ORIGINAL ARTICLE

A Comparison of the Benefits of Sonography and Electrophysiologic Measurements as Predictors of Symptom Severity and Functional Status in Patients With Carpal Tunnel Syndrome

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ABSTRACT. Kaymak B, Özçakar L, Çetin A, Candan Çetin M, Akıncı A, Hasçelik Z. A comparison of the benefits of sonography and electrophysiologic measurements as predictors of symptom severity and functional status in patients with carpal tunnel syndrome. Arch Phys Med Rehabil 2008;89:743-8.

Objectives: To clarify whether sonography or electrophysiologic testing is a better predictor of symptom severity and functional status in carpal tunnel syndrome (CTS) and to assess the diagnostic value of sonography in patients with idiopathic CTS.

Design: Cross-sectional.

Setting: University hospital physical medicine and rehabilitation clinic.

Participants: Thirty-four hands with CTS and 38 normative hands were evaluated.

Interventions: Not applicable.

Main Outcome Measures: The Boston Carpal Tunnel Questionnaire, which comprised symptom severity and functional status scale, was applied to CTS patients. Bilateral upper-extremity nerve conduction studies of median and ulnar nerves and sonographic imaging of the median nerve were performed in all participants. Sonographic evaluation was performed by a physician blinded to the physical and electrophysiologic findings of the subjects.

Results: Cross-sectional areas (CSAs) of the median nerve at the carpal tunnel entrance and proximal carpal tunnel were 12.5±2.6 and 10.6±2.6 versus 15.6±4.2 and 11.5±3.2 in CTS patients versus controls, respectively. Increased CSA of the median nerve at the carpal tunnel entrance ($P<.002$) and at the proximal carpal tunnel ($P<.000$) were detected in the hands with CTS. Flattening ratios did not differ in a statistically significant manner between the groups ($P>.05$). The best predictor of symptom severity was median nerve sensory distal latency and that of functional status was median nerve motor distal latency. The optimum cutoff value for median nerve CSA was 11.2mm^2 at the carpal tunnel entrance and 11.9mm^2 at the proximal carpal tunnel. Sensitivity, specificity, and positive and negative predictive values at the proximal carpal tunnel (88%, 66%, 71%, 80%, respectively) were higher than those at the carpal tunnel entrance (68%, 62%, 65%, 66%, respectively).

Conclusions: The best predictors of symptom severity and functional status in idiopathic CTS seem to be the electrophysiologic assessments rather than sonographic measurements. On the other hand, sonography may be helpful in the diagnosis of idiopathic CTS.

Key Words: Carpal tunnel syndrome; Electromyography; Rehabilitation; Ultrasonography.

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CARPAL TUNNEL SYNDROME (CTS), which is the most frequently reported entrapment neuropathy, displays a constellation of symptoms and signs in the hand and sometimes also in the upper extremity. Localized compression of the median nerve through the carpal tunnel is the most important factor responsible for the symptoms and functional impairment in CTS.[1] Diagnosis is mainly based on the history of symptoms (eg, pain, numbness, tingling, burning in the hand), provocative factors (sleep, repetitive movement of the wrist), mitigating factors (shaking the hands, changes in hand posture), and clinical findings (provocative tests, sensory abnormality in median nerve distribution, weakness or atrophy in the thenar region of the hand).[2] Neurophysiologic assessment of the median nerve and, more recently, structural assessment of both the median nerve and nearby soft tissues by sonography are used to confirm the diagnosis and also to exclude other conditions.[3-15] The associations of clinical symptoms and functional status with electrophysiologic and sonographic findings in CTS have been investigated in the literature; however, the results were equivocal.[9,15-19] Moreover, which of these 2 methods is a better predictor of symptom severity and functional status has not been investigated before.

The purpose of this study was 2-fold. First, we aimed to clarify whether electrophysiologic or sonographic evaluations predicted symptom severity and functional status better in CTS. Second, we aimed to assess the diagnostic value of sonography in patients with idiopathic CTS.

METHODS

The patients who applied to the outpatient clinic of the Physical Medicine and Rehabilitation Department with symptoms of CTS were consecutively evaluated between January and April 2003. Patients with symptoms of pain, numbness, tingling, and/or burning in the median nerve distribution of the hand; with nocturnal pain; and having at least 1 positive provocative test result (Tinel test, Phalen maneuver, reverse Phalen maneuver) and/or sensory disturbance in the median

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nerve territory (light touch, pinprick, 2-point discrimination) were included in the study.

