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Acute Carpal Tunnel Syndrome: Early Nerve Decompression and Surgical Stabilization for Bony Wrist Trauma

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Background: We undertook this study to investigate the outcomes of surgical treatment for acute carpal tunnel syndrome following our protocol for concurrent nerve decompression and skeletal stabilization for bony wrist trauma to be undertaken within 48 hours.

Methods: We identified all patients treated at our trauma center following this protocol between January 1, 2014 and December 31, 2019. All patients were clinically reviewed at least 12 months after surgery and assessed using the Brief Michigan Hand Outcomes Questionnaire, the Boston Carpal Tunnel Questionnaire, and sensory assessment with Semmes-Weinstein monofilament testing.

Results: The study group was made up of 35 patients. Thirty-three patients were treated within 36 hours. Patients treated with our unit protocol for early surgery comprising nerve decompression and bony stabilization within 36 hours report excellent outcomes at medium term follow-up.

Conclusions: We propose that nerve decompression and bony surgical stabilization should be undertaken as soon as practically possible once the diagnosis is made. This is emergent treatment to protect and preserve nerve function. In our experience, the vast majority of patients were treated within 24 hours; however, where a short period of observation was required, excellent results were generally achieved when treatment was completed within 36 hours. *(Plast Reconstr Surg Glob Open 2023; 11:e4929; doi: 10.1097/GOX.0000000000004929; Published online 5 April 2023.)*

INTRODUCTION

Acute carpal tunnel syndrome is characterized by an acute and progressive increase in pain and altered sensation in the distribution of the median nerve. It is uncommon, and most cases have a traumatic etiology.[1,2] The treatment is urgent carpal tunnel decompression. Distinguishing this from a less acute median nerve injury or neuropathy is important, and is on the basis of the speed of onset, progression, and the severity of symptoms. This is a clinical assessment. Carpal tunnel pressure measurements can also be taken, but these are not commonly used.[3–6] The diagnosis must be made early to facilitate timely surgery, avoiding persistent or permanent nerve injury and dysfunction.[1,2]

The etiology most frequently associated with acute carpal tunnel syndrome is a distal radial fracture.[1,2,5] Emergent decompression of the carpal tunnel may be combined with concurrent surgical fixation of the fracture.

In our practice, we aim to achieve definitive skeletal stabilization concurrently with nerve decompression, as long as both can be performed in a timely fashion. We aimed to complete surgery as soon as possible once the diagnosis is made and certainly within 48 hours, which, in our service, allows for diagnosis and treatment by an appropriately trained and experienced surgeon. A period of assessment allows for the patient to be reviewed by an experienced hand and wrist surgeon and for true acute carpal tunnel syndrome to be clinically distinguished from transient, milder median nerve symptoms, which do not require urgent surgery. The key distinguishing

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features of acute carpal tunnel surgery on which the diagnosis is based are severe pain and altered sensation in the median nerve distribution, usually of delayed onset. Symptoms are progressive over time and severe. A period of assessment is helpful to distinguish true acute carpal tunnel syndrome from an exacerbation of chronic carpal tunnel syndrome, a presentation of forearm compartment syndrome, or a much more common mild and transient median nerve neurapraxia which would not require specific treatment.

In our practice, we aim to complete assessment and diagnosis of acute carpal tunnel syndrome, distinguishing it from other nerve pathologies that do not require urgent treatment, and to undertake nerve decompression with definitive skeletal stabilization within 48 hours. Although the importance of timely surgery is well recognized, there is limited evidence for this specific approach or indeed, for a specific timeframe within which treatment should be completed.

Undertaking surgery too early risks overtreating less serious nerve injuries that do not need urgent surgery. Deferring treatment for too long risks adversely affecting outcomes and permanent nerve injury. We undertook this study to investigate the outcomes of acute carpal tunnel decompression following our protocol for early surgery to relieve the nerve compression and to achieve skeletal stabilization. We hypothesized that patients undergoing treatment using our unit protocol would have excellent results and patient-reported outcomes.

MATERIALS AND METHODS

Clinical Protocol

Patients are referred from across the region to our service, which is based in an urban teaching hospital environment and which hosts a major trauma center. Referrals are accepted for patients requiring treatment after high-energy major trauma; in addition, we receive more general trauma referrals and presentations for patients living locally.

