Technical Note

Arthroscopic-Assisted Lateral Ulnar Collateral Ligament Reconstruction for Posterolateral Rotatory Instability of the Elbow: A Technical Note

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Abstract: The lateral collateral ligament complex of the elbow is pivotal for maintaining the stability of the elbow joint. The open technique for reconstructing the lateral ulnar collateral ligament (LUCL) is a standard procedure to treat elbow instability caused by LUCL deficiency. Nevertheless, as arthroscopy procedures in the elbow have advanced, we describe an arthroscopic technique to reconstruct the LUCL with suture anchors and bone tunnel techniques.

Posterolateral rotatory instability (PLRI) of the elbow is the most common pattern of chronic instability in the elbow joint, which generally refers to insufficiency of the lateral ulnar collateral ligament (LUCL) complex.[1] LUCL injury can be caused by multiple injury mechanisms, such as trauma, deformity, or iatrogenic injury, following lateral elbow surgery.[2,3] Numerous open surgical techniques for LUCL have been described, which vary in graft source, graft configuration, and fixation modality.[1,4] Jones et al.[5] first described the docking technique in 2012, and it is now the most widely used open approach for LUCL reconstruction. In recent years, elbow arthroscopy has significantly progressed because of technological advancements and surgical skills. Recent studies on arthroscopic lateral collateral ligament repair have shown positive clinical and radiologic results and high patient satisfaction after arthroscopic repair.[6] However, an arthroscopic-assisted technique for LUCL reconstruction has yet to be developed. We present a Technical Note for arthroscopic-assisted LUCL reconstruction for patients with PLRI (see Video 1).

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Surgical Technique

Patient Setup and Preparation

Under general anesthesia, the patient is placed in the lateral decubitus position on the operating table. A preoperative assessment of the elbow instability is performed, including valgus stress and lateral pivot-shift tests. The arm is fixed to a padded support with the shoulder abducted at 90° and the elbow positioned at 90°, allowing the forearm to hang freely. A sterile tourniquet is placed and inflated to 250 mm Hg. The water pump pressure is 30 mm Hg.

Portal Establishment and Arthroscopic Assessment

The bony and soft tissue landmarks are determined and marked prior to the operation. The "soft spot" (i.e., mid-lateral portal) is identified as the center of the triangle interval formed by the olecranon tip, lateral epicondyle, and radial head (Fig 1). A 20-mL normal saline solution is administered to distend the elbow joint for insufflation using an 18-gauge needle inserted via the "soft spot." The proximal anteromedial portal is established at 2 cm proximal to the medial epicondyle and 1 to 2 cm anterior to the medial intermuscular septum for diagnostic arthroscopy of the anterior compartment (Fig 1). With a 4.5-mm, 30° arthroscope, an arthroscopic diagnosis involves the examination of elbow laxity and any concomitant pathologies or injuries, such as plica

