Technical Note

Arthroscopic Extra-articular Ulnar Nerve Release in the Setting of Stiff Elbow

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Abstract: Elbow stiffness can severely affect a patient's quality of life. If conservative treatment is ineffective, surgical treatment including open or arthroscopic release could be applied. With the advantages of being minimally invasive, reducing pain and scars, accelerating early rehabilitation, and so on, arthroscopic release has increased in popularity compared with open surgery over the years, whereas limiting factors such as the close proximity of the neurovasculature to the working field and narrow working space still have to be faced by the elbow arthroscopist, with an increasing risk of iatrogenic injury with portal creation and operations adjacent to the nerves and vessels. When elbow arthritis occurs concomitantly with cubital tunnel syndrome, osteophytes on the medial ridge of the olecranon and trochlea occur as obstacles to the elbow extending or the posterior bundle of the medial collateral ligament has to be released for extension contractures, and open procedures for the medial gutter are routinely performed. To reduce the risk of injury and produce even less scar tissue, we present a surgical technique applicable to posteromedial elbow pathology by 2 medial portals. Through this technique, the entire course of the ulnar nerve is exposed and released under arthroscopy, with the ulnar nerve retracted medially, and medial gutter osteophytectomy and soft-tissue release can freely proceed.

A stiff elbow that limits elbow motion is common in traumatic and degenerative diseases of the elbow, with flexion-extension contracture being more common than forearm rotation contracture.[1,2] Conservative treatment of elbow stiffness including mobilization, physiotherapy, and dynamic splinting is suitable for patients with mild contracture.[3-6] If conservative treatment is ineffective, surgical treatment is the most appropriate choice. Although good functional outcomes can be equally achieved by open surgery and arthroscopic surgery, arthroscopy has the advantages of being minimally invasive, improving joint visualization, reducing pain, reducing scars, accelerating early rehabilitation, and shortening the hospital stay, whereas open surgery does not.[1-3,7-12]

Arthroscopic procedures of the elbow are challenging owing to the close proximity of the neurovascular structures to the working field and narrow space. In addition, the superficial position of the ulnar nerve and arthroscopic posteromedial gutter procedures make the nerve susceptible to iatrogenic injury. To avoid iatrogenic nerve injury, ulnar nerve exposure is routinely performed by the posteromedial mini-open technique rather than arthroscopic technique, as well as medial gutter procedures such as osteophytectomy, in addition to soft-tissue resection for extension contractures.

Elbow stiffness may be combined with ulnar nerve neuropathy typically as cubital tunnel retinaculum ossification or elbow arthritis, in which the degenerative osteophytes on the medial ridge of the olecranon and retinaculum could decrease the cubital tunnel volume. Gelberman et al.[13] showed that the cubital tunnel cross-sectional area would decrease and the intraneural pressure would increase when moving the elbow from full extension to 130° of flexion in a cadaveric study; thus, patients with chronic extension contracture who underwent elbow release but without cubital tunnel release would be more susceptible to ulnar nerve compression.

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Many endoscopic techniques have been described for the management of the ulnar nerve,[14-17] and arthroscopic decompression of the ulnar nerve in a stiff elbow could be consistent with endoscopic decompression of the ulnar nerve for cubital tunnel syndrome, with the same advantages of a shorter incision, reduced nerve manipulation, smaller dissection, and faster recovery. Our aim is to help define a safe arthroscopic technique for ulnar nerve decompression and to facilitate the management of the posteromedial elbow gutter with the ulnar nerve being retracted under direct visualization by a stiff elbow release procedure.

Surgical Technique

The surgical technique is shown in Video 1.

Indications and Preoperative Planning

Arthroscopy is appropriate in the following situations: failure of conservative treatment for at least 6 months, stiffness of the elbow affecting daily work and life, confirmation of the presence of elbow joint space on radiographs or computed tomography scans, and reduction of joint motion. If the elbow space disappears, bone bridge formation or articular incongruence is present, or medial elbow surgery was previously performed, open surgery is easier and has fewer complications.[8]

Preoperative ultrasound is performed to confirm the route of the ulnar nerve, and patients with ulnar nerve instability or snapping medial triceps are excluded from undergoing the described technique. If accompanied by ulnar nerve symptoms, elbow joint ultrasound can be used to determine the degree of nerve compression, nerve shape, and so on. Patients with mild ulnar neuritis who do not require anterior transposition can be treated with arthroscopic ulnar nerve decompression as described in this article. Preoperative 3-dimensional computed tomography reconstruction of the elbow is applied, and if collateral ligament injury is suspected, magnetic resonance imaging can be used to further clarify the degree of soft-tissue damage.

