



Research Article

Outcome of Late Neurolysis on Median and Cubital Nerve Neuropathies: Insights from A Preliminary Prospective Study

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Abstract

Background: Nerve decompression represents the treatment in which a nerve is freed from compressing surrounding. It should be ideally performed before neural changes become irreversible following long-term entrapment. No consensus exists on a critical time limit that would make surgery worthwhile. This study aims to investigate whether or not late (12 months after occurrence of symptoms) nerve decompression has still a positive impact on patient's symptoms.

Methods: This prospective study included 16 patients with carpal tunnel syndrome (8) or ulnar nerve entrapment (8) lasting for more than 12 months. Symptoms, motor and sensory functions were assessed before surgery, at 3,6 and 12 months after nerve decompression.

Results: After median nerve decompression, pain decreased by 85%. Paresthesia resolved in all patients and nighttime symptoms decreased in 83% cases. Following ulnar decompression, pain decreased by 75 % and numbness resolved in 87% patients. Subjective sensibility increased by 25%, attested with Ten test. Measure of 2-PD decreased by 60% when compared to preoperative values. Grip strength improved to 40%.

Conclusion: Despite uncomplete recovery one year after surgery, we believe that nerve decompressions should be indented even in case of chronic symptoms.

Keywords: Carpal Tunnel Syndrome; Ulnar Nerve Entrapment; Neurolysis; Late Neurolysis; Cubital Tunnel Syndrome; Ulnare Nerve; Median Nerve

Introduction

Nerve compressions occur where nerves pass through narrow anatomical tunnels near joints [1].

Chronic compression affects blood flow, leading to damage to blood vessels and leakage of proteins into surrounding nerve tissue [2]. The lack of lymphatic drainage exacerbates pressure, akin to a "mini compartment syndrome," reducing blood flow and oxygen delivery [3]. Consequently, nerve fibers degenerate, leading to irreversible damage and fibrosis [4]. Nerve decompression, ideally performed before irreversible changes occur, involves freeing the compressed nerve from surrounding compressive tissue [5-6]. Carpal Tunnel Syndrome (CTS) and Ulnar Nerve Entrapment at the elbow (UNE) [7] are the most common forms, with incidences ranging from 100 to 300 and 21 to 30 cases per 100,000 person-years, respectively [8-9]. These conditions cause sensory disturbances, motor dysfunction and pain, significantly impacting quality of life and work capacity [10-11].

Conservative therapy is the initial approach for nerve compression, with surgery considered if symptoms persist [12]. Authors generally recommend surgery within 3 to 12 months of conservative treatment to balance potential spontaneous recovery with adverse changes from chronic compression. Early surgery is often preferred to prevent irreversible nerve damage [13]. However, there's no consensus on the optimal timing for surgery due to conflicting views on nerve recovery after chronic compression [14-17].

This prospective study aims to assess the impact of late nerve decompression on patient symptoms despite the changes that occur in the nerve. Focusing on CTS and UNE, we investigate late decompressions at the carpal and cubital tunnels, respectively. Surgical outcomes, motor and sensory recovery and functional scores are meticulously evaluated.

Material and Methods

Between September 2019 and August 2021, a prospective study was conducted at the University Hospital of Lausanne - Centre Hospitalier Universitaire Vaudois, after approval by the institutional ethics committee and complying with the Helsinki declaration and was approved by the ethical boards (CER-VD 2019-00854).

Demographics

Patients experiencing persistent numbness, tingling or pain in the median/ulnar nerve distribution for over 12 months, along with positive provocative tests, were included. Electrodiagnostic studies confirmed the diagnosis of CTS/UNE with compressive neuropathy and ruled out other compression sites. Exclusions comprised diabetic neuropathy, traumatic nerve injury, double crush neuropathy, radiculopathy or systemic inflammatory disease. Patients unwilling to participate or with less than 12 months of postoperative follow-up were also excluded.

Sixteen patients (8 CTS, 8 UNE), consisting of 6 males and 10 females, met the criteria, totaling 16 decompressions. Their average age was 47 (range: 26-77), with an average symptom duration of 46 months (range: 12-120) and median follow-up duration of 11 months (range: 10-14). All patients experienced sensory and motor symptoms preoperatively, predominantly in the dominant hand (69%). See Table 1 for the demographics of our study population.

