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Original article

Validity of the Upper Limb Neurodynamic Test 1 for the diagnosis of Carpal Tunnel Syndrome. The role of structural differentiation

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ABSTRACT

Background: Several studies have analysed the use of the Upper Limb Neurodynamic Test 1 (ULNT1) for diagnosing Carpal Tunnel Syndrome (CTS) obtaining weak diagnostic accuracy, which could be related to the lack of consensus in the selected diagnostic criteria of ULNT1.
Objective: To determine the concurrent validity of ULNT1 in comparison to Nerve Conduction Studies (NCS) for the diagnosis of CTS, considering the structural differentiation (SD) as an essential part of the diagnosis.
Design: Prospective diagnostic test study.
Methods: Individuals with suspected CTS referred for NCS were invited to voluntarily participate in the study. Each participant was tested with NCS and ULNT1. ULNT1 result was considered positive when the patient's clinical symptoms were reproduced during the test and symptoms changed during contralateral neck side bending (SD).
Results: 58 Participants (17 men, 44 women) with suspected CTS and a total of 95 limbs were examined using the NCS and ULNT1. Sensitivity of the ULNT1 was 57.9%, specificity was 84.2%, and the positive and negative likelihood ratios were 3.67 and 0.50 respectively.
Conclusion: Results obtained in the study may indicate the ability of the ULNT1 to generate small shifts from pre-test to post-test probability. However, imprecision in the CIs limits interpretation from the data.
Level of evidence: 1b.

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1. Introduction

Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy of the human body (Keith et al., 2009; Ibrahim et al., 2012) with an estimated prevalence of 3.8% (Atroshi et al., 1999). Clinical presentation of CTS is highly variable (including tingling, pain or numbness in the distal distribution of the median nerve, and reduction in grip strength and function of the affected hand) (Dilley et al., 2003; Keith et al., 2009). Nerve Conduction Studies (NCS) are considered the Gold Standard for diagnosing CTS (Werner and Andary, 2002). However, false negatives and false positives can occur when using only the NCS to identify CTS (Nathan et al., 1993; Witt et al., 2004). To reduce the likelihood of an incorrect diagnosis of CTS, it has been suggested that NCS be correlated with the patient history and other common clinical tests such as Tinels, Phalens, Reverse Phalens, Tethered Median Nerve Stress Test of Hand Elevation (Atroshi et al., 1999; Keith et al., 2009; Graham, 2008; Ibrahim et al., 2012). To date, studies of the reliability and diagnostic accuracy of these common clinical tests have yielded conflicting results (Aroori and Spence, 2008).

In clinical environments where NCS is not available, neurodynamic tests (NDTs) have been recommended for the diagnosis of neuropathic pain conditions such as CTS (Keith et al., 2009). However, information about the diagnostic validity and reliability of NDTs remains limited (Wainner et al., 2005; Vanti et al., 2011, 2012; Nee et al., 2012). Specifically relating to the diagnosis of CTS, a number of studies conclude that Upper Limb Neurodynamic

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Tests (ULNTs) are not valid and therefore have limited clinical utility (Wainner et al., 2005; Vanti et al., 2011, 2012).

In a recent review, Nee et al. (2012) suggested that many of the studies examining the validity of ULNTs used criteria that were too liberal to consider ULNTs positive. To address this shortcoming, Nee et al. (2012) recommended that structural differentiation (SD), defined as a movement of a distant body part that further loads or unloads the nervous system (e.g., contralateral neck side bending increases a sensory response in the forearm) without changing tension in adjacent structures such a muscles or tendons, should be added as an essential criterion for classifying ULNTs as positive (Butler, 2000; Shacklock, 2005). Nee et al. (2012) postulated that if central pain mechanisms are not the primary reason for a patient's pain experience, then a change in the Upper Limb Neurodynamic Test (ULNT) response with SD would be related to neural tissue sensitivity (Nee et al., 2012). They also proposed that a positive ULNT should at least partially reproduce the patient's symptoms and that SD should change these symptoms.

This prospective diagnostic test study examines the concurrent validity of NCS and the ULNT1 with the addition of SD as an essential criterion for classifying positive or negative test results.

2. Methods

2.1. Subjects

The sample size was estimated based on the precision level or the maximum admissible error for the evaluation procedure of the study. The maximum admissible error was set close to 10% at a 95% confidence level ($\alpha = .05$).

