Endoscopic Ulnar Nerve Release

13

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Introduction

Cubital tunnel syndrome, after carpal tunnel syndrome, is the second most common compressive nerve entrapments in the upper limb. It is defined as ulnar nerve compression around the elbow region. Apart from the cubital tunnel retinaculum (also known as the Osborne's ligament), compressive sites of the entrapment may involve: Arcade of Struthers, the fasciae of the medial triceps, medial intermuscular septum, medial epicondyle, aponeurosis of the two heads of the flexor carpi ulnaris (FCU) and anomalous anconeous epitrochlerais muscle (Fig. 13.1).

Patients suffering from cubital tunnel syndrome usually complain of intermittent numbness and paresthesia of their ulnar ½ of ring finger and little finger. This is usually aggravated by elbow flexion. They may notice weakness in grip strength and difficulty in buttoning or holding small objects. In severe cases, intrinsic muscle wasting, easily notable at the 1st web space and hypothenar area, and ulnar claw hand deformity (i.e. hyperextension of the metacarpal-phalangeal joint and flexion of the interphalangeal joints of the ring and little finger) can be observed. Tinel sign can be demonstrated along the route of ulnar nerve, posterior to the medial epicondyle.

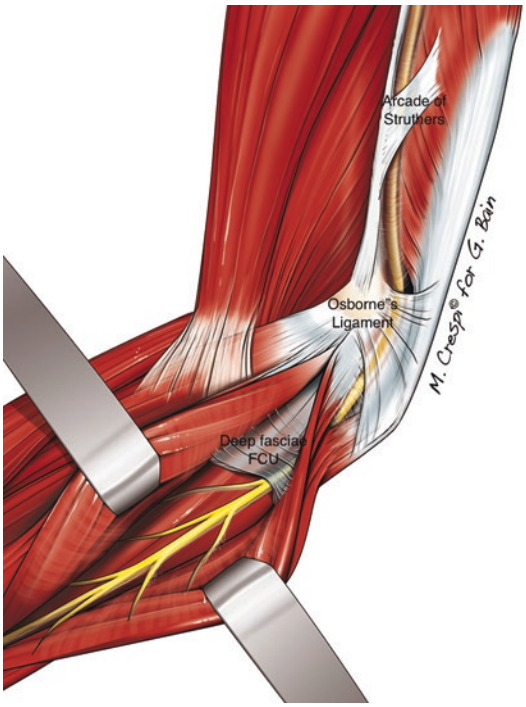

Fig. 13.1 Illustration of the extent of release in cubital tunnel syndrome

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The cause of cubital tunnel is usually idiopathic. Nevertheless, elbow osteoarthritis, joint malalignment secondary to malunion of childhood elbow fracture, post-traumatic scarring, inflammatory arthropathy and ulnar nerve subluxation are some of the common predisposing factors. Cubital tunnel syndrome is a clinical diagnosis, based on history and physical examination. Yet, in cases of uncertainty or of medical – legal concerns, nerve conduction study can be used to confirm the diagnosis and to document the severity of the neuropathy. Radiographs and ultrasound are used if structural compression is suspected [1, 2].

The primary treatment modality of cubital tunnel is conservative with activity modification, splints and physiotherapy [3, 4]. Surgical intervention is indicated when patients fail to respond with conservative modalities. Decompression of all the potential compression sites i.e. from Arcade of Struthers, 8–10 cm proximal to the medial epicondyle proximally, to the branching of motor branches of the FCU, 5–8 cm distal to the medial epicondyle, is warranted. Traditionally, open cubital tunnel release with anterior transposition is the gold standard. Yet recent literature demonstrates that simple decompression without anterior transposition has comparable outcomes in selected cases, e.g. in cases which the ulnar nerve is not subluxable [5–8].

In recent years, endoscopic surgery has gained popularity. The proposed benefits are that it can achieve a satisfactory outcome with smaller incision and less soft tissue dissection [9, 10]. Similar to open surgery, the ulnar nerve can be either release in situ or anteriorly transposed, depending on the stability of the ulnar nerve and its surrounding environment.

Endoscopic Cubital Tunnel Release (Decompression of Ulnar Nerve In-Situ)

Indications

- Idiopathic cubital tunnel syndrome, preferably confirmed by nerve conduction study.