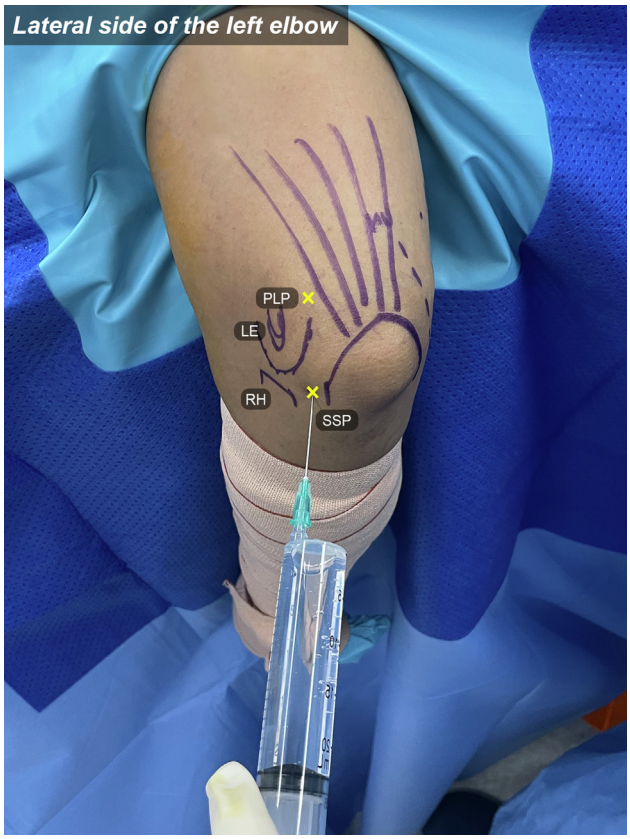

Fig 1. Setup and portals for arthroscopy. The patient is in the lateral decubitus position, with the left elbow positioned at 90°. Yellow crosses indicate the portals: the soft spot portal and the posterolateral portal. Then, 20 cc of saline is injected into the soft spot portal for insufflation. (LE, lateral epicondyle; PLP, posterolateral portal; RH, radial head; SSP, soft spot portal.)

syndrome and lateral epicondylitis (Fig 2).[3,7] The concomitant pathologies can be addressed after establishing the posterolateral working portal. The proximal posterolateral portal is established at 2 to 3 cm proximal to the tip of the olecranon on the lateral edge of the triceps tendon to visualize the posterolateral compartment. In PLRI, a "drive-through sign" is observed. This typical sign indicates that the scope will be able to be fully advanced through the radiocapitellar joint into the anterior joint compartment, allowing for a visible view of the anterior rim of the radial head. In addition, the medial trochlear is visualized through the posterolateral viewing portal, described as the "medial trochlear sign" (Fig 3).[3]

It is essential to conduct arthroscopic instability testing to confirm the diagnosis of LUCL deficiency and to determine the necessity for LUCL reconstruction prior to the reconstruction procedure.[8]

Graft Harvest and Preparation

An intraoperative diagnosis is performed to ensure that the ipsilateral palmaris longus tendon exists. A 1-cm incision is made over the distal wrist crease, and a tendon stripper is used to harvest the palmaris longus tendon with a 15- to 20-cm length. An assisting surgeon prepares the graft using a whipstitch running suture with a 5-0 Ethibond (Ethicon) suture at both free ends (Fig 4).

Ulnar Tunnel Preparation

Based on the landmark for the ulnar tunnel, located at the supinator crest, distal from the proximal margin of the radial head,[9] a 2-cm incision is made at the posterior ulna at the level of the radial neck (Fig 5). A double-strand LUCL reconstruction is conducted. The ulnar tunnel is created by drilling two 2.2-mm-diameter tunnels convergently with a 1- to 1.5-cm osseous bridge (Fig 6). The distal bone tunnel is first created 15 mm distal from the proximal margin of the radial head (approximately at the level of the radial neck) and immediately proximal to the supinator crest, according to a study based on previous computer model studies.[10] The second bone tunnel is created proximally and posteriorly to the first one, with at least a 1- to 1.5-cm-width bony bridge reserved between the 2 holes. A cerclage or looped stiff FiberWire (Arthrex) is passed through the tunnel to assist graft shuttling.

Humeral Tunnel Preparation

After the ulnar tunnel has been created, preparation of the humeral tunnel commences by making an incision centered at the lateral epicondyle. The humeral attachment of the graft is at the center of the capitellum to get an isometric reconstruction that ensures consistent stress over the whole range of the flexion-extension arc.[9] The isometric point on the capitellum for suture anchor insertion is confirmed under the intraoperative image intensifier (Fig 7). After removing soft tissue from the subchondral bone of the lateral epicondyle, a 3.0-mm knotless bioabsorbable suture anchor (Smith & Nephew) is inserted into the chosen isometric point on the lateral epicondyle. After inserting the guide into the predetermined isometric point, a 2.4-mm drill hole is created. Then, the suture anchor, with a single-strand No. 2-0 FiberWire (Arthrex) repair suture attached to the anchor, is placed through the guide into the drilled hole and impacted with a mallet. Double strands of the palmaris longus graft are secured to the suture anchor with a sliding knot (Fig 8).