Patients with hand, wrist or forearm symptoms referred to "X" for median nerve NCS were invited to voluntarily participate in this study. Exclusion criteria for the participation were any ROM limitations of the upper limbs joints, which prevented ULNT1 testing (Vanti et al., 2011), inability to lie supine, any physical contraindications for physical therapy (e.g. infection, tumours or fractures), the presence of any cognitive or communicative deficits which would prevent the patient from providing accurate feedback during the ULNT1 (Coppieters et al., 2002). The Ethics Committee of Clinical Research of "X" approved the protocol of this study. A flow diagram illustrating the study design according to the Standards for Reporting of Diagnostic Accuracy (Bossuyt et al., 2004) is provided in Fig. 1.

2.2. Gold Standard

An experienced neurophysiologist performed the NCS in all participants, using routine motor and sensory studies. Latencies and conduction velocities were measured in milliseconds and metres per second, respectively. Contact surface electrodes were used for the exploration of the motor branch and sensory branches of the median nerve. Motor responses were elicited orthodromically by supramaximal stimulation at the wrist, and antecubital fossa and recorded from the abductor pollicis brevis. Sensory responses were elicited antidromically by applying supramaximal stimulation at the palm, wrist and elbow and recorded from the index finger. The conduction from the wrist to the palm was calculated by subtracting the finger-palm latency to the wrist-finger latency. Entrapment of the median nerve in the carpal tunnel was determined by a slowing of sensory conduction velocity from wrist to palm (SCV-WP). SCV-WP was considered "abnormal" with values below 50 m/s (Bland, 2000). The hand temperature was monitored during the NCS.

2.3. Tests methods

After NCS, patients were informed about the study, invited to participate, and informed consent was obtained. Following obtaining informed consent, demographic data and symptoms characteristics (history, quality, intensity, behaviour and first onset of symptoms) were recorded using an assessment form and finally ULNT1 was performed. A 20–30 min break was required between NCS and ULNT1 (Wall et al., 1992; Vanti et al., 2011).

Prior to ULNT1, participants were informed about the test procedure, and were asked to verbally indicate the initial onset and location of symptoms during the test. In addition, they were asked to rate any change in symptoms after the SD manoeuvre as "same", "more" or "less".

An experienced physical therapist performed ULNT1 as described by Shacklock (2005). Participants were positioned in supine with straight lower limbs. ULNT1 movements were performed on the affected upper limb up to the end of the available range of motion (ROM) or until symptoms were produced. When symptoms (e.g. tightness, tension, numbness, pins and needles) were elicited during any step of the ULNT1, the movement of the arm was stopped and the arm position maintained. Then, based on the location of symptoms reported by participants, structural differentiation was performed. When symptoms were located distally on the upper extremity a second physical therapist performed passive contralateral side bending of the neck as the SD manoeuvre. When symptoms were located proximally, the first examiner changed the wrist flexion angle as SD manoeuvre. In both cases, any modifications of the provoked/evoked symptoms during the ULNT1 were recorded. Type, location and first onset of symptoms were also recorded. Both physical therapists and participants were blinded to the NCS findings.

2.4. Diagnostic criteria

The ULNT1 was considered positive according to two different criteria. The first criterion (Criterion A) was based on the Nee et al. (2012) recommendations, where ULNT1 was only considered positive when patient's clinical symptoms were reproduced during the ULNT1 and changed during SD. For this criterion, if the test produced symptoms at the wrist or hand, which is a common response for ULNT1, but did not reproduce the participant's clinical symptoms, the result was classified as negative.

Because CTS signs and symptoms commonly spread through the wrist and the first three digits of the affected hand and due to the number of subject who referred symptoms at these locations during ULNT1, a second criterion (Criterion B) was established and its validity was also calculated. For the Criterion B, ULNT1 was considered positive when symptoms appeared at the wrist or the first three digits of the affected hand and changed during SD (Fig. 2), regardless of the reproduction of patient's clinical symptoms.

2.5. Statistical analysis

All data was recorded in an electronic database and analysed in SPSS version 19.0 for Macintosh. Descriptive statistics were calculated for demographic variables and symptoms characteristics. In order to estimate diagnostic accuracy, sensitivity and specificity with 95% confidence intervals was calculated. A two-by-two contingency table for ULNT1 results and CTS diagnosis was developed and likelihood ratios (LR) were also calculated. The +LR was calculated as sensitivity/(1 − specificity) and the −LR was calculated as (1 − sensitivity)/specificity (Altman, 2000). Because the LRs were not near 1 the Taylor method was used to calculate the