In our unit, we aim to treat patients identified with acute carpal tunnel syndrome within 48 hours of diagnosis. Our protocol allows for a clear clinical diagnosis to be established, and in that time, acute carpal tunnel syndrome can be differentiated from milder transient neurapraxias which do not require urgent surgery. Our protocol and timing also allow for a practical window of time for assessment and surgery to be undertaken by a specialist hand and wrist surgeon, which we believe protects against overtreatment of less urgent neurapraxias. The intention is to achieve nerve decompression and definitive skeletal stabilization concurrently and within 48 hours. A diagnosis of acute carpal tunnel syndrome is considered where there is acute onset severe pain and altered sensation in the median nerve distribution, which is of delayed onset and progressive. The diagnosis was clinically confirmed preoperatively in all cases by a specialist hand and wrist surgeon.

Takeaways

Question: What are the outcomes for patients following a protocol for nerve decompression and surgical stabilization within 48 hours.

Findings: All but two patients underwent surgery within 36 hours.

Meaning: Once the diagnosis has been established, nerve decompression is required urgently. This should not be delayed. A short period of observation allows observation of symptom severity, acuity, and progression to distinguish acute carpal tunnel syndrome clinically. Our experience indicates that this is a safe and pragmatic approach where surgery is undertaken as soon as practically possible and certainly within 36 hours.

Specifically, a diagnosis of acute carpal tunnel syndrome was confirmed by clinical assessment undertaken by a senior specialist surgeon identifying both

- acute onset of severe pain and altered sensation of delayed onset and in the median nerve distribution within 12 hours of injury, and
- progressive worsening of symptoms and severe pain over a period of clinical observation (up to 24 hours).

PATIENTS AND METHODS

We retrospectively identified all patients treated at our trauma center using our protocol for acute carpal tunnel syndrome between 2014 and 2019. We reviewed the electronic patient record and imaging in each case to confirm the details of the diagnosis and surgery undertaken. Patients were operated on the next available trauma list once the diagnosis was confirmed, within 48 hours and with surgery undertaken or directly supervised by a fellowship trained hand and wrist surgeon.

Patients were reviewed in a designated outpatient clinic where they were assessed by an independent and experienced surgeon not involved in their original treatment. Examination included an assessment of sensation, muscle wasting, and weakness of thumb abduction or opposition. Provocative carpal tunnel tests or maneuvers were not used. All patients provided informed verbal consent and the study was approved by our institutional review board, to be undertaken in line with the principles set out in the Declaration of Helsinki.

All patients were assessed using the brief Michigan Hand Outcomes Questionnaire (bMHQ) and the Boston Carpal Tunnel Questionnaire (BCTQ).[7,8] Patients also completed a validated patient satisfaction questionnaire. Tactile sensation of the finger was assessed using graded Semmes-Weinstein monofilament testing.[9]

The bMHQ is a validated tool assessing six domains of hand function (overall hand function, activities of daily living, work performance, pain, aesthetics, and satisfaction). The questionnaire consists of 12 questions, two in each domain. Each question is scored from 1 to 5, and the total is scored out of a maximum score of 60 before this is normalized to a scale of 0 (poorest function) to 100 (ideal function).[7]

The BCTQ has two components: the Symptom Severity Score (SSS) and the Functional Status Scale (FSS). The SSS is made up of 11 items, each scored between 1 and 5, with a total maximum score of 55. The FSS is made up of eight items, each scored between 1 and 5, with a total maximum score of 40. The SSS and FSS can then be summed and reported as a total BCTQ score. A higher score indicates a poorer outcome.[8]

The primary outcome measures were clinical evidence of persisting or recurrent median nerve dysfunction (sensory deficit, thenar muscle wasting, weakness of thumb abduction or opposition), functional outcome assessment scores (bMHQ, SSS, and FSS), and patient satisfaction scores. Secondary outcomes were demographic, injury, or treatment predictors of a poor patient outcome. At the follow-up appointment, the medical records for each patient were reviewed for evidence of complications. In addition, patients were specifically asked to report any persisting symptoms suggestive of nerve dysfunction.

The study was reviewed and approved by our institutional review board. All patients provided informed consent.

STATISTICAL ANALYSIS

GraphPad Prism version 8.4.2 was used for statistical analysis. Normality was determined using the D'Agostino-Pearson test. BCTQ and bMHQ data were normally distributed, and therefore, a paired *t* test was used to assess the statistical significance of the findings. Semmes Weinstein scores were not normally distributed, and thus, a Wilcoxon matched pairs signed rank test was used to assess for significance.

