primary cause involves a lesion of the lateral collateral ligament complex and its avulsion from the lateral epicondyle. In most cases, it is the result of trauma such as a fall on an outstretched hand or any other mechanism that imparts axial compression, valgus force, and supination. Several surgical techniques have been described for the treatment of PLRI, but there is no consensus regarding the ideal surgical treatment. The advantages of an arthroscopic approach for the treatment of PLRI are first diagnostic. Arthroscopy allows for visualization and diagnosis of every compartment of the elbow. The main steps of the surgical procedure consist of reinsertion of the lateral collateral ligament, anterior capsular plication, and coronoid tunneling. By use of this technique, it is possible to perform an anatomic repair and provide stability of the elbow.

Posterolateral rotatory instability (PLRI) of the elbow consists of an initial injury to the lateral ulnar collateral ligament (LUCL) that leads to a transient external rotatory subluxation of the ulna with respect to the humerus, made possible by posterior and valgus displacement.[1] Over the years, PLRI has become a formal and recognizable clinical entity and represents the most common instability pattern in the elbow, in particular with chronic symptoms.[2] Cadaveric studies have supported the theory that the lateral collateral ligament (LCL) complex, comprising the radial, ulnar, and annular bands, is responsible for PLRI.[3-5] Diagnosing PLRI is not always easy, and patients often present with nonspecific symptoms.[6] Several open and arthroscopic surgical treatments have been proposed over the years, but a lack of consensus remains about the best possible treatment.[7,8] The aim of this study is to describe an entirely arthroscopic procedure that involves LCL reinsertion plus anterior capsular plication through a coronoid tunnel for chronic elbow PLRI.

Surgical Technique

Arthroscopic treatment is performed using an axillary block and mild general anesthesia. A pneumatic tourniquet (ATS; Zimmer, Warsaw, IN) is positioned high in the axilla and inflated to 250 mm Hg after limb exsanguination. The patient is placed in a modified lateral decubitus position with the operative arm positioned in 100° of flexion/90° of internal rotation at the level of the shoulder by an arm holder (Smith & Nephew, Andover, MA). The elbow is positioned in 90° of flexion, with the forearm hanging free to gravity. Before establishment of the portals, 30 mL of sterile saline solution is injected to distend the elbow joint through an 18-gauge needle (BD, Franklin Lakes, NJ) inserted through the proximal posterior portal.

The anterior compartment is addressed first. A proximal anteromedial portal (Table 1) is created 2 cm proximal to the medial humeral epicondyle and 1 cm

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Table 1. Arthroscopic Portals

	Landmarks	Indicative Position	Structures at Risk
Posterior portals			
Posterolateral	Olecranon apex Soft spot Epicondyle	2 cm lateral 2 cm proximal	None
Midlateral	Radial head	Soft spot	Articular cartilage
Anterior portals			
Anterolateral	Epicondyle	2 cm proximal and 2 cm anterior	Radial nerve
Anteromedial	Medial epicondyle	2 cm proximal and 2 cm anterior	Median nerve Median artery

anterior to the intramuscular septum. Insertion of a 30° arthroscope (Dyonics; Smith & Nephew) into this portal allows intra-articular diagnostic evaluation. An anterolateral portal is created as well. Visualization then switches to the anterolateral portal (Video 1). A diagnostic evaluation of the anterior joint is performed (Fig 1). From an accessory proximal anteromedial portal, a suture passer (Arthrex, Naples, FL) is introduced and a polydioxanone (PDS) suture (Ethicon, Somerville, NJ) is delivered through the capsule just anterior to the coronoid process (Fig 2). This is repeated twice to obtain an adequate anterior grip. Sutures are then retrieved through the anteromedial portal, and a high-resistance, nonresorbable suture is shuttled to substitute the PDS suture. With the C-arm positioned behind the surgeon, as shown in Figure 3, a limited posterior skin incision is performed. With mindfulness regarding the Kirschner wire (Zimmer), posterior-to-anterior drilling is performed (Fig 4). Care is taken to progress slowly and to check, with the C-arm, the K-wire advancement in order not to pass too far anteriorly. Once the K-wire exits the anterior aspect of the unfractured coronoid process, a 4-mm cannulated drill is advanced over the wire.