Patient Positioning and Setup

Under general anesthesia, the patient is placed in the lateral decubitus position. An unsterilized pneumatic tourniquet is placed on the proximal end of the affected upper arm, and the proximal one-third of the upper arm and the tourniquet are firmly stabilized together on a padded arm holder, which is fixed to the table side. The arm holder is raised to make the elbow joint slightly higher than the shoulder to allow greater elbow flexion, as well as facilitate instrument insertion and access to the elbow (Fig 1).

The surgical area is prepared and draped, and the distal forearm is wrapped with a bandage applied outside to minimize irrigation fluid diffusion. At the beginning of the surgical procedure, the tourniquet is inflated to 250 mm Hg, and the ischemic time is less than 90 minutes.[18-20]

Exposure

The medial epicondyle, olecranon, ulnar nerve location, and arthroscopic portal sites for arthroscopic arthrolysis are localized and marked (Fig 2). Posteromedial double-approach incisions that run along the ulnar nerve course at a distance of 2.5 cm above and below the medial epicondyle are made with a No. 11 scalpel blade.

Arthroscopic Extra-articular Ulnar Nerve Release and Arthrolysis for Stiff Elbow

A standard 4- or 2.7-mm 30° arthroscope is used. A blunt-tip trocar and a switching stick are introduced separately from the 2 posteromedial portals to bluntly dissect the subcutaneous soft tissue (Fig 3). After preliminary subcutaneous space is created, the scope is inserted from the proximal posteromedial portal, which is used as the viewing portal. Under direct visualization, a 4.0-mm full-radius shaver (Arthrex, Naples, FL) or bipolar vacuum radiofrequency (RF) device (Coolpulse 90 Electrode; DePuy Mitek, Raynham, MA) is introduced from the distal posteromedial portal to further expand the subcutaneous working space proximally and distally (Fig 4). The cubital tunnel retinaculum and the proximal part of the ulnar nerve are exposed, and the proximal ulnar nerve is

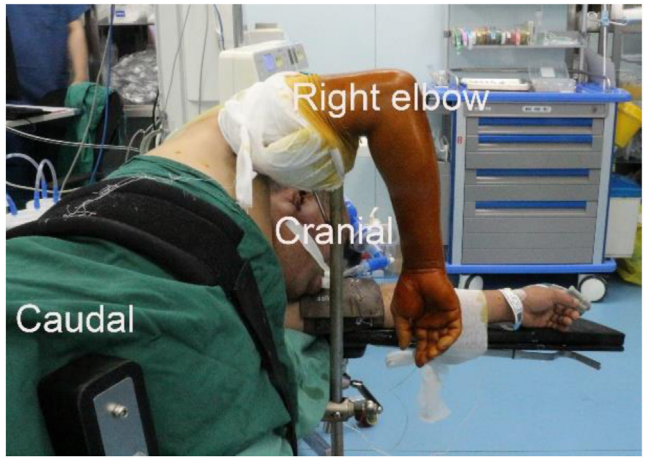

Fig 1. Patient positioning in right elbow case. The procedure is performed with the patient in the lateral decubitus position under general anesthesia. An unsterilized pneumatic tourniquet is placed on the proximal end of the affected upper arm, and the proximal one-third of the upper arm and the tourniquet are firmly stabilized together on a padded arm holder, which is fixed to the table side. The arm holder is raised to make the elbow joint slightly higher than the shoulder to allow free elbow flexion, as well as facilitate instrument insertion and access to the elbow.

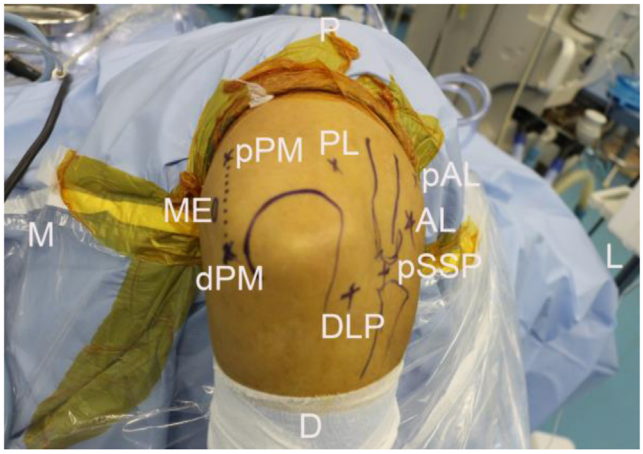

Fig 2. Landmarks and portals in right elbow case. The medial epicondyle (ME, oval), ulnar nerve location (dotted line), olecranon, lateral column of the distal humerus, and proximal radius are outlined. The arthroscopic portal sites are localized and marked, including the proximal posteromedial (pPM) portal, distal posteromedial (dPM) portal, posterolateral (PL) portal, anterolateral (AL) portal, proximal anterolateral portal (pAL), direct lateral portal (DLP), and "soft-spot" portal (pSSP). The posteromedial double approaches running along the ulnar nerve course at a distance of 2.5 cm above and below the medial epicondyle are also marked. The anteromedial portal is made variably using the in-outside-in technique by the anterolateral portal, so it is not marked. The proximal posterolateral portal for the posterior compartment retractor is also not marked in this case. (D, distal; L, lateral; M, medial; P, proximal.)

