THE ENDOSCOPIC MANAGEMENT OF CUBITAL TUNNEL SYNDROME

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The overall success rate of surgical interventions for cubital tunnel syndrome is reported to be within 80% to 90% (Szabo, 1999). The discussion, however, whether to perform in situ nerve decompression or anterior transposition continues. In this paper, we present the results of our endoscopic approach to in situ cubital tunnel release, its rationale, clinical and anatomical indications and a detailed description of the technique.

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INTRODUCTION

Compression of the ulnar nerve in the cubital tunnel is the second most frequent entrapment neuropathy of the upper extremity. Standard surgical procedures to treat this pathology include in situ decompression of the nerve, often described as "simple decompression" and subcutaneous, or submuscular, anterior transposition of the nerve (Dellon, 1989, 1991).

New approaches to peripheral nerve surgery include the introduction of minimally invasive and endoscopic procedures (Taniguchi et al., 2002; Tsai et al., 1999). Endoscopic and minimally invasive surgery represent a completely new approach to surgery which enables us to see and to do more through much smaller incisions than those used by more traditional techniques.

The purpose of this paper is to present our own endoscopic technique of in situ ulnar nerve decompression at the elbow, to assess the results in a series of 75 patients and to discuss the anatomical basis and the clinical indications for this minimally invasive procedure.

MATERIAL AND METHODS

Cadaveric dissection

Twelve fresh cadaveric arms were dissected under 3.5 × loop magnification to validate the need for extensive distal release of the ulnar nerve in patients with cubital tunnel syndrome. We evaluated the ulnar nerve anatomy in its distal course within the forearm between the two heads of the flexor carpi ulnaris muscle (FCU).

Surgical technique

Before describing the specific procedure used for the cubital tunnel, some introductory remarks about our principles of minimally invasive and endoscopic nerve surgery are necessary. For endoscopic procedures on an extremity, we cannot inflate the soft tissue with gas as in the abdominal cavity. We, therefore, create a space using a tunnelling forceps of appropriate size (Fig 1). With the blades of this forceps, the tissue layers in which we want to dissect can be gently spread apart. For good visualization, we use illuminated specula and endoscopes attached to a light source. The specula are similar to those used in ENT surgery (Fig 1) and the endoscopes – originally designed for endoscopic face lifting – have dissectors of varying size and shape at their tip (Fig 1) (all instruments, KARL STORZ, Tuttlingen, Germany). With the specula, the tunnel can be opened and the dissection started. With the endoscope and the dissector at its tip, the soft tissue envelope can be held up, enabling the surgeon to introduce instruments and to dissect deep within this space. When using illuminated specula, dissection is done under direct vision within the tunnel. When working with the endoscopes, dissection is observed and controlled on the monitor.

The principles described can be applied to the cubital tunnel. The operation is carried out under brachial plexus or general anaesthesia. A pneumatic tourniquet is always used. Draping must allow full mobility of the elbow joint. The arm is positioned in 90° abduction on a standard hand table and the surgeon flexes and supinates the arm to face the cubital tunnel area. The ulnar nerve is palpated and a 15 to 30 mm skin incision is made over the retrocondylar groove. The dissection is carried down to the retrocondylar tunnel roof, which is opened. Clearly recognizable by the vasa nervorum, the ulnar nerve is identified (Fig 2). If an atavistic epitrochleo-anconeus muscle is present, it will be found at this early stage of the dissection, because the entrance to the cubital tunnel will be obscured by the muscle mass. In our series, we had two of these cases, both in very muscular men. In such cases, it may be necessary to enlarge the incision to 4 cm.

