Journal of Hand Therapy 28 (2015) 34–38

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

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Scientific/Clinical Article

The effects of orthotic intervention on nerve conduction and functional outcome in Carpal Tunnel Syndrome: A prospective follow-up study

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ARTICLE INFO

Article history:
Received 30 September 2013
Received in revised form
14 June 2014
Accepted 22 July 2014
Available online 6 October 2014

Keywords:
Carpal tunnel syndrome
Electrophysiology
Functional outcome
Orthosis

ABSTRACT

Aim: To evaluate the effects of using night orthosis for 6 weeks in patients with mild to moderate carpal tunnel syndrome (CTS), including a follow up after 3 months using electrophysiological and functional outcome measurements.
Study design: 12 week follow-up prospective study.
Methods: Twenty-two patients with a total of 36 hands diagnosed as CTS were included. Subjects were informed about using a night orthosis for 6 weeks and were evaluated at the baseline, 6th and 12th week.
Results: Median motor distal latency was significantly decreased and median motor compound muscle action potential was significantly increased at the 6th week. Median sensory velocity was significantly increased at the 12th week. No significant difference was found in terms of functional outcome measurements.
Conclusion: Electrophysiological follow-up findings support the positive effects of using a wrist orthosis on median nerve conduction for CTS patients.

Background

Carpal Tunnel Syndrome (CTS) is the most prevalent entrapment neuropathy of the upper extremity and is described by the presence of a variety of neurologic signs and symptoms resulting from the localized compression of the median nerve in the Carpal tunnel.[1] A diagnosis is usually made on the basis of the patient's history and a clinical examination.[2] Electrodiagnostic tests are usually ordered by surgeons and performed to confirm the clinical diagnosis.[2]

Using a wrist orthosis is widely used in treatment of CTS besides other conventional treatment options including surgery, nonsteroidal anti-inflammatory drugs, and steroid injections.[3] By and large, surgery is recommended for severe cases while conservative treatment is preferred in mild to moderate cases. The rationale for utilizing a wrist orthosis was originally based on observations that CTS symptoms improve with rest and worsen with activity. Subsequent research has suggested that the therapeutic effect of using a wrist orthosis arises from minimizing carpal tunnel pressure. Carpal tunnel pressure is strongly implicated in the pathophysiology of CTS, and pressure in the tunnel increases with wrist positions away from neutral.[3]

A Cochrane database systematic review regarding the use of orthotic devices for CTS was recently published. Different comparisons with regard to orthotic intervention were reviewed in this article.[4] The authors concluded that there is limited evidence that an orthosis worn at night is more effective than no treatment in the short term, and that there is insufficient evidence regarding the effectiveness and safety of one orthotic design or orthotic regimen over others, and over other non-surgical interventions for CTS.[4] In the literature, conservative treatment is preferred in mild to moderate cases of CTS while surgical treatment is mainly applied in severe cases. However, surgical treatment is also indicated when conservative management fails for patients with CTS.[5,6]

The paper was partly presented at the 18th European Congress of Physical and Rehabilitation Medicine Thessaloniki-Greece, 28th May–1st June 2012.

Declaration of interest: The authors declare no conflicts of interest. The authors are responsible for the content and writing of the manuscript.

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0894-1130/$ – see front matter
http://dx.doi.org/10.1016/j.jht.2014.07.008

To our knowledge, there is no unequivocal evidence describing the borderline of the conservative management failure and the indication of surgical treatment in mild to moderate cases. Nerve conduction studies are highly sensitive and specific tests to diagnose CTS, and can help show focal regeneration of the injured axon. A six-week period of using a night orthosis is generally an accepted protocol for CTS.[1]

We, in this study, aimed to evaluate the effects of using a six-week night orthosis on the improvement of nerve conduction and pain in mild to moderate CTS including a 3 month follow-up period from the point of view of electrophysiological findings and functional outcome measurements. We aimed to compare the differences in the electrophysiological findings and functional outcome assessment scores between the 1) baseline and 6th week values, 2) between the 6th and 12th week values, and 3) between the baseline and 12th week values. Researchers performing electrodiagnostic testing and administering questionnaires were blinded to the initial screening values to avoid bias in data collection. A prospective study design was used.