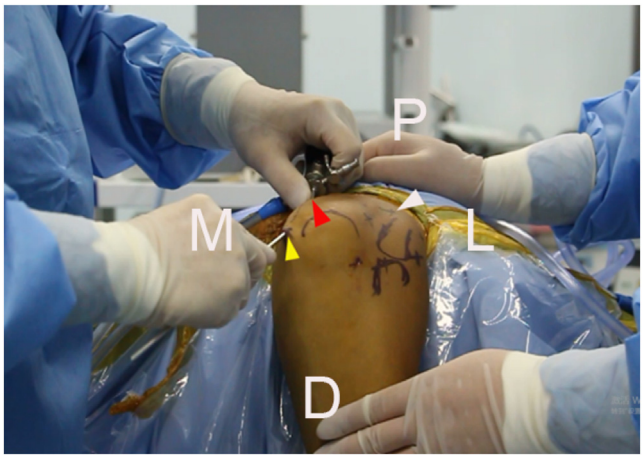

Fig 3. Creation of dual medial portals in right elbow case. A blunt-tip trocar with sheath (red arrowhead) and a straight blunt switching stick (yellow arrowhead) are introduced separately from the 2 posteromedial portals crossing over to bluntly dissect the subcutaneous soft tissue. The tunnel between the 2 portals is created after preliminary subcutaneous spreading. The proximal posterolateral (pPL) portal (white arrowhead), which is used for the posterior compartment retractor, is marked. (D, distal; L, lateral; M, medial; P, proximal.)

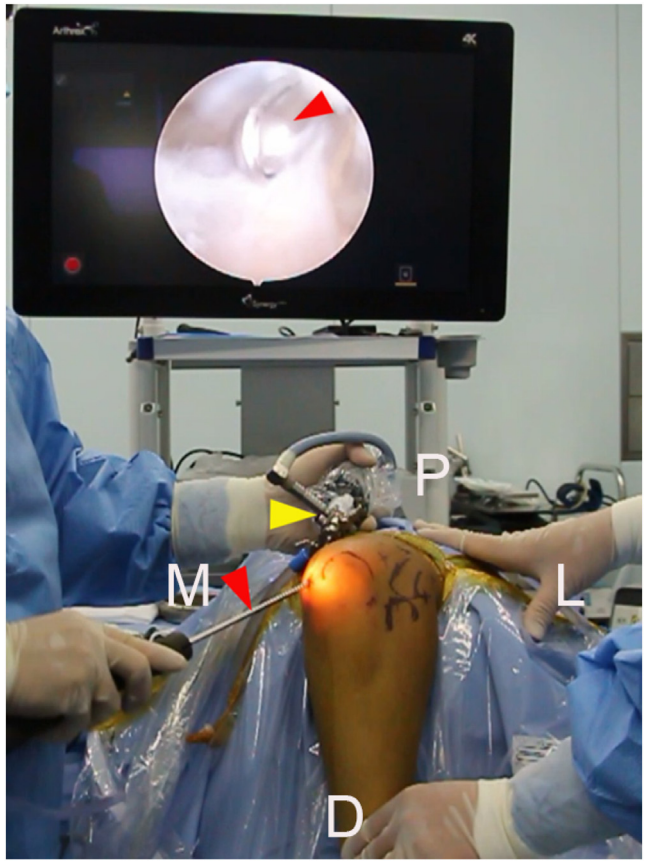

Fig 4. Creation of dual medial portals in right elbow case. After creation of the preliminary subcutaneous tunnel between the 2 portals, the 2.7-mm scope with sheath (yellow arrowhead) is inserted from the proximal posteromedial portal, which is used as the viewing portal; under direct visualization, a 4.0-mm full-radius shaver (red arrowheads) or a bipolar vacuum suction radiofrequency device is introduced from the distal posteromedial portal to further expand the subcutaneous working space proximally and distally. The blade of the shaver or radiofrequency device is under view throughout the procedure. (D, distal; L, lateral; M, medial; P, proximal.)