Parameters	CTS (n = 8)	UNE (n = 8)
Age*	50 (26-77)	45 (26-62)
Sex		
- Female	5	5
- Male	3	3
BMI*	30 (+/- 5)	28 (+/- 5)
Affected Side		
- Non dominant	2	3
- Dominant	6	5
Duration of Symptoms		
- 12 months	3	1
- 12-24 months	1	2
- > 24 months	4	5
CTS: Carpal Tunnel Syndrome; UNE: Ulnar Nerve Entrapment. * The values are presented as the mean, with the range and +/- standard deviation in parentheses. Other parameters are presented as the number of patients.		

Table 1: Baseline of the characteristics of study population.

Clinical Evaluation

Quantitative as well as qualitative evaluations of motor and sensory functions were performed by a single examiner (plastic surgery resident) preoperatively, at 3, 6 and 12 months postoperatively to assess the nerve function follow-up. Physical examination was done to evaluate muscular atrophy due to chronic denervation. Medical Research Council (MRC) scale was used for grading muscle power from M0 to M5, with M0 representing no muscle contraction and M5 normal strength against resistance [18].

For each nerve, strength of specific muscles was graded. Median motor function after the carpal tunnel is best reflected by Abductor Pollicis Brevis (AbPB), when specific ulnar innervated muscles include Flexor Carpi Ulnaris (FCU), Deep flexor to the ring (FDP4) and to little finger (FDP5). AbPB was tested palm up, with resistance applied on lateral side of proximal phalange of pollicis and asking the patient to oppose the thumb. FCU was tested palm up, with flexion of the wrist in ulnar deviation

against resistance while the forearm is maintained in a fixed position. For evaluation of FDP, the patient was asked to flex distal phalange of annular and little finger against resistance, while proximal and intermediate phalanges were blocked in extension [4,5].

Grip strength was measured using a Jamar® (JLW Instruments; Chicago; USA) dynamometer, while pinch strength was assessed with a Jamar® Gauge dynamometer in three standard positions: thumb tip to index fingertip (tip), thumb pulp to the lateral middle phalanx of index finger (key) and thumb pulp to pulps of index and middle fingers (Three-Point, 3P). These measurements were conducted for both hands following the guidelines of the American Society of Hand Therapists [19]. Froment's sign, indicating advanced disease, was reviewed in patients with UNE [20].

Sensibility testing for the median nerve included the radial three digits and radial palm, while the ulnar nerve sensibility was tested on the ulnar side of the ring, small finger and ulnar palm [21]. Light touch was assessed using the Ten test, grading sensibility from zero to ten. Sensory threshold was determined with the Semmes Weinstein Monofilament (SWM), with perception of 0.1 g referred as good; between 0.2 and 1.5 g as correct, between 1.6 and 3.5 g as passable, between 3.6 g and 10.0 g as poor, when values higher than 100 g correlated with anesthesia [23]. Static two-point discrimination (2-PD) was used to assess innervation density, with normal defined as a range from 3-5 mm, moderately disturbed with 6-10 mm and severely disturbed with values exceeding 10 mm, following the American Society of Hand Therapists guidelines [24].

Specific provocative tests, including Tinel, Phalen and Durkan for CTS and Tinel and elbow flexion with direct pressure over the cubital tunnel for UNE were conducted [20,25]. Pain intensity was assessed using a Numerical Analog Scale (NRS) ranging from 0 to 10 [22].

To assess subjective disability and functional impact on daily activities due to neuropathy, the Quick DASH questionnaire was administered [26]. This questionnaire comprises 11 items graded from one to five, with higher scores, in scale of 100 points, indicating greater difficulty in task completion (Table 2). A favorable outcome was defined as improvement in preoperative parameters, while no change or worsening was deemed unfavorable.