Before completion of the knot-tying process, the lateral side of the joint is explored from the posterolateral aspect. The arthroscope is maintained through the posterolateral portal and the instruments through the midlateral portal. If the LCL in its ulnar band is clearly detached from the humerus, a standard 5.0-mm metallic double-loaded anchor (Lupine; DePuy Synthes, Warsaw, IN) is inserted through a percutaneous accessory portal. Sutures are passed through the ligament first introducing a PDS suture shuttled from a needle percutaneously. Both limbs of the PDS suture are then retrieved through the midlateral portal together with a suture from the anchor. At this point, the suture from the anchor is shuttled through the LUCL (Fig 5).

Once the lateral side is secured, an arthroscopic button (EndoButton; Smith & Nephew) is used to perform the knotting of the sutures coming out from the coronoid tunnel (Fig 6). The button will lie on the posterior ulnar cortex at the tunnel exit.

Rehabilitation Protocol

After surgery, the elbow is immobilized in a brace with the forearm in neutral rotation and the elbow at 30° of extension. A 30° to 60° range of motion is allowed after the first 14 days. In the next few weeks, motion is increased 10° to 20° until the functional arc of motion is recovered. At 8 weeks, the brace can be removed for activities of daily living. At approximately

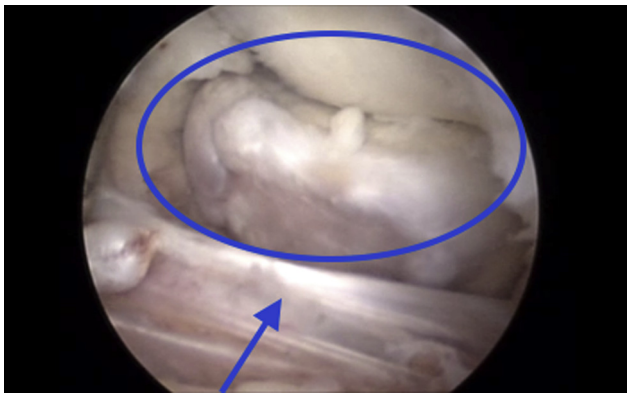

Fig 1. View from the anterior portal with a 30° arthroscope in a right elbow. The arrow shows the complete detachment of the annular ligament from the radial head (oval).

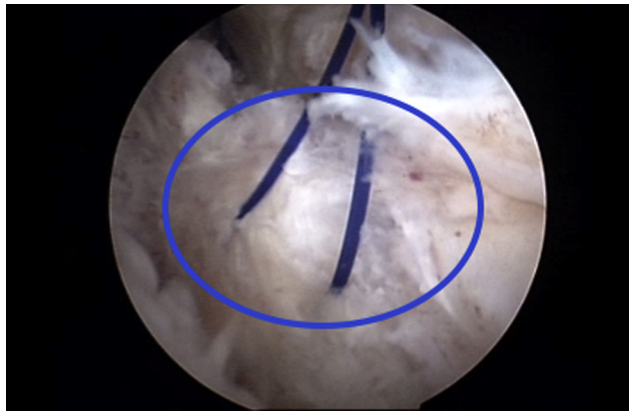

Fig 2. View from the anterior portal with a 30° arthroscope in a right elbow. From an accessory proximal anteromedial portal, a suture passer was introduced and a polydioxanone suture was delivered through the capsule just anterior to the coronoid process. The oval shows the polydioxanone suture passing through the capsule.

Fig 3. The C-arm is positioned behind the surgeon (arrows) to check coronoid tunneling, and a limited posterior skin incision is performed.

12 weeks after surgery, the patient starts strengthening exercises (Table 2).

Discussion

Since the first description of PLRI,[1] several techniques have been described for its treatment. Unfortunately, there is no consensus regarding the ideal surgical

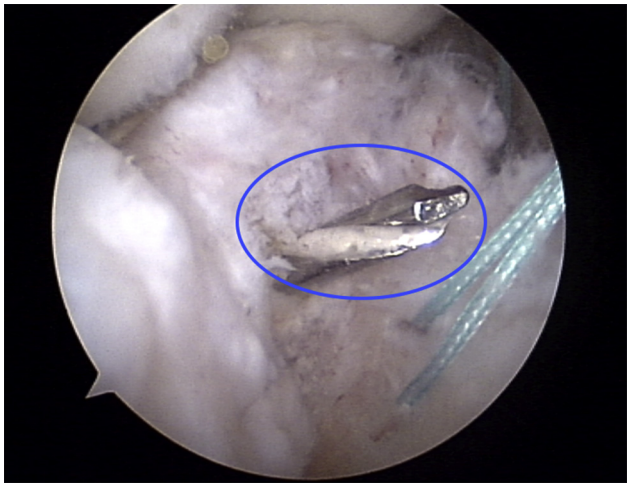

Fig 4. View from the anterior portal with a 30° arthroscope in a right elbow. The position of the K-wire is carefully checked. The K-wire is passed from posterior to anterior, drilling through the coronoid (oval). Care is taken to progress slowly and to check, with the C-arm, the advancement of the K-wire in order not to pass too far anteriorly.

