DOI: 10.21608/pajn.2022.106067.1039

Original Article

Ulnar Nerve in Situ Decompression versus Transposition for Idiopathic Cubital Tunnel Syndrome: Long-term Clinical Outcome: Multicenteric Retrospective Study

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Received: 14 November 2021 / **Accepted:** 5 January 2022 / **Published online:** 21 June 2022

BACKGROUND: Cubital tunnel syndrome is one of the most frequent upper extremity entrapment neuropathies. The best surgical therapy for cubital tunnel syndrome remains controversial and a topic of discussion.

OBJECTIVE: Our goal is to compare the results of two different surgical approaches for cubital tunnel syndrome and to correlate the preoperative findings guided by electrodiagnostic studies with the intraoperative findings regarding the accurate sites of ulnar nerve compression at the cubital tunnel in both surgical approaches, as well as to assess the long-term clinical outcome of surgical management.

PATIENTS AND METHODS: From 2012 to 2018, we retrospectively reviewed the data of 79 patients who had cubital tunnel syndrome and were managed by two different surgical procedures. To confirm the diagnosis and locate locations of ulnar nerve entrapment in the cubital tunnel, preoperative electrodiagnostic tests were done. Preoperative clinical symptoms were identified using Dellon's staging approach, and postoperative clinical outcome was assessed using a modified Bishop rating system in all patients.

RESULTS: The outcomes were graded excellent in 61 patients, good in 15 patients, and fair in three patients. Regarding the in situ group, excellent improvement was obtained in 30 patients (78.9%), good improvement in 6 patients (15.8%) and fair improvement in 2 patients (5.3%). Regarding the transposition group, excellent improvement was achieved in 31 patients (75.6%), whereas good improvement and fair improvement were observed in 9 patients (21.9%) and 1 (2.4%) patient, respectively. Electrodiagnostic studies were not accurate in detecting the actual sites of ulnar nerve entrapment, while intraoperative results were more accurate.

CONCLUSION: In situ decompression is as beneficial as anterior transposition in the treatment of cubital tunnel syndrome, according to our findings. When compared to intraoperative results, electrodiagnostic investigations perform poorly in diagnosing the precise locations of ulnar nerve compression.

KEYWORDS: Anterior transposition, Cubital tunnel syndrome, Electrodiagnostic studies, In situ decompression, Outcome.

INTRODUCTION

After carpal tunnel syndrome, cubital tunnel syndrome (CuTS) is the second most prevalent upper extremity compression neuropathy, with an incidence of 21 to 30 occurrences per 100,000 persons/year.[1]

The ulnar nerve (UN) can be compressed at several points along its path at the elbow, between the medial epicondyle of the humerus and the olecranon process of the ulna; at the intramuscular septum due to Struthers' arcade, at the medial epicondyle at the cubital tunnel entrance, and at the flexor-pronator aponeurosis between the heads of the flexor carpi ulnaris (FCU).[2-4]

Pressures that raise tissue pressure in the affected site of a peripheral nerve cause compressive neuropathies. Venous congestion can develop from any increase in pressure around a nerve, placing the circulatory system at danger. Ischemia is the primary lesion of entrapment neuropathies. According to researches, ischemia causes edema as a side consequence, which contributes to the compression. Both ischemia and compression have an impact on axoplasmic flow, which is required for neuron activity. Many authors believe that external compression affects nerve function through this process.[2-5]

The patients' symptoms range from paresthesias and dysesthesias to numbness and absolute anesthesia in the majority of cases. Because of intrinsic muscle weakness and the unopposed action of the flexor digitorum profundus (FDP), the hand might develop a claw deformity. CuTS can cause lifelong loss of sensation and consequent joint contractures if left untreated.[6]

In order to diagnose ulnar neuropathy, a combination of physical examination, electrodiagnostic testing (EDx), ultrasound, and magnetic resonance imaging (MRI) is required.

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Needle electromyography (EMG), motor nerve conduction studies (NCS) of the innervated muscles by the ulnar nerve in the hand, and sensory NCS are among the tests utilized by the EDx provider to aid in diagnosis. UN conduction latencies, waveforms, amplitudes and velocities may also be compared throughout the elbow section to see if there is a localized damage. An MRI of the elbow might potentially be used to determine the location of the entrapment.[7-10]

After conservative therapy has failed, there is no agreement in the literature on the definite surgical management for CuTS. Surgical alternatives include in situ decompression with or without medial epicondylectomy and UN transposition, which can be done subcutaneously, intramuscularly and submuscularly.[11]

Endoscopic surgery for CuTS has been available, with the benefits of a smaller incision, reduced scar burden and the lack of injury to the medial antebrachial cutaneous nerve.[12]

The aim of the study is to compare the outcome of two different surgical approaches for cubital tunnel syndrome and to correlate the preoperative findings guided by electrodiagnostic studies with the intraoperative findings regarding the accurate sites of ulnar nerve compression at the cubital tunnel in both surgical approaches.