Contra-indications

- Unstable ulnar nerve, i.e. subluxation or dislocation of nerve during elbow flexion.
- Mass or space occupying lesion compressing onto the ulnar nerve.
- Hostile ulnar nerve bed, such as scarring from previous elbow surgery or trauma.
- Severe elbow contracture.
- Concomitant conditions necessitating anterior transposition (e.g. cubitus valgus or humeral malunion or non-union).
- Recurrent cubital tunnel syndrome.
- Limited external rotation of the shoulder (relative contra-indication).
  - Depends on surgeons' expertise in performing this surgery.

Surgical Techniques

Different techniques have been described for endoscopic cubital tunnel release. It can be classified into two types, the use of specialized dissection equipment, Storz instruments (Karl Storz, Tuttlingen, Germany) [11, 12], and Agee device (3M, Orthopaedic Products, St Pauls, MN, USA) [13] and the use of cannula. (Integra LifeSciences, Plainsboro, NJ, USA) [14, 15]. Each technique has its benefits and drawbacks. The choice depends on the surgeons' preference and the availability of the instruments.

Surgical Technique Using Storz Equipment (Karl Storz, Tuttlingen, Germany) [12, 16]

The patient is in supine position, under general or regional anesthesia, with the affected arm in 90° abduction and supination on a standard hand table. Pneumatic tourniquet is applied. The ulnar nerve is palpated and a 2 cm skin incision is made over the retro-condylar groove. Once the ulnar nerve is identified, tunneling forceps is introduced distally about 10–12 cm and proximally 8–10 cm from the medial epicondyle into the space between the fasciae and the subcutaneous tissue. An illuminated speculum is then inserted

into this prepared space. Under direct vision, the fascial roof of the retrocondylar groove and the Osborne's ligament can be divided under direct vision.

A 4 mm 30° endoscope with a blunt dissector on its tip is introduced and advanced distally. The dissector is used to lift up the soft tissue, creating a space for better visualization of the nerve and its surrounding tissue. Under endoscopic guidance, a blunt-tipped scissors is used to release the forearm fasciae, followed by the fibrous raphe between the two muscular heads of the FCU and the fibrous bands over the ulnar nerve (Fig. 13.2). All the soft tissue overlying the ulnar nerve is released until the motor branches of the FCU come into view i.e. about 8 cm distal to the medial condyle.

Proximally, the endoscope is used to decompress the ulnar nerve in a similar fashion. The deep fascia and the arcade of Struthers above the ulnar nerve are divided, up to 10 cm proximal to the medial epicondyle. The intermuscular septum can be left alone if no impingement to the ulnar nerve is observed. Hemostasis can be achieved with long bipolar forceps or special bipolar micro-forceps (Fig. 13.3).

Post release, the ulnar nerve is checked for stability, by taking the elbow in full range of motion. If subluxation or dislocation of the nerve is noted, anterior transposition of the nerve is warranted. If the nerve remains stable, the wound is closed in layers. A suction drain may be inserted prior to closure.

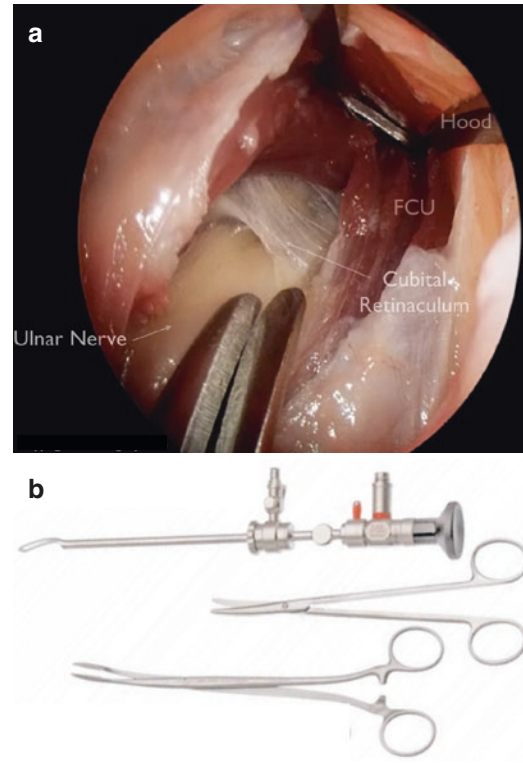

Fig. 13.2 (**a**) Endoscopic view of distal release using endoscope and specialized dissection equipment (Copyright Dr Gregory Bain). (**b**) illustration of the equipment used