released from the triceps (Fig 5). With the portals switched, the scope is inserted from the distal portal, and the RF device is inserted from the proximal portal and further into the cubital tunnel entrance. The cubital tunnel entrance opens proximally, and the transverse band of the cubital tunnel retinaculum is elevated by the RF probe, with the probe's working blade facing back to the ulnar nerve, and then transected in a proximal-to-distal direction. The elbow is mildly extended to facilitate the transection to continue down to the aponeurosis spanned between the 2 heads of the flexor carpi ulnaris muscle. The ulnar nerve is progressively visualized distally and dissected free from the adjacent medial tissue, and the ulnar nerve is released enough to be retracted

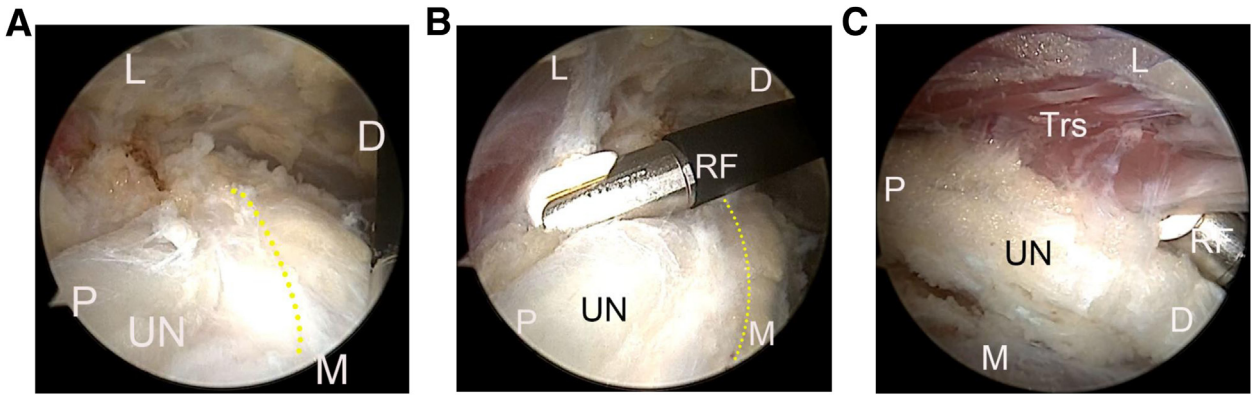

Fig 5. Exposure of ulnar nerve (UN) and cubital tunnel retinaculum in right elbow case. The scope is inserted from the proximal posteromedial portal, and the radiofrequency device is introduced from the distal posteromedial portal. (A) The distal working space is expanded to expose the UN and the cubital tunnel retinaculum (curved dotted line). (B) The distal connection between the UN and the triceps is dissected. (C) The dissection between the UN and the triceps (Trs) proceeds proximally. The vacuum suction of the radiofrequency (RF) device is ongoing throughout the procedure. (D, distal; L, lateral; M, medial; P, proximal.)

medially with its bed undisturbed to preserve stability (Fig 6).

A blunt-tip 2.0-mm K-wire is inserted from the proximal portal to retract the ulnar nerve medially, with the K-wire tip penetrating the medial intermuscular septum, to form a fixed retraction for the ulnar nerve. The scope is switched to the proximal portal, and another blunt-tip 2.0-mm K-wire is inserted from the distal portal to retract the distal section of the ulnar nerve medial to the medial epicondyle, with the K-wire tip penetrating the subcutaneous tissue to form a fixed medial retraction. With the ulnar nerve retracted medially by the 2 K-wires, the posterior bundle of the ulnar collateral ligament is exposed and resected, and the posteromedial capsule in contact with the humerus is detached using the RF probe and resected using a motorized shaver (Fig 7). The elbow is extended, and using the outside-in-out technique, the switching stick is inserted from the distal posteromedial portal into and throughout the posterior compartment to penetrate out of the posterolateral skin; the switching stick is then retreated laterally with its tip elevating the triceps to form a retractor for the triceps (Fig 8). The medial olecranon osteophytic overgrowth is trimmed with a burr (Arthrex), and any free body can be removed by the distal posteromedial portal. After medial gutter debridement, the K-wires retracting the ulnar nerve are removed (Fig 9). The elbow is extended and flexed repeatedly to reconfirm the stability of the ulnar nerve.

The posterolateral trans-triceps portal is made to debride the posterior compartment with the 2 posteromedial portals used as the viewing or working portals. The other portals are made in sequence, and the debridement of posterior and anterior compartments is carried out through these portals. To avoid injuring the ulnar nerve, the RF probe, the shaver blade, and the burr are visualized during the procedure; vacuum suction on the RF device is ongoing throughout the procedure.

Postoperative Protocol

The patient is treated with a compressive bandage and a standard sling, which are removed the day after surgery. Active-assisted and passive rehabilitation exercises of the elbow start immediately after surgery. The duration and intensity of exercise gradually increase according to the patient's tolerance. Pearls and pitfalls of our arthroscopic technique are outlined in Table 1.