PATHIENTS AND METHODS

We retrospectively reviewed the documents of all patients who were surgically treated for CuTS between March 2012 and January 2018 at Sohag, Mansoura and Fayoum University hospitals. Seventy-nine patients were included in this study after excluding those with incomplete data or who were dropped during follow-up **(Fig. 1).** Clinical, laboratory, EDx, and radiological assessments were performed for all patients to exclude any medical or surgical cause other than UN entrapment. Patients' data was gathered after informed consent to use medical data records from the departments of the participating hospitals.

This study's inclusion criteria were: age > 18 years, idiopathic CuTS based on laboratory examination, clinical assessment, neurological examination (to rule out secondary causes such as polyneuropathy or mononeuropathy multiplex), electrodiagnostic studies (EMG revealed a motor conduction velocity (MCV) across the elbow of 50m/s), as well as recurrent elbow pain after conservative treatment and radiographic evaluation (cervical X-ray and cervical MRI).

Incomplete data or results, posttraumatic cases, prior intervention, proximal compression of the UN like cervical radiculopathy, angular elbow disorder (surgeries, endoscopy or steroid infusion), thoracic outlet syndrome, and systemic disorder were excluded. Informed consent to the use of our medical data was signed by every patient.

Dellon's staging system[13] was used to identify the patients' preoperative clinical symptoms in this study. According to that classification, patients were graded as mild, moderate, and severe **(Table 1)**. Patients were divided into two surgical groups in our study; in situ and transposition.

All patients' postoperative clinical outcomes were assessed using a modified Bishop rating system.[14] Results were classified into excellent, good, fair, and poor as depicted in **Table 2.** Excellent was ≥ 8 points on a 14-point scale, good was between 6 and 7, fair was between 4 and 5, and poor was ≤ 3. The definite sites of entrapment were assessed by preoperative EDx studies and compared with intraoperative findings.

Electrophysiological assessment

EDx records were reviewed regarding the assessment of terminal latency (TL), motor and sensory conduction velocities (CV), and the amplitude of waves recorded along the course of UN to assess the actual sites of entrapment. Following the requirements of the American Association of Electrodiagnostic Medicine (AAEM), a neurophysiological protocol was developed.[15] The UN was subjected to motor and sensory NCS. The UN was stimulated at the bicipital sulcus,[16] as well as the wrist, proximal and distal to the elbow. Surface electrodes were used to record compound muscle action potentials

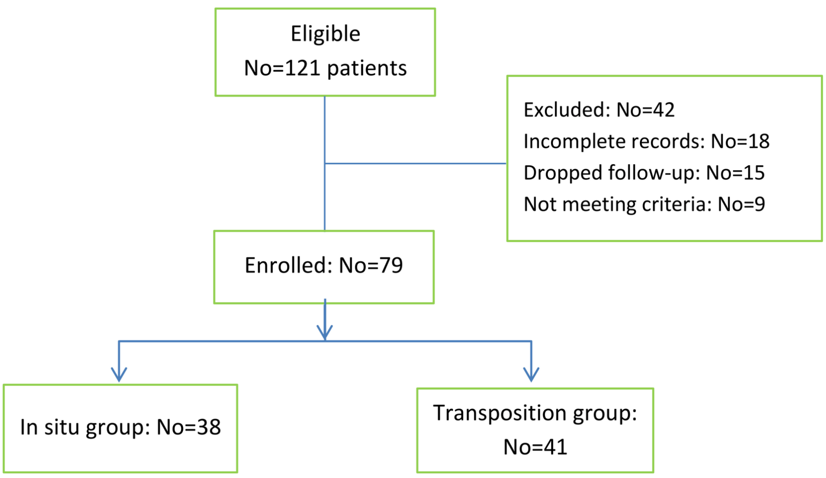

Fig 1: Patient flow chart.