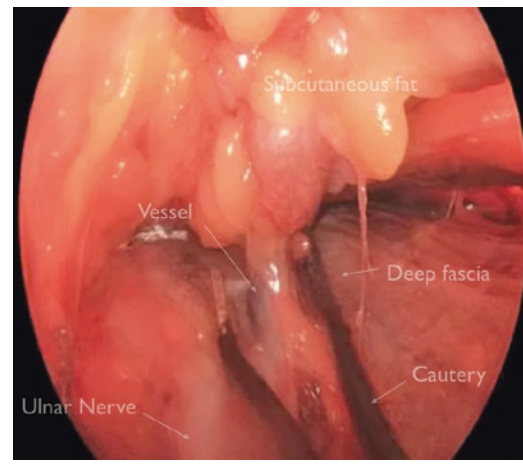

Fig. 13.3 Endoscopic view of cautery in order to achieve hemostasis. (Copyright Dr Gregory Bain)

Cannula Technique (Integra LifeSciences, Plainsboro, NJ, USA) [14, 15]

The patient is being prepared in a similar fashion, with arm board and anesthesia. A 2 cm incision is made over the retrocondylar groove, and the ulnar nerve is identified after incising the roof of the cubital tunnel. The spatula is inserted into the potential space between the ulnar nerve and the roof of the tunnel. The spatula should advance both proximally and distally without resistance to create a canal for the cannula.

A cannula specifically designed for cubital tunnel release is used. The cannula has a flat undersurface, which helps to hold the nerve under the cannula, and slots on the inferior surface, which allows visualization of the ulnar nerve during the release. The cannula has an attached retractor,

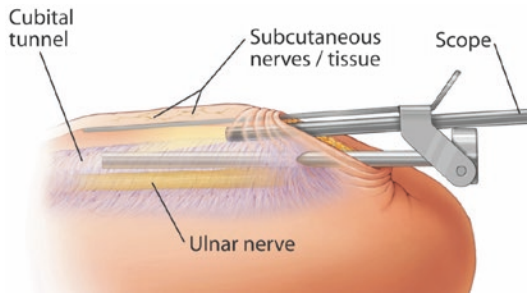

Fig. 13.4 Illustration of endoscope and cannula in place

which holds the soft tissue and the cutaneous nerve. The cannula with trocar is inserted into the canal and advanced proximally between the ulnar nerve and the roof of the canal. Meanwhile the attached retractor is allowed to slide on the extensor surface of the fasciae, elevating the soft tissue and the cutaneous nerves (Fig. 13.4). If resistance is encountered, the cannula should be removed, and a spatula is used to clear the soft tissue away from the deep fasciae. Endoscope can also be used to confirm that the fasciae is cleared of soft tissue and cutaneous nerves.

Once the cannula/trocar has been placed into the canal, the trocar is removed. A 4 mm 30° endoscope is inserted into the cannula. The inferior slot of the cannula is viewed, confirming that the ulnar nerve is protected by the cannula. The fasciae (roof of the canal) is then divided with a blade, along the superior slot of the cannula. Following the release of the fascia, the completeness of the release is checked by gradually pulling the cannula back on the scope and out of the canal.

A similar procedure is performed for the distal release. Prior to closure, the endoscope is inserted again at the space where the retractor is placed, to check the completeness of the release both proximally and distally. After confirmation of the stability of the ulnar nerve, the wound is closed in layers.

Surgical Technique Using Agee Device (3M, Orthopaedic Products, St Pauls, MN, USA) [13, 17]

This is the most economical techniques especially if one uses the Agee device for endoscopic carpal tunnel release. Its technical details are similar to the Cobbs cannula technique. The patient is put under anaesthetia with the inflation of the tornqiuet. Similar incision is made over the retro-condylar groove and the unar nerve is identified. A spatula is used to free the nerve from the surrounding soft tissue and fasciae. Then, instead of the inserting the cannula, the Agee endoscope is inserted into the prepared canal. The Agee device has 30° endoscope optic and a pistol-grip hand piece with a trigger mechanism that activates a retractable blade immediately distal to the window. After obtaining a clear and safe view of the cubital retinaculum, and confirming that the ulnar nerve and its branches are not at risk, the trigger mechanism is activated and the entire device is withdrawn, incising the retinaculum. If any at-risk structures are seen in the visual view, the knife is retracted by releasing the trigger. This procedure can be done both distally and proximally in a repeated manner until the ulnar nerve is completely released. Prior to closure, the ulnar nerve is checked for stability by taking the elbow in full range of motion.