Values are expressed as means unless otherwise specified. A *P* value of less than 0.05 was considered significant.

RESULTS

We identified 38 patients from patient and hospital records who were treated with carpal tunnel decompression for acute carpal tunnel syndrome during the 72-month study period. All patients were contacted, and 35 patients agreed to participate in the study and to attend for review. These patients form the study group. All patients in the study group underwent open carpal tunnel release under general anesthesia to allow concurrent stabilization of their bony injuries in line with our protocol.

Twenty-three patients in the study group were men, and the mean patient age at the time of surgery was 47.2 (13) years. All of the patients had acute carpal tunnel syndrome resulting from a traumatic etiology. Twenty-nine patients sustained a distal radial fracture. Five patients sustained a perilunate dislocation, and one patient sustained a Galeazzi fracture dislocation. Fourteen patients underwent initial fracture manipulation and splinting in the emergency department. All of the patients diagnosed with acute carpal tunnel syndrome developed new symptoms of acute carpal tunnel syndrome over the first 12 hours after injury and went on to have their bony injury treated definitively at the same time as the emergent carpal tunnel decompression. Surgery was undertaken at a mean of 16 (12) hours after the onset of symptoms. Patients were evaluated in the hand clinic at a mean of 24 months (6.8) after surgery.

Over the study period, we treated 1151 distal radial fractures at our center. Of these, 720 fractures (62.6%) were treated surgically. We treated 64 patients with perilunate injuries over the study period, all of whom underwent surgery.

All patients reported high levels of satisfaction and subjective improvement in their levels of pain and function after surgery, and all reported that they had returned to preinjury levels of function and activity. Mean reported functional outcome scores were excellent: bMHQ, 99 (2.2); FSS, 1.1 (0.027); SSS, 1.1 (0.21); summed BCTQ, 1.1 (0.16).

We did not identify any reliable demographic predictors for functional outcome after surgery. We examined for age, sex, ethnicity, and hand dominance, and did not find any clear effect (Table 1). The 29 patients who sustained a distal radial fracture, as classified using the Orthopaedic Trauma Association system,[10] did not show any relationship with postoperative functional scores (bMHQ, $P = 0.7553$; SSS, $P = 0.1911$; FSS, $P = 0.7611$, Kruskal Wallis test).

There was no obvious statistical relationship between time to surgery and functional outcome score ($P = 0.53$), although all patients had surgery within 48 hours, and only two patients had surgery beyond 36 hours, one at 43 and the other 48 hours after the onset of symptoms.

One patient reported reduced sensibility in the median nerve distribution at postoperative follow-up. This patient underwent surgery 48 hours after the onset of symptoms and when assessed 20 months following surgery, they reported a persistent reduction in light touch sensitivity. They also demonstrated a reduced Semmes-Weinstein assessment from 6, normal sensation, to 5, decreased light touch, in the median nerve distribution. No other patients reported persisting sensory deficit at clinical review. In addition, two patients (5.7%) reported numbness over the surgical scar, and one patient (2.9%) complained of "night-time wrist pain." There were no reports of any motor symptoms suggestive of median nerve dysfunction

Table 1. Patient Predictors of Functional Outcome Scores

	bMHQ	FSS	SSS	BCTQ	
Patient age	$P = 0.0362$	$P = 0.5718$	$P = 0.0623$	$P = 0.2745$	Spearman rank correlation coefficient
Sex	$P = 0.3444$	$P = 0.4038$	$P = 0.8468$	$P = 0.5096$	Mann-Whitney U test
Hand dominance	$P = 0.5026$	$P = 0.3230$	$P = 0.0181$	$P = 0.0193$	Mann-Whitney U test
Ethnicity	$P = 0.8183$	$P = 0.3966$	$P = 0.7805$	$P = 0.4231$	Kruskal-Wallis test

or subjective clumsiness, and no patients showed any clinical evidence of thenar muscle wasting.

One patient had undergone subsequent removal of metalwork after locked anterior plate fixation of a distal radial fracture. There were no other reported or recorded complications of treatment and no patients had undergone injection or revision surgery for carpal tunnel symptoms.

Examining data from all patients, the summed BCTQ score showed good inverse correlation with the bMHQ score ($P = 0.0253$, nonparametric Spearman test).