	Carpal Tunnel Syndrome	Ulnar Nerve Entrapment
Provocation Tests		
Tinel's	x	x
Others	Durkan, Phalen	Froment's sign
Sensibility		
Ten Tests	x	x
SWM	x	x
2-PD	x	x
Strength		
MRC	AdPB	FCU, FDP4, FDP5
Jamar Dynamometer	x	x
Gauge Dynamometer	x	x
Quick DASH questionnaire	x	x
SWM: Semmes Weinstein Monofilament; 2-PD: Static two points discrimination; MRC: Medical Research Council; NRS: Numerical Analog Scale; AdPB: Abductor Pollicis Brevis; FCU: Flexor Carpi Ulnaris; FDP4: Deep Flexor to the Ring; FDP5: Deep Flexor to the little Finger		

Table 2: Test battery.

Surgical Techniques

The same senior surgeon (W.R.) performed the surgeries and gave rise to the indication. Procedures were performed under regional anesthesia and tourniquet. For carpal tunnel decompression, a 2 cm cutaneous incision was performed in regard to carpal tunnel and subcutaneous tissues were dissected. Palmar aponeurosis and transverse carpal ligament were incised. Median nerve was freed proximally and distally. For ulnar nerve decompression, a 4 cm cutaneous incision was performed in regard to

ulnar groove. Subcutaneous tissues were dissected protecting branches of the medial antebrachial nerve, all compressive sides including Struthers fascia, Osborne's ligament, Osborne arcade was opened, allowing neurolysis of ulnar nerve in the entire cubital tunnel. Decompression and transposition were performed, before fixation of ulnar nerve with a subcutaneous flap.

Statistical Analysis

All investigated parameters were statistically analyzed (average, range, mean and standard error). Outcomes between two single normal distributed parameters were investigated by paired t-student test. When comparing qualitative variables, frequency Chi-square tests were adopted. Significance was determined as $P < 0.05$.

Results

Median Nerve Decompression (in CTS)

Prior to surgery, all patients exhibited positive provocation tests for CTS. At one-year follow-up post-op, all patients showed recovery. Preoperatively, sensory disturbances were present in 75% of patients, with significant reductions in numbness ($p = 0.007$) and paresthesia ($p = 0.007$) during follow-up, resolving completely in all patients. Nighttime symptoms, present in 75% of patients before decompression, resolved in 83% ($p = 0.004$). Pain, reported by 75% preoperatively, was successfully reduced in all patients, with only one case experiencing mild persistence (NRS score of 3/10). The difference in NRS score from pre- to post-operative was statistically significant ($p = 0.02$).

Strength measurements using the MRC scale indicated a trend toward improvement for AbPB ($p = 0.22$). Preoperatively, 50% exhibited muscle weakness (MRC grade 3/5 or 4/5) in AbPB, which reduced to 2 patients at the 12-month follow-up. Pinch strength was lower in the affected hand, with Tip pinch showing a trend toward improvement ($p = 0.1$), reaching 77% of contralateral strength. Key pinch ($p = 0.9$) and Three-Point pinch ($p = 0.7$) also improved, reaching 60% and 70% of contralateral strength, respectively. Sensibility tests did not reach significance despite improved absolute values with the SWM, ten test and static 2-PD (Table 3).

	Preoperative Mean +/- SD	Postoperative Mean +/- SD	Difference (Absolute Value)	Difference in %	% of Control at Reached	P-value
*Tip	2,3 +/- 1,6	4,3 +/- 1,8	2	+ 47	77	0,1
*Key	2,5 +/- 1,6	3,2 +/- 1,7	0,7	+ 20	60	0,9
*3P	2,4 +/- 1,7	3,5 +/- 1,7	1,1	+ 30	70	0,7
**Grip	11,7 +/- 12,6	18,9 +/- 12,2	7,2	+ 37	100	0,7
***AdPB	4,1 +/- 0,4	4,8 +/- 0,17	0,7	+ 15	96	0,22
CTS: Carpal Tunnel Syndrome, SD = Standard Deviation, * Pinch Strength Graded in Kilograms, ** Grip Strength Graded in Kilograms; *** Medical Research Council Scale (MRC), Adductor Pollicis Brevis (AdPB)						

Table 3: Outcome of motor assessment in patients with Median nerve entrapment (CTS).