Discussion

There are several advantages to releasing and retracting the ulnar nerve under arthroscopy in treating stiff elbows. First, arthroscopic surgery is a minimally invasive procedure. This surgical method uses 2 small incisions (about 5 mm) and yields less soft-tissue damage, a low pain level, and small surgical scars. This surgical method is in line with the trend of minimally invasive surgery in the future and the patient's love for beauty psychology. Second, arthroscopic surgery is safe. The surgeon operates via a fully visible endoscope, improving joint visualization and the safety of the surgical procedure. The incidence of complications and the revision rate of this surgical method are significantly reduced compared with open surgery.[3] Third, arthroscopic surgery is effective. A study involving 44 patients with post-traumatic stiffness of the elbow showed comparable results between arthroscopic osteocapsular arthroplasty and an open procedure.[21] Finally, the short hospitalization time of arthroscopic procedure is helpful for the patient's early and rapid recovery. Advantages and disadvantages of our surgical technique are shown in Table 2.

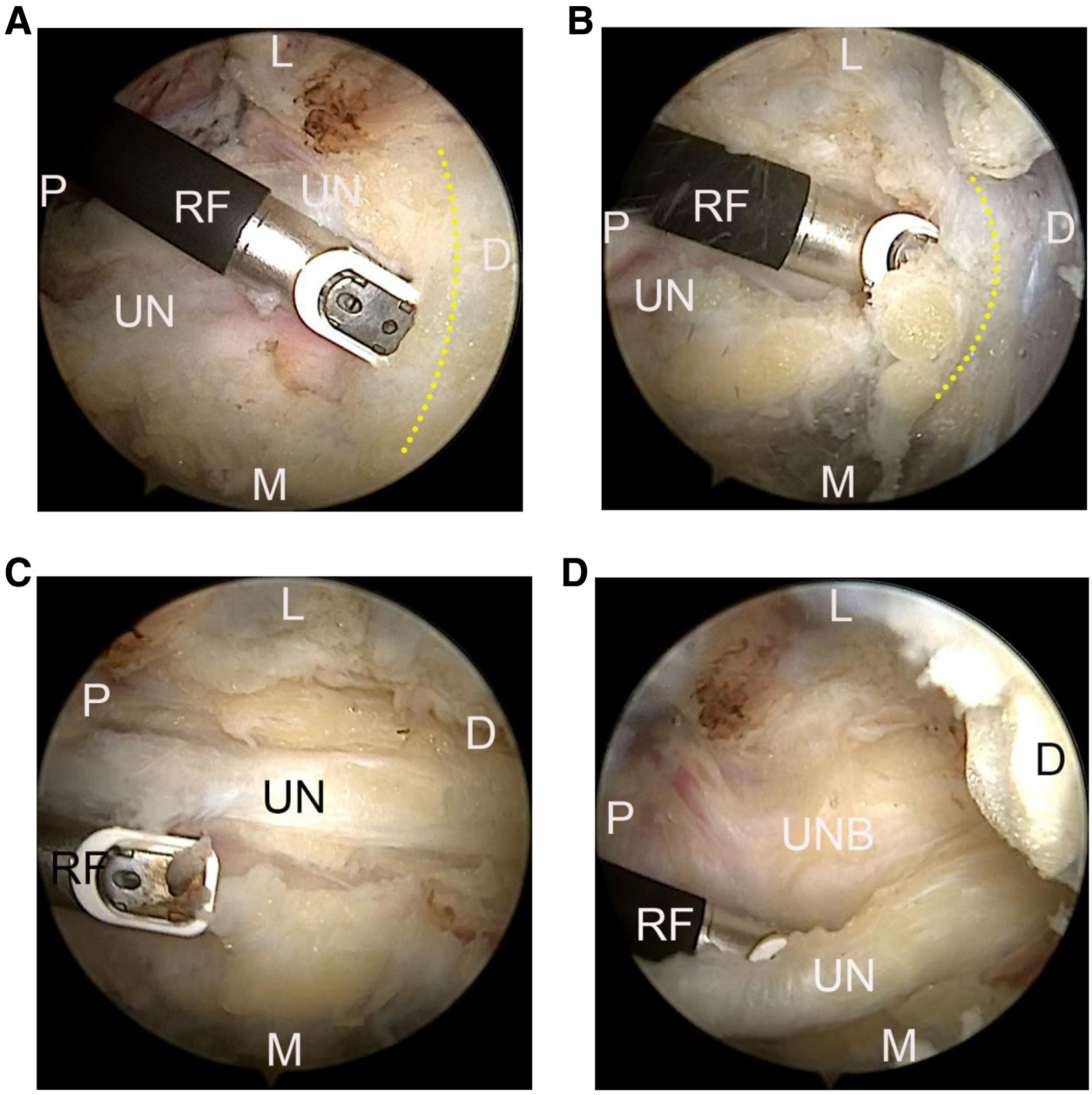

Fig 6. Exposure of ulnar nerve (UN) mobilization and cubital tunnel retinaculum resection in right elbow case. With the portals switched, the scope is inserted from the distal posteromedial portal and the radiofrequency (RF) device is inserted from the proximal posteromedial portal. (A, B) The RF device is inserted from the proximal posteromedial portal into the cubital tunnel entrance, and the cubital tunnel entrance opens proximally. The cubital tunnel retinaculum transverse band (curved dotted lines) is elevated by the RF probe, with the probe's working blade facing back to the UN, and then transected in a proximal-to-distal direction, and the elbow is mildly extended to facilitate the transection to continue down to the aponeurosis spanned between the 2 heads of the flexor carpi ulnaris muscle. (C, D) The UN is progressively visualized distally and dissected free from the adjacent medial tissue with the ulnar nerve bed (UNB) undisturbed to preserve stability, and the UN is retracted by the RF device medially to test its mobility. (D, distal; L, lateral; M, medial; P, proximal.)

Ulnar nerve symptoms and ulnar neuritis are frequently encountered in patients with stiff elbows. Many surgeons often choose to perform ulnar nerve release or ulnar nerve transposition by mini-open surgery. Not only is this traumatic with a slow recovery period, but the patient experiences more pain. The first step of our technique is to make 2 medial-posterior incisions to reveal the ulnar nerve arthroscopically because the course of the ulnar nerve can be palpated extradermally when the other incisions have not been