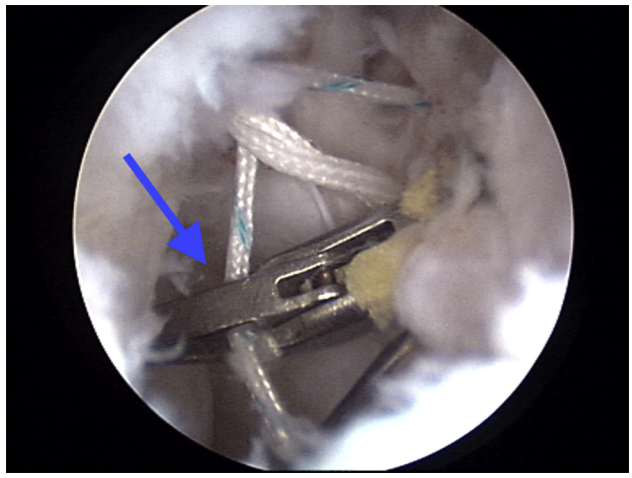

Fig 5. View from the posterolateral portal with a 30° arthroscope in a right elbow. Anchor sutures are retrieved (arrow) through the midlateral portal through the lateral ulnar collateral ligament.

treatment. The initial techniques for soft-tissue reconstruction of the elbow were open procedures. The advantages of an arthroscopic approach for the treatment of PLRI are first diagnostic. Arthroscopy allows the surgeon to visualize and diagnose every compartment

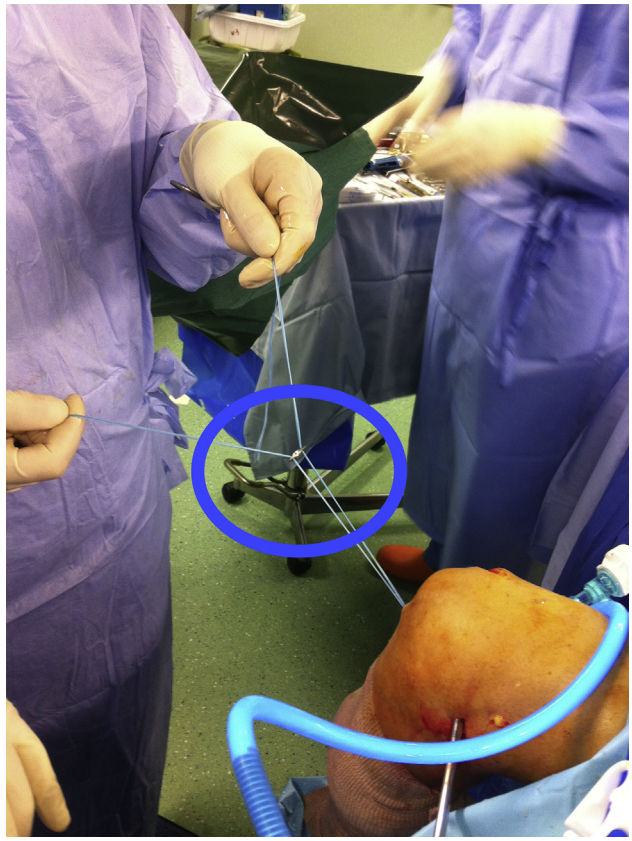

Fig 6. An arthroscopic button is used to perform the knot tying of the suture coming out from the coronoid tunnel. The oval indicates the button used for fixation.

Table 2. Rehabilitation Protocol

Days After Surgery	Protocol
0-14	The elbow is immobilized in a brace with the forearm in neutral rotation and the elbow at 30° of extension.
14-30	A 30° to 60° range of motion is allowed.
30-55	Motion is increased 10° to 20° until the functional arc of motion is recovered.
55-95	The brace can be removed for activities of daily living.
>95	Strengthening exercises are started.

of the elbow. An arthroscopic procedure includes smaller incisions with less soft-tissue dissection, better visualization of the joint, and a direct evaluation of ligament retensioning.