Ulnar Nerve Decompressions (in UNE)

All patients exhibited positive provocation tests before surgery, with a significant reduction postoperatively (Tinel $p = 0.0002$, elbow flexion with direct pressure over cubital tunnel $p = 0.0002$). Postoperative numbness and hypoesthesia significantly decreased, with total resolution reported by 87% ($p = 0.01$). Paresthesia, present in 87% preoperatively, was resolved in 57% of patients postoperatively, though not reaching statistical significance ($p = 0.12$).

Preoperatively, 75% experienced pain, with 70% reporting moderate to severe pain (NRS score ≥ 5). At 12 months follow-up, pain was reduced in all patients significantly ($p = 0.02$), with 60% reporting no pain and 40% reporting mild residual symptoms. Objective motor function improvements showed trends toward enhanced strength in FDP5, FDP4 and FCU, in key ($p = 0.17$) and tip pinch ($p = 0.34$). Grip strength improved significantly from 35% to 77% of the contralateral unaffected side ($p = 0.02$) (Table 4).

Sensibility improvements were noted, with abnormal light-touch sensitivity (under 7 in Ten Test) decreasing from 87% of patients preoperatively to 13% at 12 months follow-up ($p = 0.04$). About objective sensibility testing, Light-touch tested with the use of SWM was abnormal in 87% of patients at baseline. At 12 months follow-up, 42% regained normal values, showing

improvement in light touch ($p=0.07$). Mean absolute postoperative threshold was 0,9 g versus 3 g preoperatively. Two-point discrimination also significantly improved ($p=0.02$), passing from 21 mm to 8 mm of discrimination. The mean QuickDASH scores showing a trend toward improvement, decreasing from 58 to 37, without reaching significance ($p=0.08$).

	Preoperative Mean +/- SD	Postoperative Mean +/- SD	Difference (Absolute Value)	Difference in %	% of Control at Reached	P-value
*Tip	3,2 +/- 3	5,4 +/- 1,9	2,2	+ 41	90	0,34
*Key	2,3 +/- 1,1	4,3 +/- 2,4	2	+ 45	71	0,17
*3P	3,2 +/- 3,3	5,1 +/- 3	1,9	+ 38	75	0,65
**Grip	11,8 +/- 14,3	20,4 +/- 12,2	8,6	+ 42	77	0,02
***FDP4	4 +/- 1	4,75 +/- 0,4	0,75	+ 15	95	0,21
***FDP5	4 +/- 0,4	4,8 +/- 0,1	0,8	+ 16	96	0,09
***FCU	4,5 +/- 0,3	4,75 +/- 0,2	0,25	+ 6	95	0,8

SD = Standard Deviation, * Pinch Strength Graded in Kilograms, ** Grip Strength Graded in Kilograms, *** Medical Research Council Scale (MRC), FDP4 (Deep Flexor to the Ring), FDP5 (Deep Flexor to little Finger), FCU (Flexor Carpi Ulnaris)

Table 4: Outcome of motor assessment in patients with Ulnar Nerve Entrapment (UNE).

Discussion

The timing of nerve decompression remains a topic of debate. For the median nerve, some suggest early decompression for swift symptom relief [28]. The American Academy of Orthopaedic Surgery recommends surgery after a 2-7-week trial of conservative treatment without improvement. Even in cases of median nerve denervation, surgery can provide significant symptom relief [28,29]. This supports the notion that nerve decompression should be considered beneficial regardless of timing or severity, as surgery can improve symptoms even if not completely [30-32].

Regarding ulnar nerve decompression, literature lacks consensus on timing. Some propose a three-month period of conservative management while others advocate for decompression within three months of symptom onset [33,34]. There's a shortage of concrete data from prospective studies. However, in cases of motor weakness or fixed sensor changes, surgery is recommended as the primary treatment option and should be performed promptly [35].

This study aimed to assess the effectiveness of late nerve decompression in CTS and UNE and quantify the extent of motor and sensory nerve function recovery. The average duration of symptoms before surgery was three years, with a minimum of one year. Despite the delayed decompression, all patients experienced favorable outcomes, showing improvements in paresthesia, pain and nerve function. None achieved complete recovery, indicating severe disease and ensuring the homogeneity of our patient population.