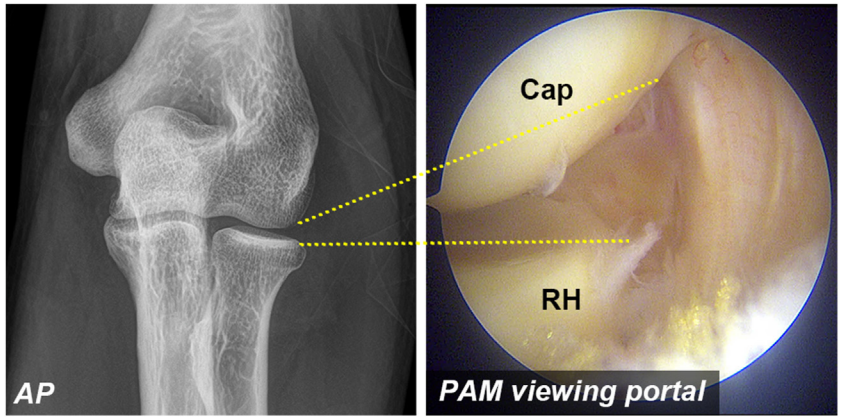

Fig 2. Arthroscopic assessment of posterolateral rotatory instability and elbow joint laxity for the left elbow in the lateral decubitus position. The viewing portal is through the proximal anteromedial portal. A widening joint space can be observed, consistent with results from preoperative stress radiography. (AP, anteroposterior view; Cap, capitellum; PAM, proximal anteromedial; RH, radial head.)

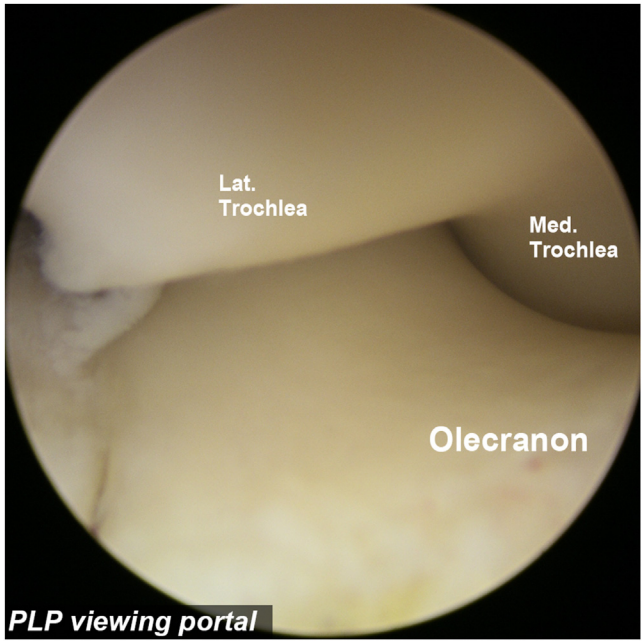

Fig 3. Arthroscopic assessment of ulnohumeral joint laxity for the left elbow in the lateral decubitus position. The "medial trochlea" sign can be seen through the posterolateral viewing portal in an elbow with posterolateral rotatory instability, particularly with ulnohumeral joint laxity, given the severe lateral collateral ligament deficiency. (Lat. Trochlea, lateral trochlea; Med. Trochlea, medial trochlea; PLP, posterolateral portal.)

Graft Passing and Fixation

A spinal needle loaded with No. 1 polydioxanone suture (PDS, Ethicon) is passed through from the ulnar tunnel into the posterolateral compartment in advance to assist with subsequent graft shuttling with the shuttle relay technique. The 2 free limbs of the graft are shuttled through the soft spot portal (Fig 9).

The graft is shuttled through the ulna with a tunnel shuttle relay technique under direct vision from the arthroscope through the posterolateral portal. At the same time, the surgeon checks the graft's position under arthroscopy to ensure that the graft sits at the posterior side of the radial head (Fig 9). Following the graft passage, the 2 free-end limbs are retrieved from the soft spot portal. One limb is passed through the predrilled ulnar tunnel. The graft is cycled, tensioned, and fixed at the elbow with 90° of flexion in neutral rotation (Fig 9). The 2 ends of the graft are sutured together using 1-0 Ethibond (Ethibond Excel; Ethicon) for augmentation (Fig 8). The arthroscope is reinserted into the posterolateral portal, with the drive-through sign and the medial trochlear sign disappearing after surgery. Then, the wound is closed in layers.

Postoperative Rehabilitation

Postoperatively, the elbow is immobilized for 3 weeks with a long-arm splint, and then active-assisted elbow flexion exercises are performed. Elbow flexion from 60° to 120° is allowed, but the extension should be limited during the first month. Activities including varus gravity motion should be avoided in the first 6 weeks. The range of motion gradually (ROM) progresses, aiming to achieve complete ROM within 2 months after the surgery.