The tunnelling forceps is introduced distally about 10 to 12 cm and proximally about 8 to 10 cm (measured from the midpoint of the retrocondylar groove) into the

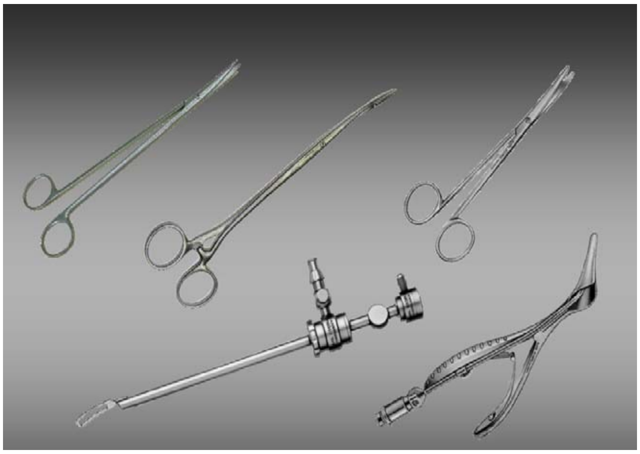

Fig 1 Instruments for endoscopic nerve decompression: tunnelling forceps (top middle), speculum (bottom right), endoscope with dissector on tip (bottom left).

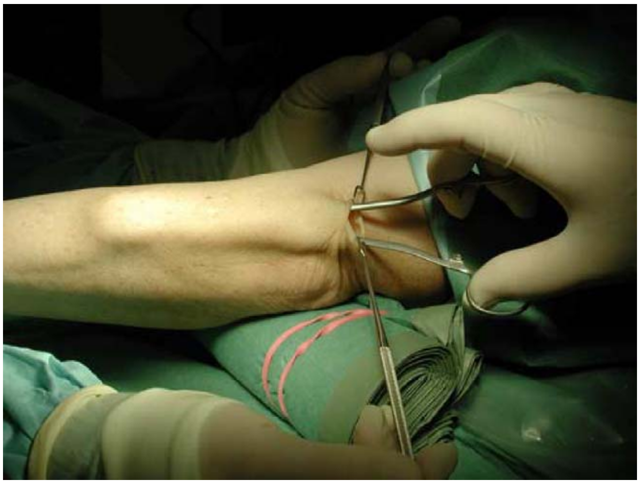

Fig 3 Blunt tunnelling of the cubital tunnel with forceps.

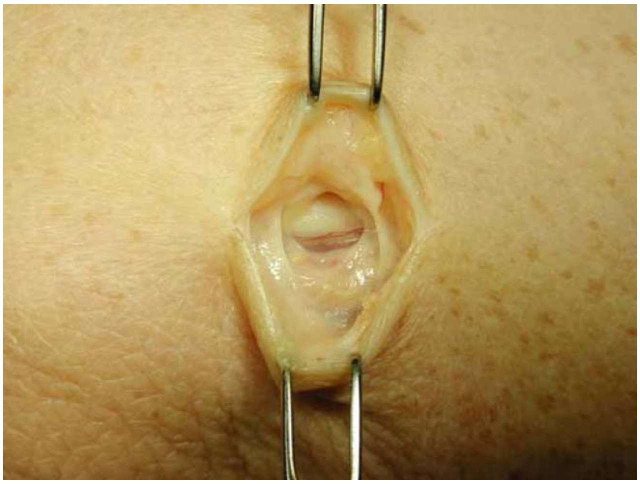

Fig 2 Retrocondylar dissection of the ulnar nerve through a small incision. The nerve is identifiable by the vasa nervorum.

space between the forearm fascia and the subcutaneous tissue. The tunnelling must be done delicately to protect the ulnar cutaneous antebrachial cutaneous nerve and its branches. By spreading the blunt-tipped forceps, which is very similar to a sponge forceps (Fig 1), a generous space is created which permits the insertion of instruments (Fig 3).

First, an illuminated speculum (blade length 9–11 cm) is inserted (Fig 4a) and Osborne's ligament (synonym: cubital retinaculum) (Osborne, 1970), which is the transverse band between the ulnar epicondyle and the olecranon, is divided under direct vision (Fig 4b and c). With the use of the speculum alone, the fascial roof of the retrocondylar groove can be divided (Fig 4d) and the fascia incised up to 5 cm distally and proximally from the midpoint of the retrocondylar groove.