Tips and Tricks

- This is an advanced technique. It is recommended that surgeons are familiarized with all the instruments, preferable in a cadaveric setting
- For the first few cases, the surgeon is advised to perform endoscopic release in thin patients as their anatomy can be more easily identified and the ulnar nerve more easily localized.
- A 3–4 cm longitudinal incision instead of 2 cm incision is recommended for the initial few cases, until surgeon is familiarized with the techniques. Larger incision may be needed for patients who are overweight or have a large build.
- Cutaneous nerves may be encountered in the incision. While surgeons do not need to look for them, if seen, they should be protected to avoid injury and neuroma.
- All instruments including endoscope/spatula/cannula should advance without resistance.

In cases which resistance is encountered, surgeons should withdraw the instruments from the canal and proceed with the following checklist:
  - Ensure the incision in the cubital tunnel retinaculum is large enough so that the instrument does not bend as it is placed into the canal.
  - Ensure the elbow is not overly flexed to create impingement.
  - Wet the instruments to minimize friction.
  - Use a spatula to ensure the appropriate plane is well developed and the angle of advancement is identified.
- The ulnar nerve must be well visualized before the dissection of the soft tissue with dissecting forceps.
- Adipose tissue may interfere with the endoscope view. Endoscope has to be cleaned often with the adipose tissue removed.
- Protection of the vascular supply of the ulnar nerve is mandatory.
- The motor branches of the FCU needs to be well visualized and should be protected during dissection.
- Good hemostasis is needed to prevent postoperative hematoma. Deflation of tourniquet is recommended prior to wound closure. Alternatively, a drain may be inserted for 1–2 days.
- After release, stability of the nerve should be checked by taking elbow in full range of motion. If subluxation of the ulnar nerve is noted, proceed to anterior transposition (see below section "Endoscopic Cubital Tunnel Release and Anterior Transposition").
- If there is any difficulty while performing this procedure e.g. if the ulnar nerve cannot be well visualized or if hemostasis cannot be achieved, the surgeon should convert to an open procedure.

Postoperative Protocol

A bulky compression dressing is applied for 2–3 days. It is then changed to simple dressing. Motion is allowed within the limits of patient's comfort. Patients can expect to return back to office activity on the first post-operative day. Full range of motion is expected in 1 week. For patients who need to return to sports or return to moderate to heavy duty, they are typically restricted for 1 week and then advanced to full duty over the subsequent 2–3 weeks.

Complications

- One of the most common complications following endoscopic cubital tunnel release is hematoma formation. It is minimized by:
  - Handling soft tissue with care, especially during dissection of soft tissue away from the fasciae.
  - Deflating the tourniquet prior to wound closure followed by good hemostasis,
  - Using local anesthesia with epinephrine at wound closure.
  - Placement of drain for 1–2 days.
- Medial antebrachial cutaneous nerves of the arm may be injured, resulting in neuroma or paresthesia of the medial forearm. This can be minimized by attention to details during dissection and the avoidance of multiple layer of soft tissue dissection.
- The main ulnar nerve or one of its branches can be injured during decompression. The nerve needs to be well visualized at all times.
- Unrecognized subluxation of the ulnar nerve can be minimized by checking the stability of the ulnar nerve in full range of elbow motion post nerve release.
- Wound dehiscence can be minimized by ensuring a tight closure, with wound closed in layers.

Results

Satisfactory and comparable results were noted by using different techniques of endoscopic cubital tunnel release.

Seventy-five patients with seventy-six ulnar nerves underwent endoscopic cubital tunnel release in situ using the Storz instruments [11].

Sensory improvement was noted in 96% of patients and grip strength was noted to be significantly improved (30.5%) as compared with preoperatively. Even patients with preoperative severe symptoms (based on Dellon's classification [18]) had 89% good to excellent results based on the modified Bishop rating [19]. Four patients suffered from hematomas and nine patients had sensory loss over the medial antebrachial cutaneous nerve of the arm. There was no recurrence at a mean follow-up of 11 months.

