Revision Cubital Tunnel: Surgical Options

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Introduction

Cubital tunnel syndrome is the second most common upper extremity compressive neuropathy [1, 2], with an increased incidence in men [3]. Different procedures have been described for the release of the ulnar nerve at the elbow ranging from simple decompression to medial epicondylectomy, as well as anterior transposition (subcutaneous, intramuscular, or submuscular). There is still no clear consensus regarding the best operation [4]. The rate of surgical management has increased during the last decades, with a preference for simple decompression [1], and failure rates ranging from 3% to 35% have been reported in the literature, depending on the severity of symptoms before surgery [5–11].

Etiology

We can categorize patients who have failed a primary cubital tunnel release procedure into three groups: those with persistent symptoms, recurrent symptoms, or new symptoms. Patients with persistent symptoms, who have no relief or incomplete relief after the primary surgery, are likely to have had an incorrect diagnosis or a missed concomitant diagnosis, an inadequate release, or an irreversible intraneural pathology. Recurrent symptoms may result from scar and perineural fibrosis after surgery, and new symptoms may occur after iatrogenic creation of a new compression site or iatrogenic nerve injury, such as a medial brachial and antebrachial cutaneous nerve (MABCN) injury [12].

We can also categorize the reasons to failure as diagnostic, biologic, or technical. Biologic reasons can be perineural fibrosis formed after the primary surgery, or severe preoperative ulnar nerve damage from long-standing compression. Diagnostic causes can be an incorrent diagnosis or even a missed concomitant diagnosis, such as a C8 radiculopathy. Finally the technical causes may be incomplete decompression, iatrogenic creation of a new site of compression, nerve injury and instability of the ulnar nerve after the primary surgery [13].

There are also factors associated with increased rates of revision surgery. Krogue et al. [10] found that prior elbow fracture or dislocation and McGowan stage I disease were associated with revision surgery and that concurrent surgical procedures were protective against revision surgery. Increased risk for recurrence may also exist for patients with

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hypercoagulable disorder, tobacco use, chronic anemia, chronic liver disease, age <65 years, diabetes mellitus, obesity and morbid obesity, and hyperlipidemia [14]. In addition, it is found that patients with chronic kidney disease are at higher risk for complications after cubital tunnel surgery and that the secondary surgery rate is higher for patients who have undergone transposition than for patients who have undergone in situ decompression [15]. This may be due to devascularization of the nerve, entrapment in scar, or a combination.

Evaluation

History

The patients who visit us after a failed primary cubital tunnel surgery deserve time in order to fully understand their symptoms and how they evolved. After a thorough history we should be able to recognize the difference between the preoperative and postoperative symptoms, the possible improvement and the period of it before the recurrence or the worsening of the symptoms. There are also pain evaluation forms that can be completed by the patients and help us determine the cause of their complaints [4].

Physical Examination

The physical examination should address all the possible causes, beginning from the cervical spine in order to assess for evidence of cervical radiculopathy, which can mimic or contribute to cubital tunnel syndrome symptoms with double crush lesion. Other conditions, such as thoracic outlet syndrome, a Pancoast lung tumor or brachial plexus injury should also be ruled out. We should examine all the possible sites of compression of the ulnar nerve, inspect the patient for possible clawing, atrophy or elbow deformity that can cause elbow stiffness and contribute to ulnar neuritis. In addition, evaluation of the sensory function, as well as palpation of the ulnar nerve for assessment of possible instability are also necessary. Lastly, examination of the scar can help us understand if all possible sites of compression were released.

Testing

We should repeat the nerve conduction and electromyography (EMG) studies and compare their results with the preoperative ones. A completely released ulnar nerve cannot be easily distinguished from an incompletely released ulnar nerve because the studies often show no improvement, but worse result may indicate need for reexplorationbecause of possible perineural fibrosis or ulnar nerve injury. If radiculopathy or Guyon canal compression is suspected, magnetic resonance imaging (MRI) may be helpful. Ultrasound could also be useful in order to assess for changes in the ulnar nerve diameter, perineural scarring, the position of the nerve or even MABCN neuromas.