A 4 mm 30° endoscope with a blunt dissector on its tip is now introduced and slowly advanced distally (Fig 5). Lifting up the soft tissue of the forearm with the dissector, the surgeon creates a wide space to view the nerve and its surrounding anatomy. All dissection and cutting is done with blunt-tipped scissors of a length between 17 and 23 cm (Fig 1). Elaborate endoscopic instruments are neither useful nor necessary. Under monitor vision, the forearm fascia overlying the flexor carpi ulnaris muscle is divided up to a point 12 to 14 cm distally from the midpoint of the retrocondylar groove (Fig 6). Care must be taken not to injure cutaneous nerve branches which may cross the fascia in the deeper fat. Once the fascia has been divided, the endoscope is carefully pulled back and further dissection is now carried out close to the nerve.

The next step is the division of the fibrous raphe between the two muscular heads of the flexor carpi ulnaris, sometimes called the "FCU arch" and the release of fibrous bands crossing the nerve distally. All constricting elements up to a distance of 8 to 12 cm measured from the mid-point of the retrocondylar groove are divided. In the course of this dissection, all motor branches of the nerve to the flexor carpi ulnaris can be seen and protected. We have regularly observed and divided distinct fibrous arcades at 3, 5 and 7 cm from the midpoint of the retrocondylar groove (Fig 7). The first of these is the FCU arch. Only rarely is it necessary to clip or cauterise a vessel. Adipose tissue, in combination with lax skin, was present in about 10% of our cases and made the dissection difficult.

Proximally, the roof of the retrocondylar tunnel roof is decompressed in the same fashion. The fascia is divided up to 8 to 10 cm from the midpoint of the