Cobb et al reported the use of cannula for endoscopic cubital tunnel release in 172 cases [20]. At a mean follow-up of 30 months, 96% had good to excellent results based on the modified Bishop rating [19]. The average return to normal work was 8 days following endoscopic cubital tunnel release compared with 71 days following anterior transposition of the ulnar nerve. Seven patients had complications including wound dehiscence, postoperative hematoma and superficial infection. There were four patients requiring revision surgery due to persistent symptoms or recurrence.

With the use of Agee endoscope, 27 cases of cubital tunnel were studied [17]. With a mean follow up of 112 weeks, 81% of patients showed a clinical improvement of the McGowan grade [13]. Two patients suffered from wound dehiscence, with one requiring revision surgery. No subluxation of the ulnar nerve nor iatrogenic ulnar nerve injury was noted.

Current Literature

Endoscopic cubital tunnel release is a minimally invasive technique which is postulated to have theoretical benefits of a small incision, less soft tissue dissection and low complication rate as compared with the conventional open cubital tunnel release. In a cadaveric study, Said et al demonstrated that the visualization of the ulnar nerve around the elbow region can be accomplished by a 2 cm incision instead of a 4 cm open incision [21]. In addition, authors using different endoscopic techniques have shown that it can lead to an adequate ulnar nerve decompression and a satisfactory outcome in both cadaveric studies and clinical settings [11, 13, 17, 20].

In spite of these promising results, studies comparing open and endoscopic cubital tunnel release in situ are mixed and not conclusive. In a prospective randomized double-blind study of 56 cubital tunnel syndrome cases, Schmidt et al demonstrated that there was no difference with respect to clinical improvement between the two techniques in both early or late follow-up [9]. Hematoma was significantly more frequent in the endoscopic group (i.e. seven cases versus one case). Meanwhile, in a retrospective cohort study of 114 patients with cubital tunnel syndrome [22], the endoscopic group had better short term results and comparable long term outcomes when compared with the open release group. Seventy-six percent of patients after endoscopic surgery returned to their full functionality within 1 week as opposed to 19% patients after open surgery. Nineteen patients in the open group suffered from complications of loss of sensation over the medial antebrachial cutaneous nerve of the arm, scar pain and superficial wound infection while six patients in the open group suffered from complications of ulnar nerve subluxation and hematoma formation. Four patients, two with hematoma and two with nerve subluxation, required additional surgeries. Similarly, the conclusion of two recent systematic reviews comparing the two techniques are mixed. Toirac et al [23], after reviewing eight articles, suggested that the clinical outcomes of endoscopic technique were more superior than open technique in regards to both complication rates and patients satisfaction. The rate of excellent/good Bishop score was 92% for the endoscopic group as compared with 83% for open group. The breakdown of each complication was not stated. In contrast, Aldekhayel et al, reviewed 20 studies and concluded that there was similar effectiveness between the endoscopic and open techniques for treatment of cubital tunnel syndrome with similar outcomes, complication profiles and reoperation rates [24].

Endoscopic Cubital Tunnel Release and Anterior Transposition

This describes subcutaneous anterior transposition of the ulnar nerve performed under endoscopic guidance.

Indications

- Unstable ulnar nerve, either pre-operatively or post nerve release.
- Hostile ulnar nerve bed, such as scarring from previous trauma or elbow surgery.

Contraindications

- Previous trauma or surgery to the ulnar nerve and/or elbow.
- Severe elbow contracture.
- Concomitant conditions necessitating open surgery such as management of humeral malunion or non-union.
- Patients' particular conditions necessitating sub-muscular transposition, e.g. thin patient who is prone to have ulnar nerve irritation.
- Limited external rotation of the shoulder (relative contra-indication).
  - Depends on surgeons' expertise in performing this surgery.

Surgical Technique

Endoscopic ulnar nerve release is performed as described in the endoscopic cubital tunnel release in situ section, using either Storz instruments (Karl Storz, Tuttlingen, Germany) or specific designed cannula (Integra LifeSciences, Plainsboro, NJ, USA). In cases which subluxation of the ulnar nerve is observed either pre-operatively or post ulnar nerve decompression, anterior transposition of the nerve is recommended [25].