Management

If symptoms do not alleviate after the primary surgery and other causes have been excluded, then the goal of revision surgery must be to completely decompress the ulnar nerve. Similar to the situation for primary cubital tunnel surgery, there is no widely accepted superior technique for revision surgery. Submuscular transposition seems to be the most commonly recommended revision technique [8, 16–20]. Other options include simple neurolysis [21], subcutaneous transposition [19, 22] and intramuscular transposition [23]. Revision surgery should be performed after thorough diagnosis by a highly experienced surgeon [24]. The results are generally not as good as for primary techniques [5, 18]. In general the surgical management of persistent or recurrent peripheral nerve compression needs a more aggressive sur-

gical approach [25]. Complete visualization and release of all potential sites compression is critical and neuromas of superficial sensory nerves need also to be addressed. According to Sarris et al. [26] great care must be taken in identifying and preserving the branches of the medial cutaneous nerves during both primary and revision cubital tunnel surgery, as an injury to these branches can compromise the overall results following revision cubital tunnel surgery.

The literature is still limited in studies evaluating outcomes after revision cubital tunnel surgery, but till now most of the existing studies recommend external neurolysis and submuscular transposition as the method of choice.

Gabel and Amadio performed a retrospective review of 30 patients who were followed for a minimum of 2 years postoperatively. They suggested that for a reoperation to be successful all potential levels of compression must be released. They also found that an age of more than 50 years, electromyographic evidence of denervation and previous submuscular transposition were associated with poor outcomes [19].

Rogers et al. [17] reported their results or revision with external neurolysis and anterior submuscular transposition. All patients with McGowan grades I-II improved in almost all parameters, 3 (from 14) patients, who had McGowan grade III, had no improvement in sensation or motor weakness, and all patients returned to work.

Caputo and Watson [22] reported their results on 20 patients treated with neurolysis and anterior subcutaneous transposition and had 75% excellent or good results. They also suggested that increasing age and procedures were associated with fair or poor results.

Dagregorio and Saint-Cast [21] described external neurolysis in situ of the previously submuscularly transposed ulnar nerve in nine patients and reported 89% good or fair Wilson-Krout grade.

Vogel et al. [18] described submuscular transposition in 18 patients with persisted cubital tunnel syndrome after failed surgery. They concluded that most patients had partial relief of their pain and the satisfaction rate was 78%.

Bartels and Grotenhuis [27] reported their results on external neurolysis with anterior submuscular transposition in 40 patients and found that 20% had an excellent result whereas only one patient self-reported a complete cure.

There is also literature suggesting the use of adjunctive techniques. Varitimidis et al. [28] described neurolysis and autogenous saphenous vein wrapping in four patients with recurrent cubital tunnel syndrome. All patients reported significant pain relief and improvement in sensation. Two-point discrimination and EMG findings also improved.

Kokkalis et al. [29] also used autologous vein wrapping in 17 patients with recurrent cubital tunnel syndrome. All patients reported significant pain relief, and improvements in grip strength and 2-point discrimination were observed. Vein grafts are found to improve the recovery of nerve function by protecting the nerve from surrounding scar and so they are proven to be an effective and feasible technique for the surgical treatment of recurrent compressive neuropathy [30, 31].

Papatheodorou et al. [32] described the use of porcine extracellular matrix wrap in addition to decompression and minimal medial epicondylectomy in 12 patients and reported a significant improvement in postoperative pain levels, grip strength and pinch strength, as well as 2-point discrimination.

Other techniques such as amniotic membrane nerve wrapping [33] and ulnar nerve wrapping with a tissue engineered bioscaffold [34] have also been described and reported good results but the indication for all types of adjunctive techniques is still debatable and their efficacy is still to be studied (Fig. 17.1).