(CMAP). Antidromically recorded sensory nerve action potentials (SNAP) were evaluated in all subjected UNs and the terminal latencies were recorded from the stimulus to the onset of wave deflection. All segments' conduction velocity was calculated. The abductor digiti minimi (ADM) and FDP muscles were studied.[17]

Statistical analysis

The statistical packages for social sciences (SPSS) software statistics computer program version 22 was used to arrange, tabulate, and statistically analyses the obtained data (SPSS Inc, USA). The mean, standard deviation, and range were used to show quantitative data. Numbers and percentages were used to portray categorical data. As a significance test, the Chi-squared test was utilized. The Kappa test was performed to assess the number of compression sites by comparing EDx and intraoperative data. A p-value of 0.05 or less was considered statistically significant.

Ethical considerations

The study was authorized by the medical research ethics committee of the participating universities, and each participant patient (or his or her legal guardians) gave written informed permission.

RESULTS

In situ decompression was performed as the main surgery in 38 (48%) of the 79 patients, while transposition was performed in 41 individuals (52%) **(Figs. 2, 3)**. Patient follow-up was assessed over a period of 2-3 years (average = 2.4 years). According to the current study, the mean age of the studied groups was 40±10 years in the situ group and 42 ± 14 years in the transposition group. The study included 59 (74.6%) males and 20 (25.3%) females. There were no statistically significant variations in demographic statistics between the two groups ($p > 0.05$).

In the in situ and transposition groups, the average duration of symptoms before surgery was 19 ± 8 and 23 ± 9 months, respectively ($p < 0.05$). CuTS affected the right side in 48 individuals (60.7%) and the left side in 25 patients (31.6%). Six of our patients had bilateral symptoms (7.6%). **Table 3** shows the data from these 79 patients.

All patients were rated before surgery using Dellon's categorization **(Table 1)**. According to this categorization, 6 (6.8%) patients were judged mild, 54 (68.2%) patients were considered moderate, and 19 (25%) patients were labeled severe. There were no statistically significant variations ($p > 0.05$) in the preoperative clinical picture between the two groups tested.

Preoperative EDx studies were done in all cases. In our study, we highlighted the data of the definite sites of UN entrapment as stated by these studies and when compared to intraoperative findings. We found that EDx was not accurate in detecting the actual number of sites of UN entrapment and intraoperative findings were more accurate in that concern.

In situ group; one site compression was found in 29 patients in the preoperative EDx, but was found intraoperatively to be in 18 patients only while the rest had two sites of compression. Two-sites compression was found in 8 patients in the preoperative EDx, and was discovered to be in 19 patients intraoperatively **(Table 4)** ($p < 0.05$); Kappa value (0.649).

In the transposition group; one site compression was documented in 26 patients in the preoperative EDx, compared to 18 patients only intraoperatively, while the rest had two sites of compression. Two sites of compression were found in 11 patients in the preoperative EDx, but were found to be in 19 patients intraoperatively ($p < 0.05$); Kappa value (0.7) **(Table 4)**.

Blood loss was observed to be lower in the in situ group than in the transposition group (280 ± 37 cc vs 350 ± 80 cc, respectively). In addition, the mean operating time in the in situ group (50 ± 5 minutes) was considerably lower ($p < 0.05$) than in the transposition group (60 ± 4 minutes).

The results were rated as excellent outcome in 61 patients (77.2%), good outcome in 15 patients (19%), and fair outcome in three patients (3.8%) using a modified Bishop rating system **(Table 3).** When we examined the outcomes of the two surgical techniques, we found that out of 38 patients treated with in situ decompression excellent improvement was obtained in 30 patients (78.9%), good improvement in 6 patients (15.8%) and fair improvement in 2 patients (5.3%). Regarding the transposition group, excellent improvement was achieved in 31 patients (75.6%), whereas good improvement and fair improvement were observed in 9 patients (21.9%) and 1 (2.4%) patient, respectively.

In terms of postoperative complications, one patient (2.46 %) in the in situ group and 3 patients (7.3 %) in the transposition group had hematomas that were treated. Infection was found in two individuals in the transposition group (4.9%) but not in the in situ group. One patient (2.4%) in the transposition group suffered from an anterior cutaneous nerve damage. All of these patients were managed by conservative treatment. Between the two groups, there was no statistically significant difference as regards postoperative complications ($p > 0.05$).

During the follow-up period, 6 patients (15.8%) in the in situ group and one patient (2.4%) in the transposition group experienced recurrence of symptoms ($p < 0.05$). EDx tests were performed on all of these individuals to confirm the recurrence. For the first three to four months, all patients received conservative therapies. The single patient in the transposition group recovered completely, but only four patients in the in situ group recovered completely, with the remaining two patients scheduled for repeat surgery.