Discussion

Surgical reconstruction of the LUCL is a dependable method in individuals with LUCL insufficiency. Reconstruction of the LUCL remains the primary treatment strategy for chronic PLRI. An arthroscopic LUCL reconstruction is an adaptation to the previously well-described open LUCL reconstruction by O'Driscoll et al.[11] A few advantages exist for an arthroscopic approach to LUCL reconstruction, including reduced tissue resection (Table 1). There are 3 advantages of arthroscopic LUCL reconstruction based on the capacity of arthroscopic technology to provide adequate visualization of the lateral glenohumeral joint: (1) it indicates the severity of the

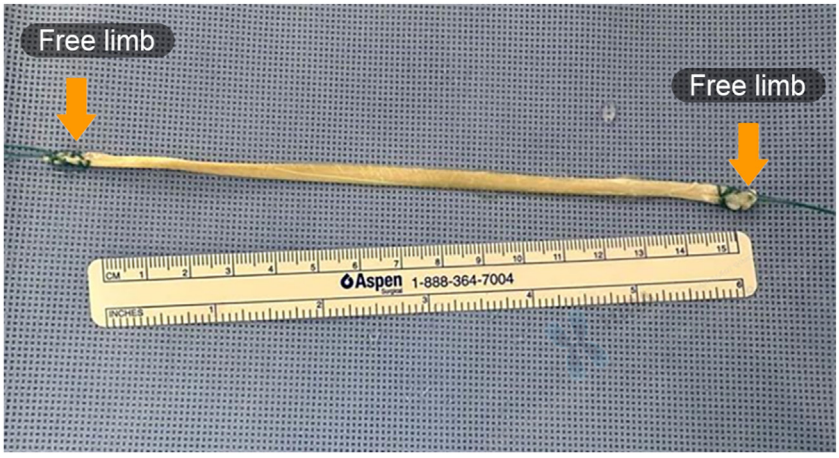

Fig 4. Graft preparation. The ipsilateral palmaris longus tendon is harvested as a graft and prepared to facilitate its easy passage through the 2.2-mm-diameter ulnar tunnel. Each of the 2 free limbs is sutured using a whipstitch-running suture technique with 5-0 Ethibond (Ethicon).

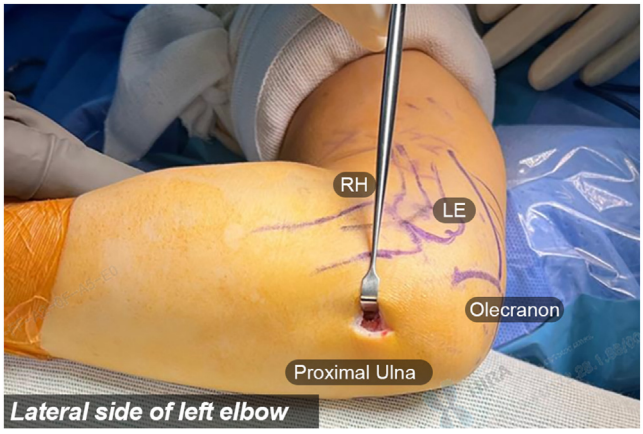

Fig 5. Small incision at the posterior ulna of the left elbow in the lateral ducubitus position. Before creating the ulnar tunnel, a 2-cm incision is made on the posterior ulna at the radial neck level. (LE, lateral epicondyle; RH, radial head.)