Our technique does not need the use of screws for soft-tissue fixation and does not include harvesting and use of tendon grafts, differently from other techniques, avoiding all the related complications.[9,10] It also enables a reconstruction as anatomic and minimally invasive as possible; this allows patients to have a rapid recovery, and they are able to return as soon as possible to the activities of daily living.[11] Moreover, an arthroscopic approach allows the surgeon to identify and treat minor injuries, such as a lesion of the articular portion of the radial collateral ligament or the annular drive-through, that would not be identifiable with an open procedure.[12]

Lee and Teo[13] performed reconstruction with a tendon graft in 6 elbows and reattachment of the LUCL to the humerus in 4 for clinically symptomatic PLRI of the elbow. They noted that the tendon graft appeared to produce better results than the reattachment of the injured ligament by itself in achieving an excellent outcome. Olsen and Søjbjerg[14] reported a technique for reconstruction and reinforcement of the LCL complex in patients with posterolateral instability of the elbow with a triceps tendon graft from the ipsilateral elbow that was inserted through bone tunnels and fixed with bone anchors augmented the reconstruction.

In 2001, Smith et al.[15] first described an arthroscopic technique to suture the ligaments of the elbow in an anatomic way for the treatment of PLRI. In his study Eygendaal[16] reported a technique using ipsilateral triceps tendon, fixed in drill holes using bioabsorbable interference screws, and showed promising short-term results.

Sanchez-Sotelo et al.[17] in 2005 reported that reconstruction using a tendon graft seems to provide better results than ligament repair and the results do not seem to deteriorate with time. Jones et al.[18] reported good results using a docking technique for reconstruction of the LUCL in patients with PLRI, with a low complication rate.

Lin et al.[19] showed that reconstruction of the LUCL using an autogenous tendon graft is an effective method for patients with PLRI of the elbow. A retrospective study evaluated LUCL reconstruction with autologous palmaris longus tendon graft, concluding that this technique provided reliable and lasting results.[20]

The general risks with our technique are the standard risks for an arthroscopic elbow procedure and more specifically are related to portal management.[21] For the posterolateral portal, the risks are related to piercing the capsule at its insertion into the humerus to avoid interference with arthroscopic viewing. Placement of the midlateral portal is performed in the soft spot of the elbow; in this case it is mandatory to perform the exploration with a needle to search for the correct height, which should be done so that the tools enter parallel or slightly inclined with respect to the radial head. A useful tip is to enter toward the radioulnar joint instead of the radiocapitellar joint to reduce the risk of iatrogenic injury to the articular cartilage. For the anteromedial portal, it is fundamental not to pierce the intermuscular septum because of the risk of encountering the ulnar nerve (the nerve identification makes this portal safer). The same care must be used, passing as close as possible to the bone surface, to pass under the brachialis muscle, which protects against iatrogenic lesions of the median nerve and vascular structures. Finally, the anterolateral portal is probably the most dangerous portal, given the proximity of the radial nerve to the joint capsule, especially in correspondence with the radial head. For this reason, we recommend performing placement of this portal with an out-in technique, controlling the position with the optics from the anteromedial portal (Table 3).

Specific attention has to be taken during coronoid tunneling. If the tunnel is too proximal, there is a risk of a fracture of the tip of the coronoid. If it is too distal, visualizing the K-wire exit may be difficult and the K-wire could be advanced through the brachialis muscle, where the artery and median nerve are at great risk.

Table 3. Pearls and Pitfalls

Pearls
A proximal incision (close to the epicondyle/medial epicondyle) will make it difficult (and sometimes impossible) to enter the articulation and view or work in the anterior chamber.
A distal incision makes the portal more dangerous regarding iatrogenic neurovascular injury.
Pitfalls
The surgeon must not suture the capsule too low; doing so can cause stiffness of the joint.
Care must be taken not to place the tunnel too proximally to avoid a fracture of the tip of the coronoid.
If the K-wire exits too distally, it will be difficult to visualize, and if it is advanced through the brachialis muscle, it will be too close to the artery and median nerve.

Our technique has some limitations: It is a demanding technique with numerous risks, and only surgeons experienced in arthroscopic elbow surgery should perform it; moreover, the indications must be limited to those patients who report pain and instability for a long period and are unresponsive to conservative treatments such as physical therapy. To properly perform the technique, instrumentation appropriate for its execution is fundamental.