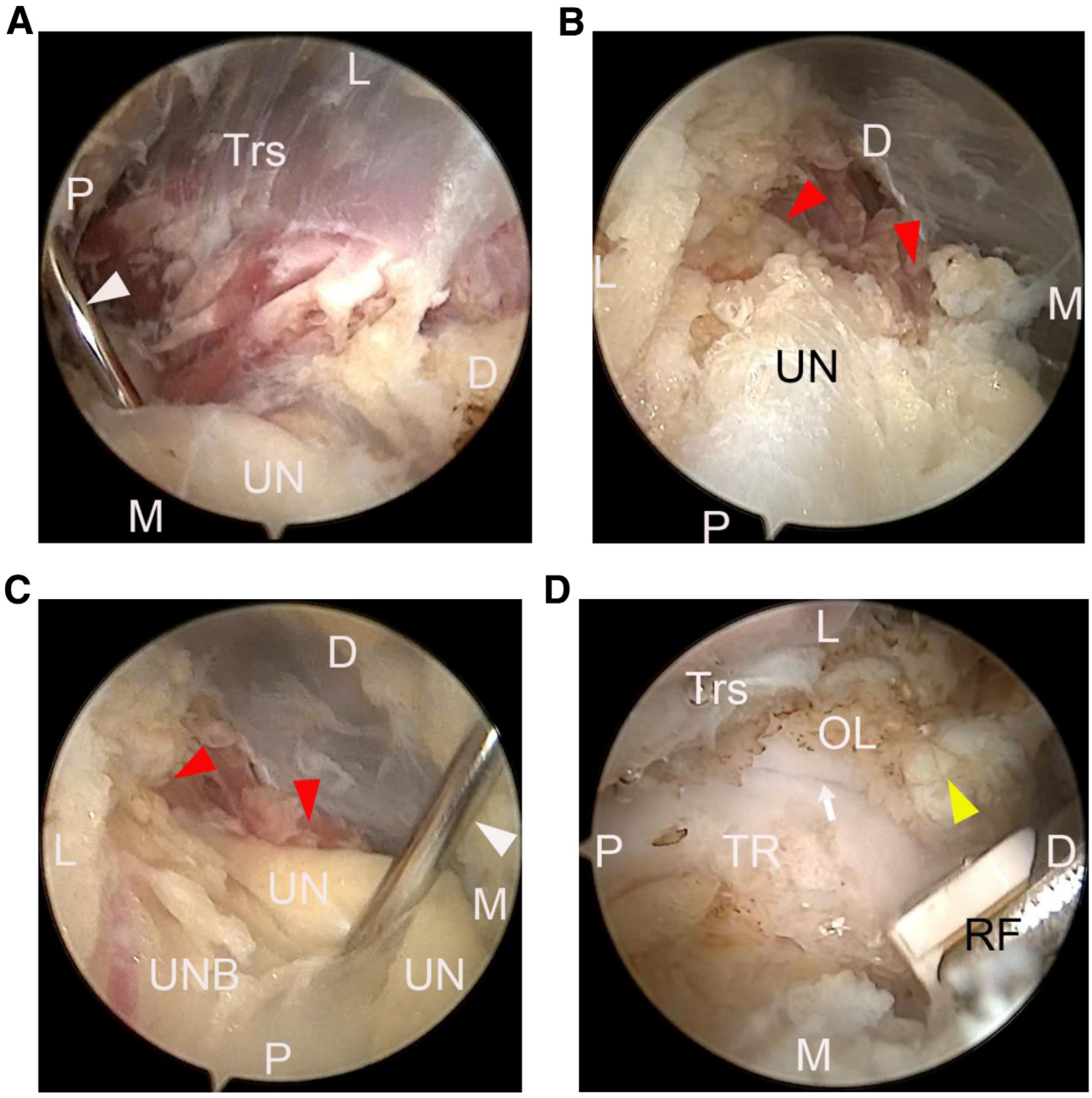

Fig 7. Exposure of ulnar nerve (UN) and cubital tunnel retinaculum in right elbow case. (A) The proximal portion of the UN is released from the triceps (Trs), the scope is inserted from the distal posteromedial portal, and a blunt-tip 2.0-mm K-wire (proximal K-wire, white arrowhead) is inserted from the proximal posteromedial portal to retract the UN medially, with the K-wire tip penetrating the medial intermuscular septum to form a fixed retraction for the UN. (B) The working portal and viewing portal are switched, and the scope is introduced from the proximal posteromedial portal. The transected aponeurosis spanned between the 2 heads of the flexor carpi ulnaris (red arrowheads) muscle can be observed. (C) Another blunt-tip 2.0-mm K-wire (distal K-wire, white arrowhead) is inserted from the distal portal to retract the distal portion of the UN medial to the medial epicondyle, with the K-wire tip penetrating the subcutaneous tissue to form a fixed medial retraction. The ulnar nerve bed (UNB) is intact. (D) The radiofrequency (RF) device is inserted from the distal posteromedial portal. The medial capsule and the posterior bundle of the ulnar collateral