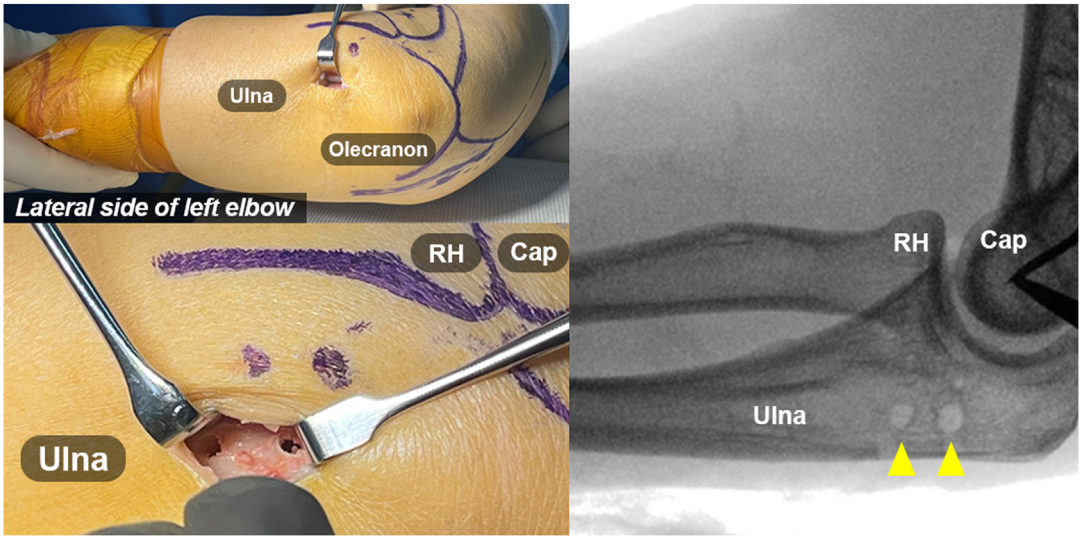

Fig 6. Ulnar tunnel creation on the left elbow in the lateral decubitus position. Two 2.2-mm-diameter convergent ulnar tunnels are made with a 1- to 1.5-cm osseous bridge reserved. On the intraoperative image intensifier of the left elbow, tunnels and bony bridges are visible (marked by yellow triangles). (Cap, capitellum; RH, radial head)

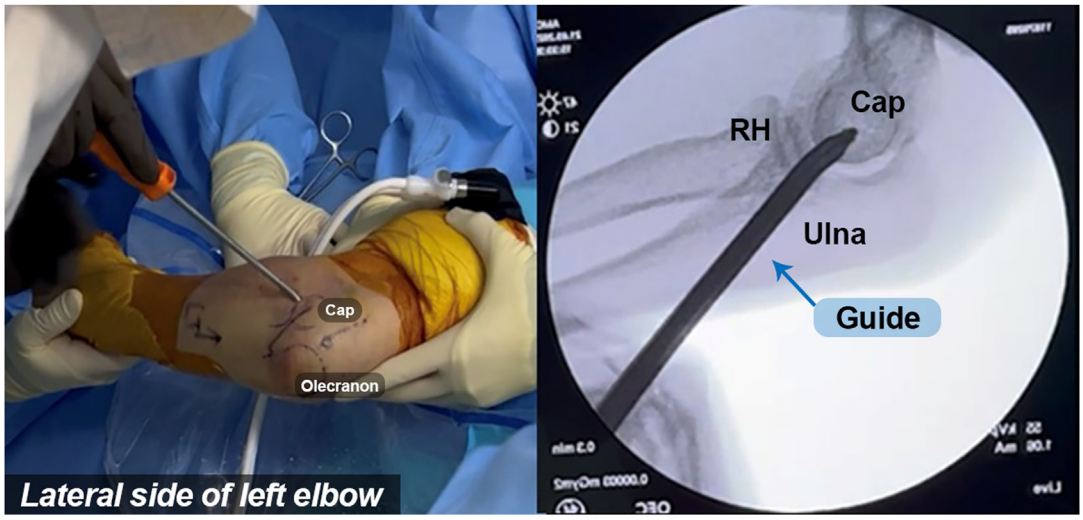

Fig 7. The isometric point on the capitellum of the left elbow in the lateral decubitus position. In humeral tunnel preparation, the intraoperative image intensifier is used to determine the isometric point on the capitellum. (Cap, capitellum; RH, radial head.)