We reported direct accidental trauma to the UN during the period of follow-up in one patient in the in situ group (2.6%) and 4 patients (9.8%) in the transposition group. All those patients were treated conservatively without any need for surgical intervention. **(Table 3).**

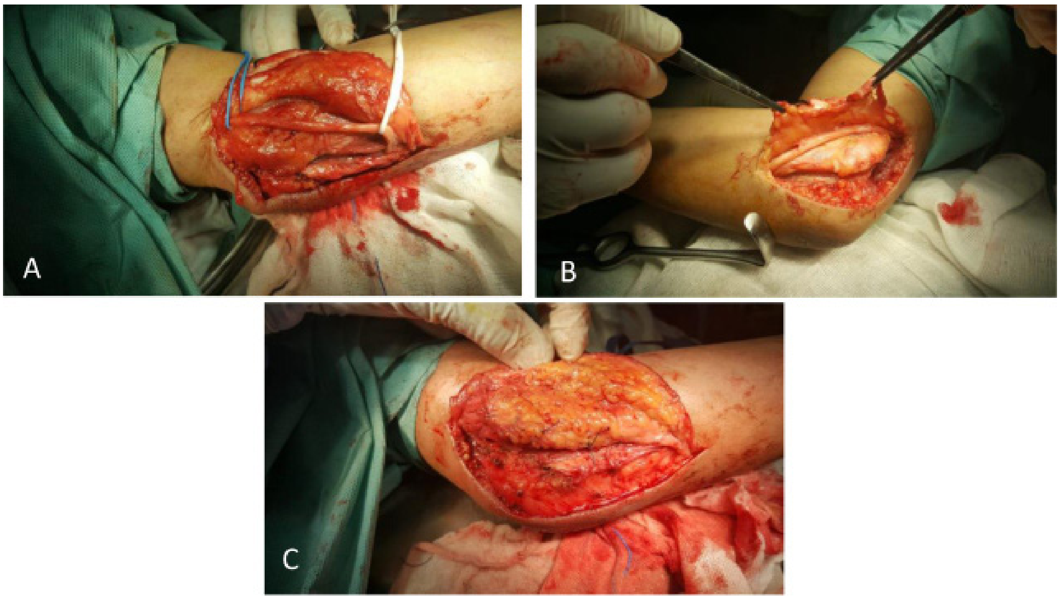

Fig 2: (A) Fifty one years old male patient with complete decompression along the tract of ulnar nerve and anterior transposition. (B) Facial muscle flap dissection. (C) A new tunnel for the ulnar nerve with nearly complete covering after confirmation of free nerve movement.

Fig 3: Forty three years old female patient with complete nerve decompression along the tract with anterior transposition of the ulnar nerve into a new tunnel from partial facial muscle sling after confirmation of free nerve movement.

Table 1: Dellon's cubital tunnel syndrome (CuTS).[13]

	Mild (I)	**Moderate (II)**	**Severe (III)**
Sensory	Intermittent paresthesia, vibratory perception increased	Intermittent paresthesia, vibratory perception normal or decreased	Permanent paresthesia, vibratory perception decreased, abnormal two point discrimination
Motor	Subjective weakness, clumsiness, or loss of coordination	Measurable weakness in pinch or grip strength	Measurable weakness in pinch or grip strength plus muscle atrophy (palsy)
Tests	Elbow flexion test, Tinel sign, or both are positive	Elbow flexion test, Tinel sign, or both are positive. Finger crossing may be abnormal	Elbow flexion test, Tinel sign, or both are positive. Finger crossing usually abnormal

Table 2: Modified Bishop rating system.[14]

Residual symptoms	
None	3
Little/Intermittent	2
Moderate	1
Severe	0
Subjective improvement	
Better	2
Unchanged	1
Worse	0
Ability to work	
Working in old job	2
Changed job due to complaints	1
Incapable of working	0
Muscle strength	
Better	1
Unchanged	0
Sensory disturbance	
Better	1
Unchanged	0
Evaluation	
Excellent	8–9
Good	6–7
Fair	4–5
Poor	≤3