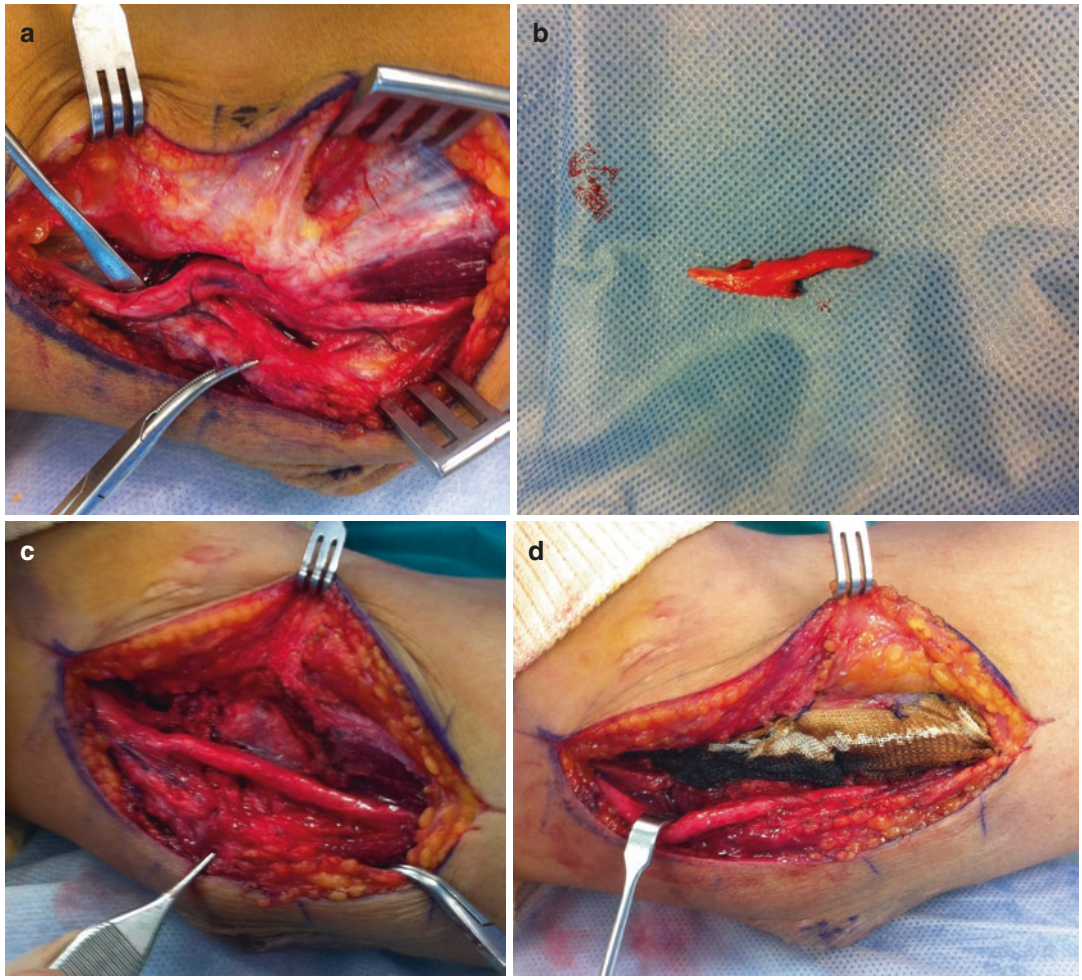

Fig. 17.1 A 40-year-old male patient after previous simple decompression of the ulnar nerve undergoing revision surgery. (**a**) Compressed ulnar nerve by a bony spur at the site of the medial epicondyle. (**b**) The bony spur compressing the ulnar nerve excised. (**c**) The completely decompressed ulnar nerve. (**d**) Dural allograft positioned at the medial epicondyle for protection of the ulnar nerve during gliding and avoidance of the formation of new adhesions

Surgical Techniques

As we have previously analyzed, there is not enough evidence to suggest a superior technique for revision cubital tunnel surgery. There is also literature suggesting the repositioning of the ulnar nerve in the cubital tunnel if possible, in order to regain its regular function [35], but most surgeons agree that the surgical technique tailored according to the intraoperative findings [36]. So, over the last decades, the most accepted techniques for revision surgery are the subcutaneous and submuscular anterior transposition with complete decompression and external neurolysis when needed. In order to achieve complete decompression one must be familiar with all five basic potential sites of compression encountered in primary surgery: the arcade of Struther's, the medial intermuscular septum, the medial epicondyle, the cubital tunnel with the arcuate ligament of Osborne as its roof, and the aponeurosis of the flexor carpi ulnaris [37], or any other possible

fascial bands overlying the ulnar nerve [38, 39]. As for preserving the vascular supply to the ulnar nerve, it is found that the appropriate distance that the vascularized ulnar nerve can be moved into the subcutaneous tissue under tension-free conditions is 1.8 ± 0.6 cm (1.1–2.5 cm) [40].