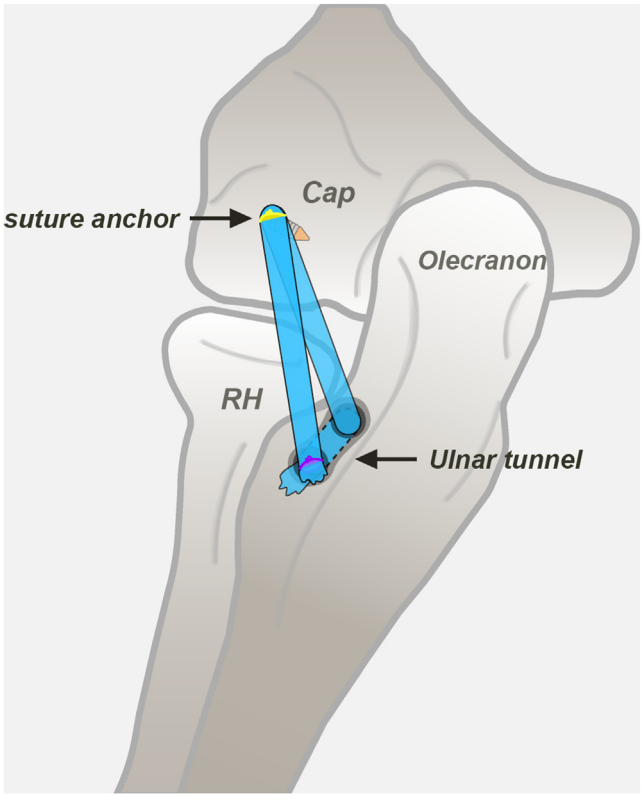

Fig 8. Illustration of the graft fixation method (e.g., a left elbow in the lateral decubitus position). On the humeral side, the double-stranded palmaris longus graft is secured to the suture anchor using a sliding knot. On the ulnar side, the 2 free limbs are sutured together and secured with a knot. (Cap, capitellum; RH, radial head.)

elbow instability, which can further clarify the indications for LUCL reconstruction to avoid in case of unclear diagnosis; (2) it can detect any associated lesions such as scar tissue, loose bodies, heterotopic ossification, and lateral epicondylitis; and (3) it can visualize the width of the lateral ulnohumeral joint space immediately and directly to verify the efficient tension of passed graft.[1,3] Arthroscopic LUCL reconstruction uses a posterolateral viewing portal, which replaces the posterolateral approach in an open manner, and this can present the anconeus muscle, an essential dynamic lateral stabilizer of the elbow joint. Furthermore, minimizing surgical dissection is crucial to avoid affecting the proprioception of the elbow joint.[12]

The most common concerns from surgeons about this technique are the determination of tunnel location and proper graft tension (Table 2). The bone tunnel location will primarily dictate the survivorship of the joint, which serves as a critical step in this technique. The graft tensioning should be performed to avoid overtension as it can limit the ROM exercise in the early postoperative period.

In conclusion, arthroscopic LUCL reconstruction using palmaris longus autograft is an option for traditional open LUCL reconstruction in treating PLRI. It provides less insult and dissection to the soft tissue at the lateral side of the elbow while being an excellent tool to diagnose any concomitant intra-articular pathologies. However, the demanding