Starting proximally, the medial intermuscular septum (MIMS) identified during the decompression must be excised. The MIMS does not usually cause impingement of the ulnar nerve if the nerve is decompressed in situ. Yet. If the nerve is transposed, impingement of the nerve is likely. Excision of the MIMS is needed.

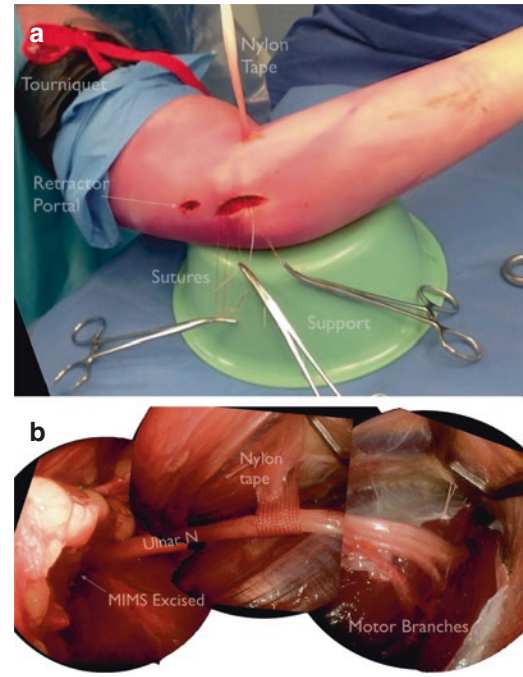

Fig. 13.5 (**a**) Additional portal for anterior transposition. (**b**) nylon tape. (Copyright Dr Gregory Bain)

The tunneling forceps or spatula is used to create an anterior subcutaneous space into which the nerve will be placed after transposition. In order to aid in the mobilization of the ulnar nerve into the anterior compartment, an additional subcutaneous portal is created at this space just distal to the medial epicondyle (Fig. 13.5). A nylon tape is then introduced into this portal for the manipulation of the nerve. The ulnar nerve, together with its accompanied vessels is mobilized from the loose areolar tissue under endoscopic guidance.

Once the ulnar nerve is freed and positioned anteriorly to the medial condyle, the entire "new" course of the nerve is checked to ascertain that there is no new site of compression or kinking of the nerve. The nerve is then secured to prevent subluxation back into its original position. First, the medial condyle is rasped, in order to promote adhesion to the adjacent soft tissue. The subcutaneous tissue is then sutured to the medial condyle

to prevent the nerve from falling back behind the epicondyle. To ensure the stability of the nerve in its new course, the position of the ulnar nerve is checked, taking the elbow in its entire range of motion. Hemostasis is performed after the deflation of the tourniquet. The wound is closed in layers, taking care of not catching the nerve. An arm sling is given to keep the elbow in flexed position.

Tips and Tricks

- This is an advanced technique, with a significant learning curve. Surgeons are recommended to be familiarized with the technique of endoscopic release of ulnar nerve prior to his/her attempt in performing anterior transposition of the ulnar nerve endoscopically.
- Larger incision is recommended to be made for the initial few cases and for overweight patients.
- When using the nylon tape to retract the ulnar nerve during the mobilization from its native bed, it is important not to employ significant traction, as this may result in iatrogenic ulnar nerve palsy.
- The MIMS is to be excised in a generous manner prior to the transposition of the ulnar nerve. This is to prevent a new site of ulnar nerve impingement.
- During the creation of the subcutaneous tunnel, the medial antebrachial cutaneous nerve of the arm may be damaged. The surgeon is recommended to dissect just above the fasciae using forceps and spatula. Dissection in multiple planes should be avoided.
- Prior to closure, the surgeon should ensure that there is no new site of compression and the ulnar nerve is stable in its new route. The elbow should be taken over its entire course of motion for confirmation.
- Hemostasis should be achieved by using bipolar forceps under endoscopic guidance to prevent haematoma formation. Drain may be placed for 1–2 days. It is recommended to close the wound in layers to avoid wound dehiscence.

Postoperative Protocol

A longer rehabilitation period is needed after anterior transposition as compared with decompression in situ. An arm sling is used for 10 days. Gentle active elbow mobilization is allowed out of the sling, but the elbow should be not straightened. Full elbow mobilization exercise is only permitted after 10 days, allowing the soft tissue to heal around the nerve. Light duties can resume after 10 days. Patients should delay return to moderate to heavy duties or return to sports for 6–12 weeks.