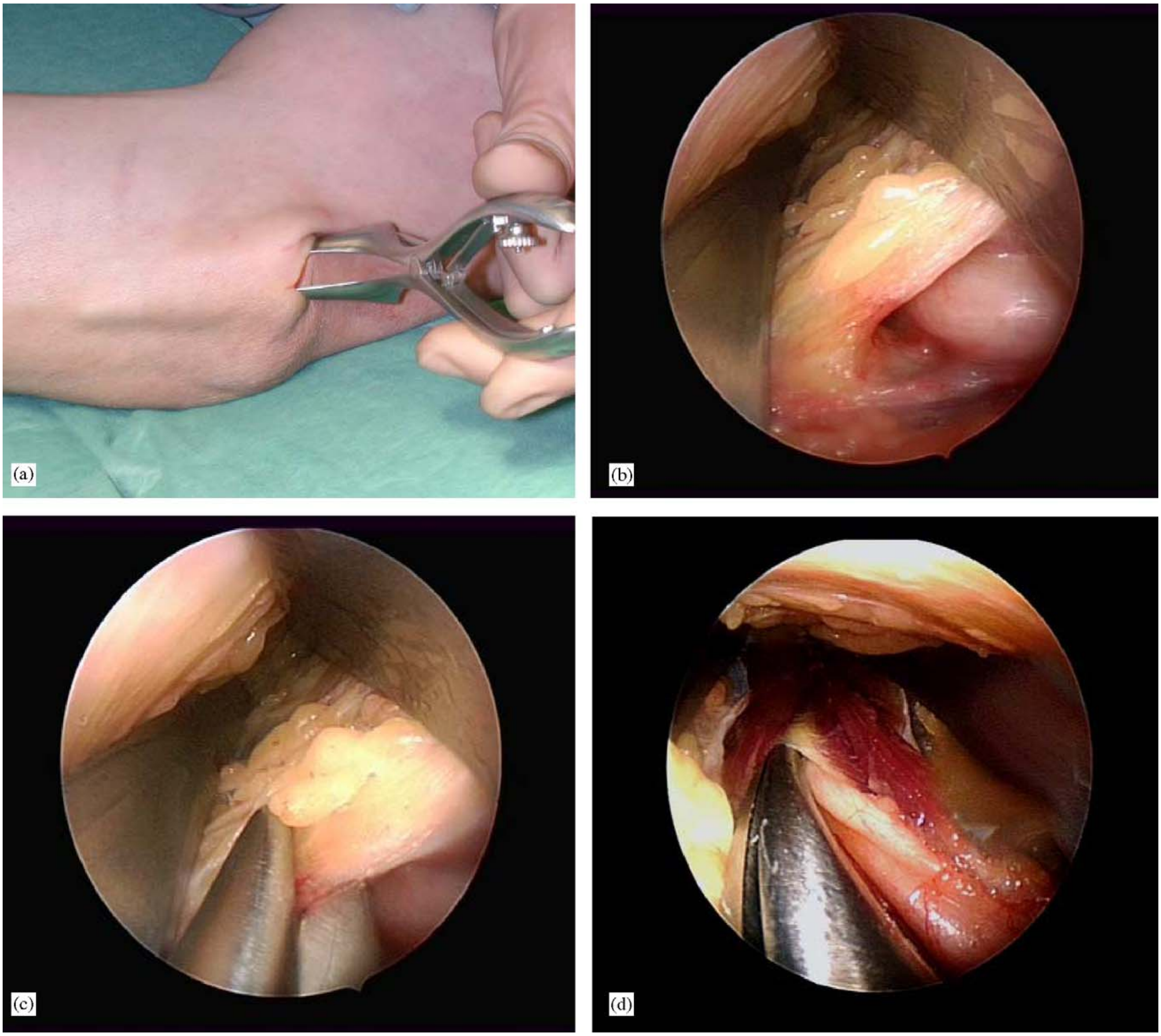

Fig 4 (a) Speculum inserted for initial viewing of the distal cubital tunnel. (b) Ulnar nerve entering the cubital tunnel under Osborne's ligament (cubital retinaculum). (c) Speculum view of scissors about to cut Osborne's ligament and the first part of the flexor carpi ulnaris fascia. (d) Osborne's ligament and the first part of the flexor carpi ulnaris fascia released. The scissor blades are under the first fibrous arcade between the two heads of the flexor carpi ulnaris (the FCU arch).

retrocondylar groove. The intermuscular septum is left alone but the rare Struther's arcade, if present, is divided.

Finally, a suction drain is inserted, the wound closed and a bulky dressing applied. Then, the tourniquet is let down. Patients are allowed to move their elbow but are instructed to avoid resting the arm in flexion for 4 to 6 weeks, to prevent secondary nerve subluxation during the healing period. After 3 days, an elastic elbow bandage is prescribed for use for 4 to 6 weeks.

Clinical study

The study included 76 nerves in 75 patients who underwent surgery between 2001 and 2004. There were equal numbers of male and female patients (Table 1). The diagnosis was based on the history and clinical and neurophysiological examinations. Patients were tested for Tinel's sign, distribution of sensory loss (using static two-point discrimination) and weakness or palsy of the ulnar nerve innervated muscles. We regularly tested and

Fig 5 Distal endoscopic dissection of cubital tunnel.

Fig 6 Dissecting scissors ''en route'' dividing the superficial forearm fascia 8 to 10 cm from the retrocondylar groove. A tiny nerve, identifiable by the vasa nervorum, crosses the fascia distal to the scissor points.

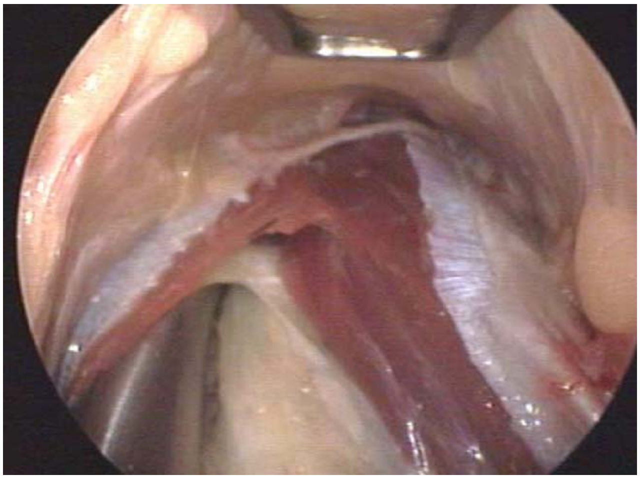

Fig 7 The third fibrous arcade at the distal end of the dissection, about 7 cm from the midpoint of the retrocondylar groove. The two layers of dissection are shown: the superficial fascia already split, and the arcade close to the nerve is seen before release.