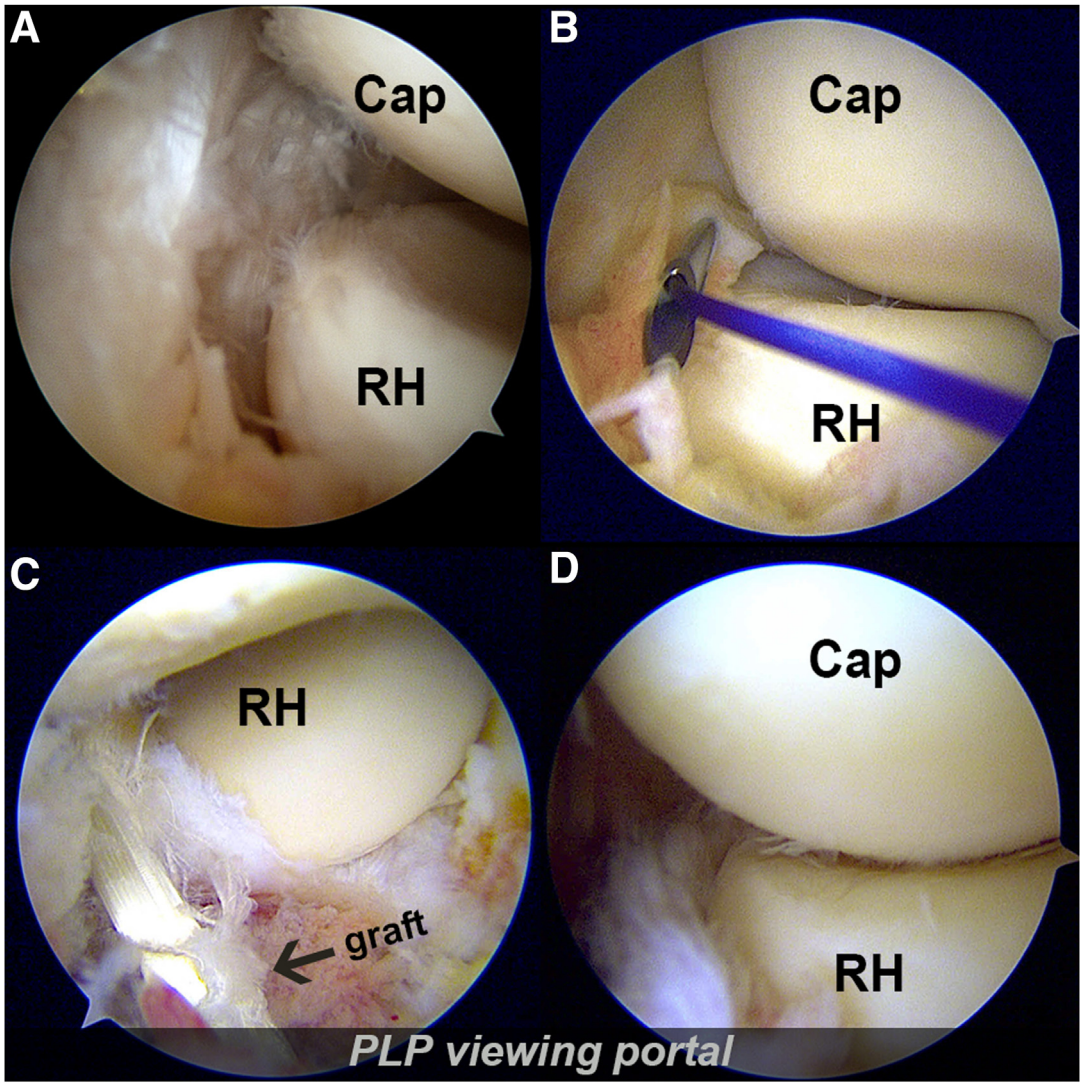

Fig 9. Arthroscopic view of the left elbow in the lateral decubitus position shows the process of graft passage from the posterolateral viewing portal. (A) The radiocapitellar joint gap widening can be observed before the lateral ulnar collateral ligament reconstruction. (B) A spinal needle loaded with No. 1 polydioxanone suture (PDS, Ethicon) is passed through from the ulnar tunnel and inserted into the posterolateral compartment of the elbow joint. (C) The graft sits at the posterior side of the radial head with the shuttle relay technique. (D) After graft passage and fixation, the joint space is reduced after tensioning the graft. (Cap, capitellum; PLP, posterolateral portal; RH, radial head.)

Table 1. Advantages and Disadvantages of Arthroscopic LUCL Reconstruction

Advantages	Disadvantages
1. Adequate visualization of the anterolateral and posterolateral compartments	1. Donor site morbidities compared to nonreconstruction techniques such as imbrication
2. Thorough arthroscopic assessment to determine the level of elbow instability and concomitant pathologies	2. Overtension of the graft can interfere with ROM exercise in the early postoperative period
3. Accurate determination of the humeral attachment site to obtain an isometric LUCL reconstruction by using the intraoperative image intensifier	3. Technically demanding because of the necessity of experience in posterolateral compartment work
4. Less soft tissue dissection because of its arthroscopic manner	4. Determination of the ulnar and humeral footprint necessitates the use of an image intensifier
5. No irritation from the suture knot compared to the non-reconstruction technique	
6. More robust constructs compared to nonreconstruction technique	
7. No insult to the anconeus muscle as part of the lateral stabilizer of the elbow	
8. Used in patients with inadequate tissue for repair	

LUCL, lateral ulnar collateral ligament; ROM, range of motion.

Table 2. Pearls and Pitfalls

1. Determination of both humeral and ulnar footprints should be performed under an image intensifier to ensure optimal placement.
2. The graft should be placed at the posterior side of the radial head.
3. Eliminating the medial trochlear sign is key to a sufficient lateral collateral ligament complex reconstruction as the ulna-humeral joint is tightened.

technique necessitates a long learning curve and experience to work at the posterolateral compartment.

Disclosures

All authors (J.G., E.K., H.B., I-H.J.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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