Significant outcomes were observed regarding pain and relief of paresthesia, with complete resolution in 75% of the patients. Negative provocative tests confirmed complete nerve release, indicating resolution of the ischemic underlying demyelination [4,36]. Pain and paresthesia typically improved shortly after nerve release, with substantial resolution within three months and further reduction at 12 months post-surgery. Mild persistent symptoms were noted in approximately one-fourth of patients, consistent with findings from previous studies [37].

Assessing sensory loss is crucial in nerve compression cases. In advanced stages, Wallerian degeneration leads to decreased innervation density, resulting in enlarged 2-PD [38]. Sensory recovery gradually improves after nerve release but rarely reaches full restitution [39]. A study involving 41 long standing CTS patients showed significant improvement in 2-PD two years post-decompression. Our study also demonstrated improvement in 2-PD (from 21 mm to 8 mm) one year after decompression, although this improvement was not statistically significant. After decompression, improvements in pressure threshold (SWM) were noted in both nerves one-year post-release, with significance observed in the ulnar nerve. Other studies also suggest a one-year delay for significant cutaneous pressure threshold improvement [42-43].

Literature indicates no difference in potential sensory recovery between median and UNE following early decompression [44-47]. However, our study revealed greater sensory improvement in the ulnar nerve, particularly in Ten test and two-point discrimination. Muscle strength quantification is crucial for assessing patient satisfaction post-decompression [48]. Pinch strength relies mainly on ulnar innervated muscles, such as the AbPB and first dorsal interosseous, while median nerve innervated muscles contribute to 3-P strength [26,49].

Our results in UNE patients showed stronger improvement in tip and key pinch compared to 3-P pinch strength at follow-up, though not reaching significance. Grip strength evolution post-decompression varies in the literature, with some reporting improvement at three months and others showing non-significant change at 12 months [43,50,51]. In CTS, weakening of intrinsic thenar muscles may cause a minor loss in grip strength, while the ulnar nerve plays a significant role in grip strength through control of intrinsic hand muscles and extrinsic finger flexors [52]. Grip strength symmetry between the operated and healthy sides was achieved in CTS decompressions. In UNE, grip strength progressively improved, reaching significance at 12 months but not reaching strength levels of the healthy side, consistent with literature findings [50].

Our study aligns with previous research of severe entrapment neuropathies, indicating that reductions in paresthesia and pain occur earlier than improvements in daily life activities regardless of symptom duration [36,39,43,53]. Functional improvement typically begins around three months post-decompression and continues for at least one year [39]. Even in severe cases, significant improvement in Quick DASH scores was observed at 12 months post-surgery, allowing patients to engage in previously challenging activities despite mild residual symptoms.

However, literature of chronic nerve decompression is limited, with few studies reporting symptom duration before surgery. Chandra, et al., compared the outcome of 100 patients with moderate to severe CTS lasting for 2 years approximatively and surgery performed either early (<1 week) or late (> 6 months after diagnosis) [14]. At mean 7 months follow-up, improvement was significant in both groups but recovery was greater in the early group. Cha, et al., compared postoperative outcomes between patients undergoing primary conservative treatment then delayed surgery and cases with surgery as their initial treatment for CTS [54]. Outcome was less satisfying in the group where surgery had been delayed compared with patients with surgery as a primary management. Long-term follow-up is essential for advanced neuropathies as both sensory and motor parameters can continue to improve even up to a year post-decompression [36,55,56].

Our study has limitations, including a small sample size, warranting confirmation through larger multicenter collaborations. Despite these limitations, the prospective design and consistency in surgical approach and follow-up examinations strengthen our findings. We utilized various validated assessment tools to comprehensively evaluate symptoms, function and sensation, providing robust evidence regarding the efficacy of late decompression.

Conclusion

Late decompression after chronic CTS or UNE at the elbow, represents an efficient method for pain and symptoms relief. Sensory and motor function show delayed but significant improvement 12 months after surgery. Despite uncomplete recovery, we believe that nerve decompression should be indented even in case of chronic symptoms.

Conflict of Interests

The authors have no conflict of interest to declare.

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