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The segmental palmar test in diagnosing carpal tunnel syndrome reassessed

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HIGHLIGHTS

- Slowing of sensory nerve conduction velocity in the median nerve distal to the carpal tunnel is frequently found in carpal tunnel syndrome.
- In contrast, slowing of forearm median nerve conduction velocity is less frequent in these patients.
- Therefore, comparing the median nerve conduction velocities of the forearm with the wrist segment provides a greater sensitivity than comparing the palm with the wrist segment, in the segmental palmar test.

ABSTRACT

Objective: To test our hypothesis that comparing the sensory nerve conduction velocity of the median nerve across the wrist with that of the forearm is more sensitive than comparing it with that of the palm in the electrodiagnostic confirmation of carpal tunnel syndrome (CTS).
Methods: One hundred and fifty seven consecutive patients with clinically defined CTS were prospectively included and electrophysiologically examined. Antidromic nerve conduction velocities were measured in 3 segments of the median nerve: forearm, wrist, and palm. Differences and ratios in nerve conduction velocities were computed between the forearm and wrist and between the palm and wrist segments.
Results: Comparing the median nerve conduction velocities of the forearm with the wrist segment provides a greater sensitivity (79.6% and 82.8% for the second and third digit, respectively) than comparing the palm with the wrist segment (65.6% and 65.0%). Applying the ratio leads to slightly higher sensitivities for both comparisons.
Conclusions: The modified segmental palmar test is a sensitive, robust and easily applicable method in diagnosing CTS.
Significance: We recommend to use the median nerve sensory conduction velocity in the forearm as a reference in the segmental palmar test instead of that in the palm.

1. Introduction

Decrease in nerve conduction velocity (NCV) of the median nerve across the carpal tunnel is the most sensitive test to confirm the clinical diagnosis of carpal tunnel syndrome (CTS). Abnormalities in more than a single test are needed to confirm the clinical diagnosis of CTS (Redmond and Rivner, 1988). It is most common to compare sensory nerve conduction velocities of the median nerve across the wrist segment to nerve segments which are presumed to be normal, and therefore can be used as a reference. Comparison of the NCV of median nerve fibers across the carpal tunnel with those distal from the carpal tunnel (PALM test) (Padua et al., 1996; Buchthal et al., 1974) is a sensitive test. However, this specific test has several disadvantages. Because of the short conduction distance, the inherent small distance between stimulus electrodes and recording electrodes often introduces uncontrollable stimulus artefacts, which prevent accurate measurements of the latencies of the sensory nerve action potentials (SNAPs). On the other hand, conduction slowing over a small segment is more easily detected when applying small conduction distances. However, at the same time, this introduces larger measuring inaccuracies than in larger conduction distance (van Dijk et al., 2001). More importantly, however, and not withstanding appropriately controlled skin temperature, we often find conduction slowing in segments distal from the carpal tunnel in CTS patients. As a

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consequence, in such cases this segment may be less suitable as a normal reference. In contrast, conduction slowing in sensory median nerve fibers over the forearm segment is rarely found (Buchthal et al., 1974). The aim of the present study was to elucidate a more sophisticated variant of the traditional segmental palmar test with a potentially higher diagnostic yield. Therefore we reassessed the diagnostic value of the segmental palmar test in a prospectively conducted study to test which segment is best to be used as a reference.

We tested our hypothesis that comparing the NCV of the more proximal segment of the median nerve (i.e. forearm) with the palm to wrist segment is a sensitive and reliable test in the electrodiagnostic confirmation of CTS. Therefore, we determined the value and sensitivity of the segmental test of the median nerve in CTS patients, in which the NCV in the palm to wrist segment was compared to the NCV in the wrist to elbow segment.

2. Materials and methods

2.1. Subjects

In this prospective cohort study, 157 consecutive patients with clinically defined carpal tunnel syndrome were included.

Carpal tunnel syndrome was considered clinically present in patients with pain and/or paresthesias in and restricted to the sensory distribution of the median nerve (involvement of the fifth finger was an exclusion criterion), and if patients met 2 or more of the following criteria: (1) nocturnal paresthesias, (2) reproduction or aggravation of paresthesias or pain by provocative tests (Tinel or Phalen's sign), (3) aggravation of paresthesias by activities such as driving a car, riding a bike, holding a book, or holding a telephone, (4) paresthesias relieved by shaking the hand. These clinical criteria have previously been used in other studies (Witt et al., 2004). Patients were not included in this study in the following cases: clinical signs of polyneuropathy or known hereditary neuropathy with liability to pressure palsy, history of trauma or previous surgery of the symptomatic wrist, pregnancy, severe atrophy of the abductor pollicis brevis muscle, history of rheumatoid arthritis or arthrosis of the wrist, known diabetes, thyroid disease, or alcoholism. In case of bilateral complaints compatible with clinical CTS, only the most symptomatic hand was included. All candidates gave their written informed consent, and the study was approved by the local medical ethics committee.