Subcutaneous Transposition

The incision for the revision surgery incorporates the scar when possible, but extends proximal and distal. The most difficult part is to isolate the nerve from the surrounding scar tissue. This may need a nerve stimulator especially for cases with prior multiple surgeries. External neurolysis then is always necessary, but internal neurolysis may not be required. We should also excise any neuromata of the MACN and transpose them in soft tissues away from the surgical wound. Afterwards, all possible areas of entrapment must be released. A large strip of the medial intermuscular septum is excised, protecting the vessels to the ulnar nerve, and a large fascial window is created in the fascial origin of the flexor carpi ulnaris with excision of the superficial to deep fascial septae within muscle mass. The nerve then lies anteriorly without tension (Fig. 17.2). One 3-0 suture is used to approximate the adipose tissue from the anterior flap to the medial epicondyle and to prevent return of the nerve into the epicondylar groove. Complete proximal and distal decompression is confirmed and the surgical wound is closed. The patient is immobilized for 2 weeks in 90° flexion and then subsequently allowed to progressively begin full active range of motion.

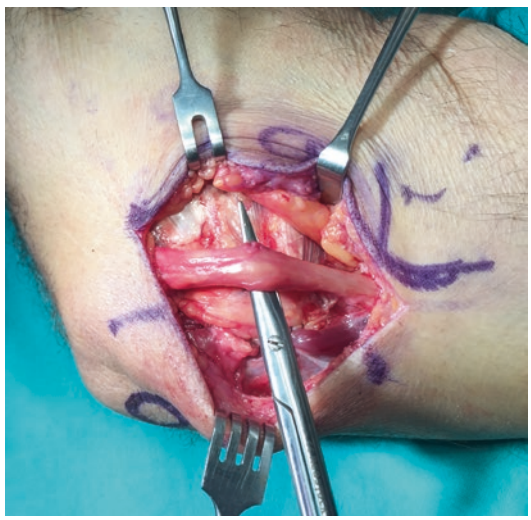

Fig. 17.2 Ulnar nerve after complete decompression lying anteriorly without any tension

Submuscular Transposition

After following the same steps as in the subsutaneous transposition till the stage of the complete decompression, as described above, we lengthen the medial epicondylar muscles by first developing a flap with distal pedicle on the lateral half of the medial epicondylar muscles, and then on the medial half. Next a fascial and tendon flap pedicled to the epicondyle is developed. The ulnar nerve is then transposed and then we oppose and suture the various fascial and tendinous flaps of the medial epicondylar muscles. Postoperatively the patient is immobilized with the arm in 90° flexion, allowing minimal forearm pronation. Subsequently, the patient undergoes 2 weeks of passive mobilization in a sling, followed by 3 weeks of active mobilization without lifting objects weighing more than 1 kg.

Conclusion

As discussed before, the rates of primary cubital tunnel surgery are continuously increasing. As a result of that we may also anticipate an increased need for revision surgeries in the future. We should be ready to face the difficulties of one or multiple revision cubital tunnel surgeries and most of all respect the anatomy of the area and keep a strong adherence to surgical principles in order to avoid ulnar nerve injury, that could worsen patient outcomes [41]. It is found that anterior transposition results in lower ulnar nerve strains than simple decompression during elbow flexion, but in higher nerve strains during elbow extension [42]. So, complete and careful decom-

pression as well as external neurolysis must always accompany an anterior transposition.

Further research comparing different techniques is needed, in order to provide stong evidence-based information about the technique that could provide better outcomes for the patients with recurrent cubital tunnel syndrome.

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