DISCUSSION

Our study supports the hypothesis that patients undergoing early surgery for acute carpal tunnel syndrome with concurrent skeletal stabilization using our treatment protocol have excellent outcomes in the medium to long term. Surgery should be undertaken as soon as practically possible, but outcomes are shown to be generally excellent when treatment is completed within 36 hours of the onset of symptoms. Only two patients underwent surgery later than 36 hours after the onset of acute carpal tunnel syndrome. One patient underwent surgery 43 hours after the onset of carpal tunnel syndrome and had made a full recovery at final follow-up. The second patient underwent surgery 48 hours after the onset of carpal tunnel symptoms. This second patient continued to report ongoing mild median nerve symptoms at final follow-up, 20 months after surgery, although we did not identify time to surgery as an independent statistical predictor of patient outcome.

All of the patients in our series had a traumatic etiology, and in our study, undertaking bony stabilization at the same time as emergent carpal tunnel release did not compromise the result when this was undertaken within 48 hours. This is in keeping with a previous study that found that for patients with acute CTS, excellent results were achieved where carpal tunnel decompression was undertaken within 40 hours of the onset of symptoms.[11]

The prevalence of median nerve neuropathy in association with a distal radial fracture is not insignificant and has been estimated to be between 4% and 8% but much higher in the region of 25%–45% for perilunate fracture dislocations and more complex carpal injuries.[5,12,13] Distinguishing a true acute carpal tunnel syndrome from a less severe nerve injury that might be expected to resolve over time is key and depends on the prompt recognition of progression and worsening of symptoms. This is a clinical assessment and as such, the case definition is open to interpretation. This does, however, represent contemporary clinical practice and real-time decision-making. In our study and in the patient cohort that we present, the definitive clinical assessment and all surgery was performed or supervised by a fellowship-trained hand and wrist surgeon who assessed the patients preoperatively. This senior and experienced assessment represents real-world clinical decision-making and practice in the diagnosis of acute carpal tunnel syndrome but also acknowledges the potential for overdiagnosis or inclusion of less serious median nerve pathology, which might not require treatment.

The available evidence suggests that idiopathic carpal tunnel syndrome is extremely common and that carpal tunnel decompression has low morbidity.[14,15] This is, however, not zero morbidity, and the evidence from our study suggests that a short period of observation from the onset of symptoms may safely be allowed to allow acute carpal tunnel syndrome to be distinguished from less severe nerve injuries, and to allow for any associated injuries that may take preeminence. Establishing a safe time period for treatment will help mitigate against overtreating transient median neuropathies that might be expected to settle without surgery and reflects the practicalities of delivering acute expert care. Nevertheless, where this is likely to result in a delay, we advocate emergent carpal tunnel decompression as soon as possible to prevent long-term sequelae of acute carpal tunnel syndrome, even where this will necessitate a second surgical procedure for the patient to definitively address the bony injury.

There are several limitations to our study. Distinguishing an emerging diagnosis of acute carpal tunnel syndrome from a less serious and transient nerve injury can be difficult and subjective. Nevertheless, this decision is generally made as a clinical assessment based on the pattern, severity, progression, and unrelenting nature of symptoms, and our study reproduces the usual patterns of clinical presentation and decision-making.

Retrospective identification of the patient group is also a limitation of the study, but this is not a common injury, and our study allowed us to recruit and examine a relatively large number of patients who have been treated with a consistent treatment protocol. We believe that it offers useful information as to the potential outcomes of surgery, as well as a safe and practical protocol for treatment.

Our study shows that concurrent acute carpal tunnel decompression and bony surgical stabilization achieves excellent early and medium-term patient outcomes. We propose that nerve decompression and bony surgical stabilization within the 36 hours achieved for the vast majority of our patients represents a practical and achievable standard of care for these injuries. Surgery should be undertaken as soon as can be practicably achieved, but our experience indicates that a short period of observation to confirm the diagnosis and to allow specialist assessment and treatment is safe.

The vast majority of patients in our study group presented with clear clinical features of the diagnosis and were treated within 24 hours. On the occasions where the diagnosis evolved over time, a short period of observation allowed for the diagnosis to be reliably made and for acute carpal tunnel syndrome to be distinguished from a lesser median nerve neuropathy that would not require emergent surgery. This time period also allowed for the surgery to be scheduled and undertaken by an appropriate fellowship trained surgeon. We do not advocate delay, but our experience has been that following our protocol, provided that surgical decompression is achieved as soon

as practically possible and within 36 hours of the onset of symptoms, excellent outcomes can generally be expected.

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DISCLOSURE

The authors have no financial interests to declare in relation to the content of this article.

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