Complications

- Iatrogenic injury to the ulnar nerve or its branches may occur. Patients usually complain of persistent or worsen symptoms and signs. Ulnar nerve must be well visualized under direct or endoscopic vision at all times. Significant traction should be avoided during the retraction of the ulnar nerve.
- Subluxation of the ulnar nerve back to its original route may be observed especially if patients undergo excessive movement of the elbow in the early post-operative period. A snapping sensation may be noted during elbow movement.
- New site of ulnar nerve compression may be noted if the MIMS is not excised or if the nerve is not completely mobilized and not completely seated in its new bed in a tension free manner.
- Paresthesia of medial forearm due to injury of the medial antebrachial cutaneous nerve of the arm.
- Wound dehiscence and hematoma formation may be encountered.

Results

Eleven patients with an average age of 52 years old underwent endoscopic cubital tunnel release and transposition over a 3 year period [25]. Satisfactory relief in symptoms was noted in

most patients, though patients with significant preoperative nerve involvement (e.g. McGowen Grade 3) [26] had persistent paresthesia and muscle wasting post-operatively. Snapping of the ulnar nerve was resolved for patients with subluxable ulnar nerve. There was no major complication including reoperations, infections, nerve injures, or recurrent ulnar nerve instability.

Current Literature

There is limited literature on endoscopic cubital tunnel release with anterior transposition [25, 27]. Kirshnan et al described 11 patients with cubital tunnel syndrome irrespective of ulnar nerve stability undergoing endoscopic release and transposition. At a mean follow-up of 15.5 months, 91% showed good to excellent results, based on the modified Bishop rating [19], with no complications. Current literature supports that both simple cubital tunnel release in situ and cubital tunnel release with anterior transposition resulted in comparable outcomes [5, 6]. Yet most of these prospective randomized controlled trials exclude patients with ulnar nerve hypermobility. Bartels et al [8] randomized patients into simple release and anterior transposition irrespective of the ulnar nerve stability. It reported that just over 50% of patients had completely resolved symptoms in both groups with no statistical significance between groups. It is generally accepted that anterior transposition of ulnar nerve is indicated in patients with ulnar nerve hypermobility or hostile ulnar nerve bed or recurrent cubital tunnel syndrome [28, 29]. Higher complication rates of up to 31% as opposed to 9.1% has been reported with open nerve release with anterior transposition in a prospective randomized trial. The majority of complications were loss of sensation around the scar and superficial wound infection [8]. With the growing familiarity of performing cubital tunnel release under endoscopic guidance, concomitant anterior transposition appears to be a viable option. The preliminary result shows promising outcomes with minimal complication.

Learning New Techniques

As the interest of endoscopic ulnar nerve release is growing, a rise in complications is foreseeable if training of using endoscopic equipment is not adapted accordingly. To master this endoscopic technique, a detailed knowledge of the anatomy, pathology and necessary equipment is essential.

Surgeons should be equipped with general arthroscopic skills prior to the attempt of performing endoscopic procedure. As the decompression is under close proximity of the ulnar nerve and its accompanied vessels, good hand – eye coordination and triangulation techniques, acquired by mastering arthroscopic skills is essential. Surgeon must be familiarized with the anatomical environment around the ulnar nerve, so that they can avoid any potential injury to the surrounding area e.g. medial antebrachial cutaneous nerve of the arm. Soft tissue needs to be handled carefully in order to minimize iatrogenic nerve injury and hematoma formation.

In order to train specific psychomotor skills for the endoscopic nerve release, actual instruments handling on a regular basis is preferably performed in a simulated training setting away from the patients. This can be done through hands on cadaver courses, anatomic bench-top models or even virtual reality simulators. Unfortunately, high-fidelity virtual reality simulators include both passive and active haptic devices to perform a full-scale simulation are not yet commercially available for elbow region.

Authors recommended that interested surgeons should start endoscopic technique initially in uncomplicated patients requiring a simple ulnar nerve release. The surgeon should start with a larger Incision (i.e. >2 cm) until they are familiarized with the procedure. In cases which the visuality of the nerve is not good, one should convert to an open procedure without hesitation.

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