ligament (remnant of the posterior bundle of the ulnar collateral ligament, yellow arrowhead) are removed to expose the medial rim of the trochlea (TR) and olecranon (OL), and the ulnohumeral joint line (white arrow) is exposed. (D, distal; L, lateral; M, medial; P, proximal.)

made and the elbow joint is not swollen. This greatly reduces the possibility of ulnar nerve injury and improves safety. As the first step of arthroscopic stiff elbow release, the dual posteromedial portals could be used as the viewing portal for the posterior compartment release, and the scar is reduced.

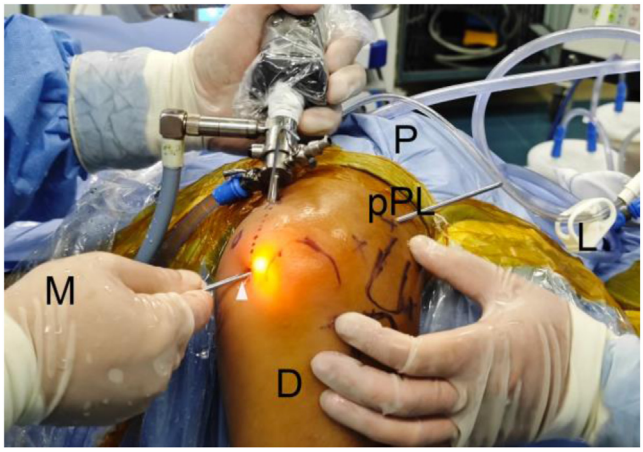

Fig 8. Use of triceps retractor in right elbow case. The outside-in-out technique is used for the retraction of the triceps. The switching stick (white arrowhead) is inserted from the distal posteromedial portal into and throughout the posterior compartment and then penetrated out of the posterolateral skin. The switching stick is retreated laterally out of the proximal posterolateral (pPL) portal with its end in the distal posteromedial portal and beneath the triceps to form a posterior compartment retractor for the triceps. (D, distal; L, lateral; M, medial; P, proximal.)