Table 3: Demographical data of the studied group

		In situ group: 38		**Transposition group: 41**		**p-value**
Age (Mean ± Standard Divation)		40±10	(23-59y)	42±14	(25-62y)	0.331
Sex	Male	30	78.9 %	29	70.7%	0.401
	Female	8	21.1 %	12	29.1%	
Onset of symptoms in months		19±8	(3-36)	23±9	(4-43)	0.006*
Affected side	Right	25	65.8%	23	56.1 %	0.607
	Left	11	28.9%	14	34.1 %	
	Bilateral	2	5.3%	4	9.8 %	
Preoperative Dellon's classification	Mild (I)	4	10.5%	2	4.9 %	0.392
	Moderate (II)	27	71.1%	27	65.8 %	
	Severe (III)	7	18.4%	12	29.3 %	
Intraoperative timing		50±5	40-60 minutes	60±4	50-70 minutes	<0.0001*
Intraoperative bleeding		280±37	200-350 ml	350±80	290-430 ml	<0.0001*
Post operative Bishop rating	Excellent	30	78.9 %	31	75.6 %	0.658
	Good	6	15.8 %	9	21.9 %	
	Fair	2	5.3%	1	2.4 %	
Postoperative complications	Hematoma	1	2.6%	3	7.3 %	0.343
	Infection	0	0.0 %	2	4.9%	0.168
	Antebrachial cutaneous nerve injury	0	0.0 %	1	2.4 %	0.333
	Recurrence	6	15.8 %	1	2.4 %	0.037*
	Direct trauma	1	2.6%	4	9.8 %	0.194
Hospital stay (day)		1.5±0.2	1-2	3±0.6	2-4	<0.0001*

* Significant.

Table 4: Correlation between EMG & NCS and intraoperative finding regarding UN compression sites

	In situ group: 38		P-value#	Transposition group: 41		P-value#
	Electrophysiology (EMG & NCS)	Intraoperative		Electrophysiology (EMG & NCS)	Intraoperative	
One site	29	18		26	18	
Two sites	8	19	<0.0001*	11	19	<0.0001*
Three sites	1	1		4	4	

* Significant.

DISCUSSION

In situ decompression is the preferred surgical procedure for most instances of CuTS,[18-21] according to several publications. Others argue that anterior transposition of the UN is not only pointless for effective therapy, but can also be hazardous and cause difficulties.[12,22,23]

In terms of our findings, we agree with the previous authors who claim that if all surgical procedures have a comparable success rate, the surgical technique of choice should be based on simplicity.[12,22-24]

In the current study, there were no significant differences in age or sex between both study groups ($p > 0.05$). Males constituted the majority of cases in both study groups and that approached the findings of Asamoto et al.[25] who assessed the outcomes of 81 patients surgically treated for UN entrapment at the elbow; 55 males (67.9%) and 25 females (30.9%).

Apart from the duration of symptoms before surgery ($p < 0.05$), there were no statistically significant variations in preoperative clinical data between both groups. The current results agree with Said et al.[26] and Anker et al.[27]

With a sensitivity of 37 to 100%, motor NCS in patients have revealed localizing anomalies in symptomatic elbows. Campbell et al.[28] found sensitivity of 53 to 56% in severe cases and 27% in moderate cases. Generally, absolute CV abnormality is a more precise predictor of abnormality than relative CV abnormality.

In terms of operative time and intraoperative blood loss, there was a significant variation ($p < 0.05$) between both groups. Said et al.[26] found that in the in situ group, the mean quantity of blood loss without wearing a tourniquet was considerably ($p < 0.05$) lower than in the transposition group (26.67± 7.07 cc vs. 48.89 ±13.6 cc). In addition, the in situ group's operation time (46.6 ±3.5 minutes) was substantially ($p < 0.05$) less than the transposition group's (67.78 ±16.2 minutes).

When opposed to anterior transposition procedures, in situ decompression offers several advantages. First, in situ decompression is a straightforward technical procedure that has no impact on the UN's blood supply. Second, it is successful because it targets the cubital tunnel, which is the major focus of the lesion. Third, there are fewer surgical problems and greater prospects for faster rehabilitation. However, in situ decompression is not advised in patients with a bad bed, significant cubitus valgus, or a subluxing nerve.[29-31]

Patients managed by in situ decompression or transposition showed similar excellent, good, and fair results in our study. So far, all prospective trials have shown that in situ decompression and anterior transposition are equally helpful, with a preference for avoiding transposition as the preferred treatment due to the greater complication rate.[32-34] A meta-analysis showed no statistically significant differences in the surgical techniques offered.[35]

Grigorios et al.[36] investigated the outcomes of three distinct surgical approaches for CuTS treatment; in situ decompression, partial epicondylectomy, and anterior subcutaneous transposition. They found that individuals treated with transposition had a poorer outcome than those treated with the other two techniques, and they recommended in situ decompression as a simple, straightforward, and successful approach for CuTS. According to Ogata et al.[37] anterior subcutaneous transposition was linked to a higher rate of UN devascularization, which impaired the ultimate result and raised the chance of direct trauma. Contrary to the previous two studies, we arrived at varied conclusions, none of which revealed a statistically significant difference between the present study groups.