Table 1—Data of patients in this study

Number of patients	75
Number of nerves	76
Male (mean age – years)	38 (51)
Female (mean age – years)	37 (53)
Follow-up (months)	11 (1–34)

documented weakness of the first dorsal interosseus and adductor pollicis muscles (Froment's sign), the third palmar interosseous muscle (small finger adduction) and the other ulnar innervated interossei (cross finger test, where the patient is asked to cross his middle finger over the index finger). Grip strength was measured with the Jamar dynamometer. Concomitant pathology of the upper extremity was ruled out or verified. All patients underwent nerve conduction velocity and EMG studies. In all 76 nerves, the neurophysiological findings were pathological.

There were nine patients excluded from the series. Two patients who had recurrent cubital tunnel syndrome following open surgery elsewhere and seven other patients who presented with concurrent diagnoses of chronic alcoholism, cervical spine tumour, Raynaud's disease, polyneuropathy, chronic multifocal pain syndrome, chronic rheumatoid arthritis or brachial plexus irradiation were excluded.

None of the patients had posttraumatic or significant osteoarthritic changes of the elbow joint. None of the patients showed significant abnormal nerve dislocation on full elbow flexion. Fifteen patients had another procedure performed at the same time as the cubital tunnel release, viz. carpal tunnel decompression (eight cases), trapezometacarpal arthritis surgery (two cases), Guyon's canal decompression (one case), excision of the pisiform (one case), radial picondylitis treated by steroid injection (one case), surgery for Dupuytren's contracture (one case) and first extensor tendon compartment release for de Quervain's tendovaginitis (one case).

Patients were classified pre-operatively according to Dellon's Classification (Table 2). There were five (7%) mild, 52 (68%) moderate and 19 (25%) severe ulnar nerve compressions in this series.

Patients were followed-up clinically and the results were evaluated in accordance with the Bishop Rating system (Kleinman and Bishop, 1989; Nouhan and Kleinert, 1997) (Table 3). Muscle power and grip

Table 2—Dellon's classification of ulnar nerve compression at the elbow

	Mild (I)	*Moderate (II)*	*Severe (III)*
Sensory	Intermittent paresthesiae	Intermittent paresthesiae	Permanent paresthesiae
Motor	Subjective weakness	Measurable weakness	Palsy
Patients in this study	5 (7%)	52 (68%)	19 (25%)

Table 3—Modified Bishop rating system

Severity of residual symptoms	
Asymptomatic	3
Mild	2
Moderate	1
Severe	0
Improvement	
Better	2
Unchanged	1
Worse	0
Work Status	
Working in previous job	2
Changed job	1
Not working	0
Strength	
Grip ⩾ 80% (compared with other hand)	1
Grip ⩽ 80% (compared with other hand)	0
Sensibility	
⩽ 6 mm static two-point discrimination	1
> 6 mm static two-point discrimination	0
Maximum score	9

Score: 8 to 9 excellent; 5 to 7 good; 3 to 4 fair; 0 to 2 poor (Kleinman and Bishop, 1989; Nouhan and Kleinert, 1997).

strength were measured clinically (M0–M5 for adduction and abduction of fingers) and with the Jamar dynamometer. Sensory testing was carried out by static two-point discrimination testing.

RESULTS

Cadaveric dissection

Our findings were consistent in all specimens studied and showed evidence of fascial bands crossing the ulnar nerve on its route between the two heads of the FCU muscle. After dissection of the intermuscular raphe between the two heads of the FCU, the ulnar nerve was found to be covered by a thin layer of transparent fascia. Under loop magnification, three distinct zones of fascial thickening creating visible bands were encountered. The first band was seen at 3 cm distance from the middle of the retrocondylar groove. It was 1.5 cm wide, ending 4.5 cm from the midpoint of the retrocondylar groove. This was the "FCU arch", described in the surgical technique (see text above and Fig 4d). The second band started 5 cm distal to the midpoint of the retrocondylar groove and was narrower, measuring only 0.5 cm in width. It ended 5.5 cm distal to the midpoint of the retrocondylar groove (Fig 8). The third band started 7 cm to the midpoint of the retrocondylar groove. This band was the most prominent and measured 2 cm in width. This band extended up to 9 cm from the midpoint of the groove. In our group of cadavers, we did not find a specimen with an epitrochleo-anconeus muscle crossing the ulnar nerve proximal to the FCU arch.