2.2. Electrodiagnostic evaluation

All patients and healthy volunteers underwent standardized nerve conduction studies (NCS) in accordance with our laboratory's standard procedure in carpal tunnel syndrome. NCS were performed using a Viking Myograph type IV (Nicolet Biomedial Inc., Maddison, WI, USA). Skin temperature at the site of the recording electrode was maintained at a minimum of 31.0 °C, by means of hot packings, and was measured before and after each test by means of an infrared thermometer (62 Mini IR thermometer, Fluke Biomedical, Cleveland, OH, USA). Electrophysiological studies were all performed by the same examiner, who was blinded to the results of the preceding physical examination. In all patients, sensory as well as motor nerve conduction studies were performed.

Ring electrodes were applied for recording sensory nerve action potentials (SNAP). The proximal electrode was placed at the first interphalangeal joint and the distal recording electrode at a distance of at least 3 cm, if feasible. The ground electrode was placed between the proximal recording electrode and the stimulation site and, if necessary, repositioned in order to reduce stimulus artefacts. The hand was manually fixed by the examiner to reduce movement artefacts. Stimuli with a duration of 0.3 ms were applied and stimulus current was adjusted in order to obtain supramaximal stimulus conditions. The optimal stimulation site was carefully determined. In case of disturbing stimulus artefacts, i.e. stimulus artefacts interfering with the observed potentials, repositioning of the anode without changing the position of the cathode by turning the stimulator was performed, and stimulus duration or current was adjusted in order to try to reduce the stimulus artefact. Signal averaging was applied on all SNAPs at least 3 times or, if necessary, several responses more in order to obtain an acceptably sharp potential take-off from baseline.

Sensory nerve conduction studies comprise comparing the onset latencies between the median nerve and the ipsilateral ulnar (D4) and radial nerve (D1) at the same conduction distance, as well as segmental antidromic sensory conduction studies of the median nerve across the wrist. In the latter, digit 2 and digit 3 were used for recording with ring electrodes. Conduction distances were measured with a precision of 1 mm using a measuring tape. Distances were measured in a straight line from the recording electrode at the first interphalangeal joint to the stimulation site at the palm and subsequently the stimulation site at the wrist, which is just medial to the flexor carpi radialis tendon. The stimulation site at the palm was exactly halfway the distance from interphalangeal joint to the wrist for both digit 2 and 3. Finally, the distance to the stimulation site at the cubital fossa was measured (Fig. 1). Subsequently, nerve conduction velocities of the three separate segments were computed.

Motor nerve conduction studies were performed by stimulating the median nerve at the wrist and at the cubital fossa. Compound muscle action potentials (CMAPs) were recorded from the thenar eminence by means of surface electrodes, at a recording distance of 6 cm from the stimulation site at the wrist. Recording position was chosen in a way that enabled recording a CMAP as maximal as possible with a sharp initial negative deflection. A distal motor latency (DML) of >4.0 ms is considered to be consistent with CTS. Finally, the terminal latency index (TLI) was calculated by the following equation: TLI = terminal distance/(motor conduction velocity forearm $*$ DML).

Sensory nerve conduction velocities were computed for the following segments of the median nerve: from elbow to wrist (FOREARM), from wrist to a point halfway wrist to base of the phalanx (WRIST), from halfway the wrist to the base of the phalanx to the proximal recording ring electrode (PALM) and from wrist to the

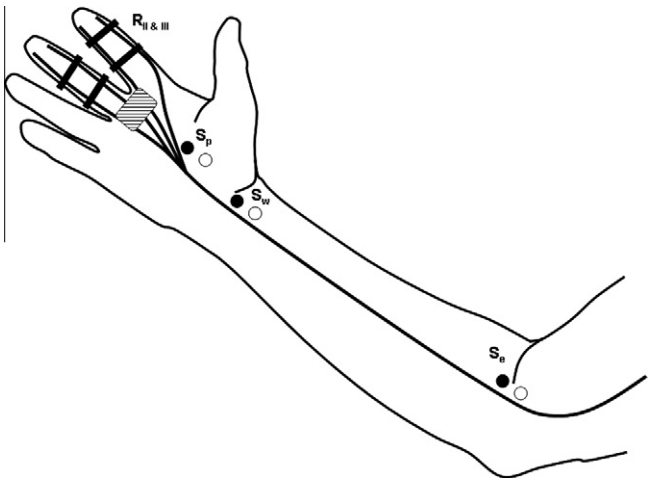

Fig. 1. Schematic diagram of segments in segmental palmar test. R_{II} & R_{III}, recording site second and third digit; S_p, stimulation palm; S_w, stimulation wrist; S_e, stimulation elbow; FOREARM, S_e–S_w; WRIST, S_w–S_p; PALM, S_p–R_{II} or S_p–R_{III}; Black circle, cathode; White circle, anode; Hatched square, ground electrode.