We have performed the described arthroscopic technique for about 18 months and have treated 4 patients. Thus far, our patients have not presented with intraoperative or postoperative complications. None of the patients have had more episodes of PLRI, and all have reported a high level of satisfaction with the surgical procedure. All patients have returned to normal daily activities, and 1 has resumed the sport in which the patient participated before intervention.

References

1. O'Driscoll SW, Bell DF, Morrey BF. Posterolateral rotatory instability of the elbow. *J Bone Joint Surg Am* 1991;73:440-446.
2. O'Driscoll SW. Classification and evaluation of recurrent instability of the elbow. *Clin Orthop Relat Res* 2000;(370):34-43.
3. Dunning CE, Zarzour ZD, Patterson SD, Johnson JA, King GJ. Ligamentous stabilizers against posterolateral rotatory instability of the elbow. *J Bone Joint Surg Am* 2001;83:1823-1828.
4. McAdams TR, Masters GW, Srivastava S. The effect of arthroscopic sectioning of the lateral ligament complex of the elbow on posterolateral rotatory stability. *J Shoulder Elbow Surg* 2005;14:298-301.
5. Takigawa N, Ryu J, Kish VL, Kinoshita M, Abe M. Functional anatomy of the lateral collateral ligament complex of the elbow: Morphology and strain. *J Hand Surg Br* 2005;30:143-147.
6. Ahmed I, Mistry J. The management of acute and chronic elbow instability. *Orthop Clin North Am* 2015;46:271-280.
7. O'Brien MJ, Savoie FH III. Arthroscopic and open management of posterolateral rotatory instability of the elbow. *Sports Med Arthrosc* 2014;22:194-200.
8. Anakwenze OA, Kwon D, O'Donnell E, Levine WN, Ahmad CS. Surgical treatment of posterolateral rotatory instability of the elbow. *Arthroscopy* 2014;30:866-871.
9. Wong R, Alam N, McGrouther AD, Wong JK. Tendon grafts: Their natural history, biology and future development. *J Hand Surg Eur Vol* 2015;40:669-681.
10. Kupperman E, Franko O, Indresano A, Girard P. Cannulated screw unraveling: A case series and literature-based review of an under-recognized complication. *Arch Orthop Trauma Surg* 2013;133:65-67.
11. Reuter S, Proier P, Imhoff A, Lenich A. Rehabilitation, clinical outcome and return to sporting activities after posterolateral elbow instability: A systematic review. *Eur J Phys Rehabil Med* January 15, 2016. [Epub ahead of print.].
12. Arrigoni P, D'Ambrosi R, Randelli P. Arthroscopic treatment of annular drive through and radial lateral collateral ligament articular-side tear of the elbow. *Arthrosc Tech* 2015;4:e647-e650.
13. Lee BP, Teo LH. Surgical reconstruction for posterolateral rotatory instability of the elbow. *J Shoulder Elbow Surg* 2003;12:476-479.
14. Olsen BS, Søjbjerg JO. The treatment of recurrent posterolateral instability of the elbow. *J Bone Joint Surg Br* 2003;85:342-346.
15. Smith JP III, Savoie FH III, Field LD. Posterolateral rotatory instability of the elbow. *Clin Sports Med* 2001;20:47-58.
16. Eygendaal D. Ligamentous reconstruction around the elbow using triceps tendon. *Acta Orthop Scand* 2004;75:516-523.
17. Sanchez-Sotelo J, Morrey BF, O'Driscoll SW. Ligamentous repair and reconstruction for posterolateral rotatory instability of the elbow. *J Bone Joint Surg Br* 2005;87:54-61.
18. Jones KJ, Dodson CC, Osbahr DC, et al. The docking technique for lateral ulnar collateral ligament reconstruction: Surgical technique and clinical outcomes. *J Shoulder Elbow Surg* 2012;21:389-395.
19. Lin KY, Shen PH, Lee CH, Pan RY, Lin LC, Shen HC. Functional outcomes of surgical reconstruction for posterolateral rotatory instability of the elbow. *Injury* 2012;43:1657-1661.
20. Vernet E, Bacle G, Marteau E, Favard L, Laulan J. Lateral elbow ligamentoplasty by autologous tendon graft in posterolateral rotatory instability: Results in 18 cases at a mean 5 years' follow-up. *Orthop Traumatol Surg Res* 2015;101:S199-S202.
21. Adams JE, King GJ, Steinmann SP, Cohen MS. Elbow arthroscopy: Indications, techniques, outcomes, and complications. *Instr Course Lect* 2015;64:215-224.