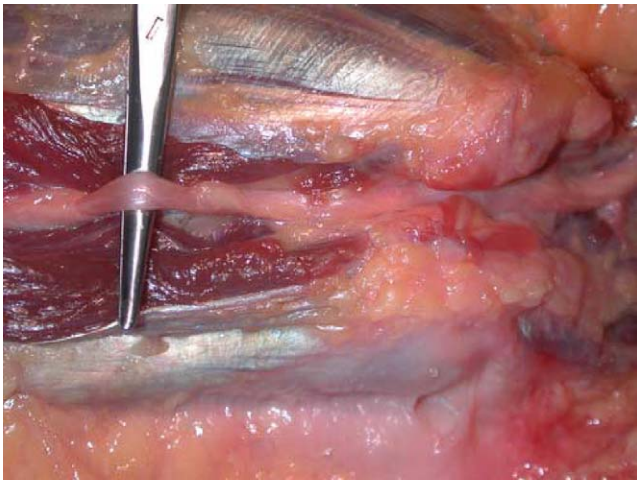

Fig 8 Cadaver dissection of the ulnar nerve distally, showing the first (the "FCU arch") and second fibrous thickenings around the nerve.

Clinical study

The mean length of the skin incision in this study was 28 mm and the mean length of the ulnar nerve decompression was 17 (range 15 – 23) cm.

All patients were questioned on the day after the operation. Ninety-five per cent reported improvement of their symptoms within 24 hours after surgery. More than 90% of the patients had full elbow motion within 2 days after surgery; the remainder had achieved this within a week.

Pre-operative sensory loss improved in 96% of all patients. Measurements of grip strength before and after surgery in the operated hand showed a highly significant gain in strength after surgery, relative to the non-operated hand (Table 4). There were no recurrences of ulnar nerve symptoms. Postoperative nerve conduction study were carried out in 80% of cases. In all of these cases, the results had improved. Ninety-eight per cent of the patients returned to their previous jobs or activities.

Table 4—Pre- and post-operative grip strength

	Pre-operative (mean) (Kg)	*Post-operative (mean) (Kg)*	*Improvement (%)*	*P-value*
Operated hand	29	38	30.5	<0.001
Non-operated hand	38	40	4	<0.523

Table 5—Results

	Dellon I ($n = 5$)	*Dellon II* ($n = 52$)	*Dellon III* ($n = 19$)	*All*
Bishop – Rate				
Excellent	2	33	11	46 (61%)
Good	2	17	6	25 (33%)
Fair	1	1	2	4 (5%)
Poor	0	1	0	1 (1%)

According to the modified Bishop Rating System (Table 3), we found excellent results in 46 patients (60.5%), good results in 25 patients (33%) and fair results in 4 patients (5%). One patient (1%) had a poor result (Table 5). The group of patients with mild symptoms was small, so the results are difficult to interpret. In the group with moderate symptoms, representing the most frequent clinical situation, we found 97% good and excellent results. Surprisingly, the group with severe symptom, i.e. manifest palsy, did very well with 89% good and excellent results. This contradicts a commonly expressed view, recommending more complex procedures, especially transpositions of the nerve, in advanced ulnar nerve compression neuropathies.

Four patients developed superficial haematomata. All resolved within a week and no interventional treatments were necessary. One patient developed Complex Regional Pain Syndrome Type 1 (Algodystrophy, Reflex Sympathetic Dystrophy) and, in spite of prolonged intensive physiotherapy, the result was poor. Nine patients developed hypoaesthesia in the ulnar forearm skin area innervated by the ulnar antebrachial cutaneous nerve, most likely due to stretching of the nerve by the tunnelling procedure. In all but one patient, this resolved within 3 months. This patient continued to have dysaesthesia in the mentioned area, but no pain due to neuroma. There was no case in whom post-operative nerve subluxation was a problem.