Materials and methods

Twenty-two patients (21 females, 1 male) with a total of 36 hands who were referred to the electrodiagnosis laboratory with clinical features suggestive of CTS and whose nerve conduction studies indicated CTS, were included in the study. The clinical features suggestive of CTS were as follows: presence of paresthesia, tingling and pain in the median nerve distribution area for at least 1 month and 3 times per week, nocturnal symptoms typical of CTS, normal physical examination findings of neck and bilateral shoulder and elbow joints. Prior to the electrophysiologic evaluation a complete history was taken and a full physical examination including musculoskeletal system and neurologic examination of bilateral upper extremities and neck were performed. The Phalen and Tinel tests were also used as provocative tests. Patients with a history of CTS surgery, decreased ulnar sensory nerve action potential amplitude ($<$12 μV), increased ulnar sensory nerve onset latency ($>$3.7 ms), documented polyneuropathy and/or radiculopathy, and pacemaker users and pregnant women were excluded from the study.[7]

Nerve conduction studies

All the nerve conduction studies were performed by the same investigator, with the patients lying in a supine position using a Nihon Kohden Neuropack S1 (Japan) device. The temperature is the most important of all the physiologic factors. It affects nearly every parameter in a nerve conduction study, including conduction velocity, distal latency, and waveform morphology.[8] The skin temperature was kept between 29 and 32 °C. The temperature was measured by a Dermatherm perfusion monitor and the trend indicator was left on for continuous monitoring of the skin temperature. The filter band pass was 20 Hz to 10 kHz for the motor studies and 10 Hz to 5 kHz for sensory studies. Stimulus duration was 0.2 ms, sweep speed was 10 ms/division for the motor studies and 2 ms/division for sensory studies. Motor and sensory conductions of the ulnar nerve were also analyzed in the suspected limb in all patients in order to exclude a possible polyneuropathy associated with CTS. The compound muscle action potentials (CMAP) of the median and ulnar nerves were recorded with cup surface electrodes over the belly of the abductor pollicis brevis (APB) and abductor digiti minimi (ADM) muscles, respectively. Supramaximal stimulation was applied to obtain optimal CMAP.[7] Distal stimulations of the nerves were performed at the wrist and 7 cm proximal to the active electrode. Proximal stimulations were carried out for the median nerve at the elbow crease, on the ulnar side of the pulsating brachial artery, and for the ulnar nerve at the elbow sulcus, and at the points below and above of the wrist. In every case when CTS was confirmed electrophysiologically in the symptomatic arm, the median nerve conductions were also checked in the opposite arm. Bipolar surface electrodes were used to stimulate the nerves and to record the potentials from the muscles or nerves in conduction studies. The ground electrode was attached to the limb being tested and was placed between the stimulating and recording electrodes.[7] Sensory nerve conduction studies were evaluated antidromically. Needle electromyography with concentric disposable needle electrodes was performed to evaluate the APB and ADM muscles for the presence of active denervation potentials at the baseline visit. Motor and sensory nerve conduction studies were also performed at the 6th and 12th week evaluation time. The investigator was blinded to the previous nerve conduction studies and scores on the questionnaires.

The following tests were performed respectively for the diagnosis of CTS in each limb: 1) median and ulnar motor nerve conduction velocities (MNCV), 2) ulnar sensory nerve conduction velocity (SNCV) of the 5th digit to-wrist (D5-W) segment, 3) median SNCV of the second digit to wrist (D2-W) segment, 4) sensory median-ulnar distal latency difference (MUDF) from the fourth digit.

Functional outcome measurements

The Duruoz Hand Index was developed as a self-reporting questionnaire that can be routinely used to assess hand-related activity limitation in patients with rheumatoid arthritis.[9,10] It has been cross-validated for outcome assessment of hand-related activity in patients with osteoarthritis,[11] systemic sclerosis,[12] and those receiving hemodialysis.[10,13] Its reliability has been shown in patients with rheumatoid arthritis,[9] osteoarthritis,[11] and systemic sclerosis.[10,12] It was also found to be time and labor efficient in patients with stroke.[10] The questionnaire yields a total score from 0 to 90, takes about 3 min to complete, and 6 levels of answers allow a more sensitive grading of hand-related activity limitation. A higher score indicates greater activity limitation or more difficulty.[10]

The Boston Carpal Tunnel Syndrome Questionnaire is a self-administered questionnaire consisting of two subscales: a symptom severity scale and a functional status scale.[3,14] Levine[14] demonstrated that the questionnaire is highly reproducible, internally consistent, valid and responsive to clinical change.

The Duruoz Hand Index, the Boston Carpal Tunnel Syndrome Questionnaire, and the Visual Analog Scale (VAS) were performed by the second investigator at the baseline, and at the 6th and 12th week point. The investigators conducting nerve conduction studies and administering the questionnaires were blinded to the previous scores of the questionnaires and the nerve conduction study results.

Wrist orthoses and follow-up

A pre-fabricated neutral wrist orthosis was used. Subjects were taught to wear the orthosis at night and avoid repetitive movements during the day. Instructions on how to wear the orthosis were given by the orthotic/prosthetic technician. Patients were asked to keep a diary and return it to the second researcher at the 2nd week of using the wrist orthosis so as to evaluate the orthotic compliance. Feedback from patients at the 2nd week follow-up visit was that they minimized repetitive hand activities during the day. They were only allowed to take acetaminophen as an analgesic.

The local ethics committee approved this study. Informed consent was obtained from each patient participating in the study.