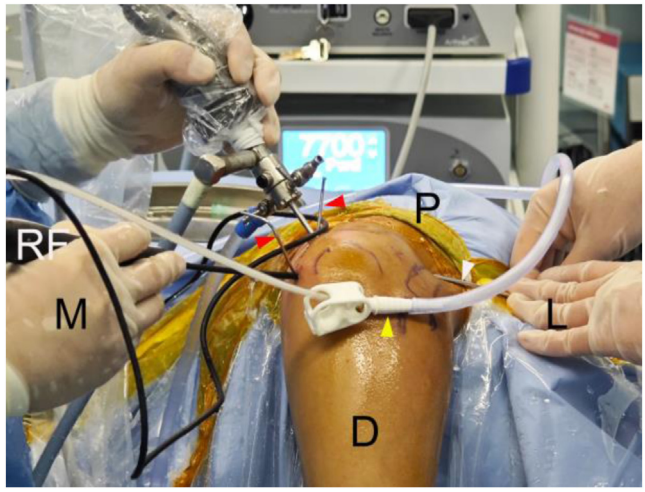

Fig 9. Insertion of 2 retracting K-wires in right elbow case. After the ulnar nerve is freed from the triceps, a blunt-tip 2.0-mm K-wire (red arrowhead on right) is inserted from the proximal posteromedial portal to retract the ulnar nerve medially, with the K-wire tip penetrating the medial intermuscular septum to form a proximal fixed retraction for the ulnar nerve. The scope is then switched to the proximal posteromedial portal, and another blunt-tip 2.0-mm K-wire (red arrowhead on left) is inserted from the distal posteromedial portal to retract the distal portion of the ulnar nerve medially to the medial epicondyle, with the K-wire tip penetrating the tissue on the medial epicondyle to form a distal fixed medial retraction. The switching stick (white arrowhead) is used to elevate the triceps as a retractor. Clearance of the posteromedial capsule and the posterior bundle of the ulnar collateral ligament proceeds with the radiofrequency (RF) device, and the motorized burr is inserted from the distal posteromedial portal to trim the medial osteophytic overgrowth. After medial gutter debridement, the K-wires retracting the ulnar nerve are removed immediately; the other portals as the posterolateral portal is made orderly for debridement of the posterior compartment and anterior compartment. Vacuum suction (yellow arrowhead) of the RF device is ongoing throughout the procedure. (D, distal; L, lateral; M, medial; P, proximal.)

Our arthroscopic technique is quite different from techniques of ulnar nerve release in previous studies. Some investigators make a 2-cm incision in the posterior condylar groove between the medial epicondyle and the olecranon for endoscopic ulnar nerve release in patients with cubital tunnel syndrome. The scope is inserted from the 2-cm incision, and under endoscopic vision, a subcutaneous tunnel is created between the subcutaneous tissue and fascia along the course of the ulnar nerve, reaching 10 to 12 cm proximal to the medial epicondyle proximally and 8 to 10 cm distal to the medial epicondyle distally.[14,16] The ulnar nerve must always be kept in view. If the endoscopic view is cloudy (e.g., due to blood) and cannot be removed, consideration should be given to conversion to open surgery; one of the potential complications of this technique is the formation of hematoma, which may lead to the formation of ulnar nerve symptoms.[14] In summary, for patients with stiff elbows or even ulnar nerve symptoms that meet the indications, we recommend arthroscopic ulnar nerve release and arthrolysis because of the advantages of being minimally invasive, safe, and effective, with early accelerated rehabilitation.

Table 1. Pearls and Pitfalls of Arthroscopic Extra-articular Ulnar Nerve Release in Setting of Stiff Elbow

Preoperative ultrasound is crucial for ulnar nerve location.
The ulnar nerve is first visualized and released from the triceps proximally because its cubital tunnel section is covered by the retinaculum.
The cubital tunnel opens up proximally, so the release of the retinaculum proceeds in a proximal-to-distal direction, with the retinaculum transverse band being elevated and transected.
The ulnar nerve should be released enough to be retracted medially with its bed undisturbed to preserve stability.
Two blunt-tip 2.0-mm K-wires are inserted to form fixed retraction for the ulnar nerve, and the retracting K-wires should be removed immediately after medial gutter clearance.
The scope can be switched between the 2 portals to facilitate visualization and manipulation.

Disclosures

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Table 2. Advantages and Disadvantages of Arthroscopic Extra-articular Ulnar Nerve Release in Setting of Stiff Elbow

Advantages
Minimally invasive
Safe
Effective
Improved joint visualization
Pain reduction
Fewer scars
Accelerated early rehabilitation
Shortened hospital stay
Fewer complications
Disadvantages
High cost of arthroscopic equipment
Long learning curve of doctors
Longer time required to perform arthroscopic surgery compared with open ulnar nerve release

Doctoral Research Start-up Fund of Luoyang Orthopedic Hospital of Henan Province (No. 2023BS03). Full ICMJE author disclosure forms are available for this article online, as supplementary material. The authors declare there is no conflict of interest.

Ethics Statement

The studies involving human participants were reviewed and approved by Ethics Review Form for the Branch for Medical Research and Clinical Technology Application, Ethics. Committee of Luoyang Orthopedic Hospital of Henan Province (KY2022-023-01). The patients/participants provided their written informed consent to participate in this study.

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