DISCUSSION

Our view, like that of other authors (Assmus, 1994; Nathan et al., 1992, 1995; Pavelka et al., 2004; Taniguchi et al., 2002; Tsai et al., 1999), is that transposition of the ulnar nerve is not only unnecessary for the treatment of cubital tunnel syndrome, but that it may often be harmful and seriously disadvantageous, considering its potential complications (Heithoff, 1999, Mariani et al., 1999).

The endoscopic approach to in situ decompression of the ulnar nerve is not new. Tsu-Min Tsai et al. (1999) used an endoscopic technique for cubital tunnel syndrome as early as 1992. They concluded that their results failed to show any superiority of the technique over other standard techniques. The description of their technique suggests that it was similar to that used for endoscopic surgery for carpal tunnel syndrome. They describe extensive division of the forearm fascia only. The extent of division of constricting structures close to the nerve remains unclear.

In our own series, the feature of the technique which impressed us most was the rapidity of postoperative improvement of symptoms. This is reflected in the results of the 75 patients reported. Our previous experience of more than 20 years with a limited in situ release, in which we divided Osborne's ligament and the FCU arch as the most distal point of dissection, had been that immediate resolution of symptoms was the exception rather then the rule. One had to wait for months to observe and measure improvement. Nathan (1995) defines the immediate resolution of symptoms as "within 6 months of surgery". Assmus (1994), describing the results of a series of 523 cases which he treated by "simple decompression", had to wait for 2 to 4 months for measurable success in mild and moderate cases and for over 12 months in severe cases. In contrast to Nathan's findings that, with time, results got worse, with the percentage of excellent cases in his series dropping by 10% after 6 months and the unimproved cases increasing by 10%, we have seen no such recurrence or worsening of symptoms in our patients.

This begs the question why patients undergoing endoscopic decompression of the ulnar nerve should show superior short-term and, possibly, long-term results. Our hypothesis is that ulnar nerve compression around the elbow and in the forearm is a multifocal neuropathy. Amadio et al. (1986) described a single compression site more distally in the musculature. In our study, each of the fibrous bands found during cadaveric dissections was similar in form and shape to Frohse's arcade in the supinator muscle. Each of these arcades from 3 to 9 cm distally from the midpoint of the retrocondylar grove is as likely to constrict the nerve as is Osborne's ligament in the retrocondylar area of the elbow or, if present, an epitrochleo-anconeus muscle or ligament of the same name. Any operation which decompresses the nerve effectively up to a distance of 9 to 10 cm distally from the midpoint of the retrocondylar groove, is, therefore, likely to improve the patient's symptoms. On the other hand, if, by limited dissection, compression sites are missed, a less successful outcome may result, because of incomplete release or because of the nerve kinking on an unreleased band.

Surgeons recommending a complex transposition (Dellon, 1991) or an extensive open in situ release

(Pavelka et al., 2004) are probably decompressing the nerve more radically than others. We achieve an equally extensive decompression with an endoscopic technique and less tissue dissection. The mean length of decompression in our cases was 17 (range 15–23) cm. Small incisions for open neurolysis have been described by Nathan (1995) and Taniguchi (2002). It is hardly possible to dissect the nerve up to the distance we suggest with small Langenbeck retractors, as shown on Taniguchi's illustrations. These small incision techniques probably also increase the risk of damage to the medial antebrachial cutaneous nerve.

In conclusion, we recommend our technique as a valuable alternative to the known techniques of simple decompression of the ulnar nerve at the elbow. It is a ''long distance'', in situ and atraumatic nerve decompression, based on anatomical evidence which is simple. It also avoids the complexity and complications of transposition procedures. It is a procedure which, apart from the endoscope, requires no special instruments, has a relatively short learning curve, is safe and, in our hands, has proven to be efficient.

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