In our study we found postoperative complications to be more prevalent in the transposition group than in situ group where hematoma, infection rates, and antebrachial nerve injury were more prevalent in the transposition group. Lower incidence of complication rates in in situ group made postoperative hospital stay shorter in in situ group. In a randomized prospective study, Bartels et al.[32] discovered that the transposition group had a greater complication rate than the in situ group (31.1 % vs. 9.6%), with more numbness (18.6% vs. 2.5%) and more infections (9.3 percent vs. 2.5 %). Biggs and Curtis showed that in another prospective randomized study comparing in situ versus transposition, transposition resulted in higher infection rates than in situ group.[33] In terms of recurrence, it was more common in in situ groups than in transposition groups, which was statistically significant ($p < 0.05$), and the risk of direct injury (blow) to the UN was greater in the transposition group at the final follow-up period, although statistically insignificant. According to Ogata et al.[37] anterior subcutaneous transposition was linked to a higher rate of UN devascularization, which harmed the result and increased the risk of direct trauma.

Our EDx assessment of patients who presented with manifestations of UN entrapment revealed that the majority of patients (70%) had entrapment at a single site (55 out of 79) while just 30% had entrapment at more than one site (24 out of 79) which is concomitant with the majority of studies investigating UN entrapment. Other studies showed the majority of cases having multiple entrapment sites which may be due to the sample selection of patients with severe symptoms and long-standing complaints.[38,39]

To the best of our knowledge, little is written in the literature comparing the accuracy of EDx studies in localizing the different sites of UN compression at the cubital tunnel with intraoperative findings. This is a point that should be considered in future studies as we found that EMG & NCS studies were seemingly inaccurate regarding the site of entrapment when compared with intraoperative findings in both surgical groups ($p < 0.05$). Further prospective studies with greater data analysis should be carried out to consolidate these results.

Simmons et al.[40] ascribed this to technical and biological factors like body mass index (BMI) and temperature that impact the measurement of ulnar forearm and across-elbow NCV. As the BMI rises, the distance measurement rises as well, becoming further dissociated from the real nerve distance. As a result, establishing a difference in NCV between the two groups is more difficult in people with high BMIs (possible false-negative result) and simpler in those with low BMIs (possible false-positive result). The influence of ambient temperatures on ulnar forearm and across-elbow NCV is variable. Low skin temperature has no influence on forearm NCV, but it does have a significant effect on across-elbow NCV,[41] which was not used in our study.

The limitations of our study include the retrospective nature and the small number of patients in study groups, as well as the lack of MRI findings, which limit the application and solidity of our findings and highlight the need for more research to reach reliable conclusions about the efficacy of current treatments. Prospective studies comparing various surgical procedures can offer greater data to allow defining the optimal treatment choice.

CONCLUSION

When comparing their efficacy, in situ decompression exhibited the same rates of excellent and good results in comparison to UN transposition. When it comes to pinpointing the exact location of UN compression, EDx data are not always reliable when it comes to defining the accurate sites of UN entrapment in the cubital tunnel. Elbow MRI and ultrasonography should be included in future studies in the context of addressing the sites of UN entrapment in the cubital tunnel.

List of abbreviations

AAEM: American Association of Electrodiagnostic Medicine.
ADM: Abductor digit minimi.
BMI: Body mass index.
CMAP: Compound muscle action potentials.
CuTS: Cubital tunnel syndrome.
CV: Conduction velocities.
EDx: Electrodiagnostic testing.
EMG: Electromyography.
FCU: Flexor carpi ulnaris.
FDP: Flexor digitorum profundus.
MCV: Motor conduction velocity.
MRI: Magnetic Resonance Imaging.
NCS: Nerve conduction studies.
SNAP: Sensory nerve action potentials.
SPSS: The statistical packages for the social sciences.
TL: Terminal latency.
UN: Ulnar nerve.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

Funding

The authors received no financial support for the research, authorship, and/or publication of this paper.

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