Exclusion criteria were lack of symptoms in digits 1, 2, and 3 (unlikely pattern of Katz hand diagram)[20]; existence of disorders like hypothyroidism, gout, systemic lupus erythematosus, rheumatoid arthritis, diabetes mellitus, chronic renal failure, and acromegaly; any orthopedic or neurologic disorders mimicking CTS such as polyneuropathy, cervical radiculopathy, brachial plexopathy, thoracic outlet syndrome, proximal median nerve entrapment, or other upper-extremity nerve entrapments; drug usage causing neuropathy; vitamin B_{12} and folic acid deficiency; history of CTS surgery; wrist fracture and repetitive trauma to the hand; thenar atrophy and thumb abduction and opposition weakness determined with manual muscle testing (to restrict the study to patients with mild and moderate CTS); being currently under treatment for CTS including analgesic medication during the last 2 weeks; and pregnancy.

All exclusion criteria were assessed with medical history, neuromuscular examination, and radiologic, electrophysiologic, and sonographic evaluations.

Age- and sex-matched healthy volunteers from the hospital staff and their relatives were enrolled as the control group. All were evaluated, and volunteers who had any of the exclusion criteria were excluded. All subjects gave informed consent in accordance with the Helsinki Declaration of 1975. Range of motion, muscle strengths, hypoesthesia (light touch and pinprick), fingertip 2-point discrimination, and specific tests for CTS (Tinel test, Phalen maneuver, reverse Phalen maneuver) were performed. Thumb abduction and opposition strength and thenar atrophy were checked. Complete blood count; erythrocyte sedimentation rate; liver and renal function; and thyroid hormone, vitamin B_{12}, and folic acid levels were measured. All patients underwent anteroposterior (AP) and oblique cervical plain radiographies, AP wrist-hand radiography and electrophysiologic evaluations. The Turkish version of Boston Carpal Tunnel Questionnaire including symptom severity scale (SSS) and functional status scale (FSS) was applied. It has been validated by Sezgin et al.[21] Patients who had bilateral symptoms were asked to answer 2 questionnaires, one for each hand separately. Symptom severity and functional status were determined as described by Levine et al.[22] Clinical diagnoses of CTS were classified according to the Katz hand diagram.[20]

Electrophysiologic Testing

All participants underwent median and ulnar nerve sensorimotor nerve conduction studies (NCSs). Electrophysiologic tests were performed using a 5-channel electromyography device in normal room temperature.[a] Skin temperature on the hand was measured and maintained between 32° to 34°C. Standard techniques of supramaximal percutaneous stimulation with a constant current stimulator and surface recording were used for NCSs as recommended in the literature.[23-25] A ground electrode was placed on the dorsum of the hand. Motor responses were recorded with 1-cm stainless steel disk electrodes. The active electrode was located over the thenar eminence (abductor pollicis brevis muscle) for the median nerve and over the hypothenar eminence (abductor digiti minimi) for ulnar nerve to record compound muscle action potentials. The reference electrode was placed over the first or fifth metacarpophalangeal joint. The median and ulnar nerves were stimulated at the wrist and elbow (antecubital region for median nerve, ulnar fossa for ulnar nerve) at a distance of 8cm from the wrist to the active electrode. Sensory responses were obtained antidromically. Ring electrodes were used to obtain sensory nerve action potentials. Electrodes were placed over the third finger for the median nerve and fifth finger for the ulnar nerve, 3 to 4cm apart. The active recording electrode was placed more proximally, closest to the stimulator. The median and ulnar nerves were stimulated at the wrist and elbow (antecubital region for median nerve, ulnar fossa for ulnar nerve) at a distance of 14cm from the wrist to the active electrode.

Sonographic Evaluation

Sonographic measurements were all performed by using a linear array probe[b] of 8 to 16MHz on the same day with the clinical and electrophysiologic studies. All measurements were performed on both hands of the participants by the same physician who was also blind to the diagnosis, physical findings, and electrophysiologic testing results. During the examination, patients were seated in a comfortable position with the hands supported so as to keep a position of slight wrist hyperextension, elbows in flexion, and forearms in supination. The median nerve was examined axially at the levels of the distal radioulnar joint (carpal tunnel entrance) and pisiform bone (proximal carpal tunnel). No additional force was applied other than the weight of the probe to avoid causing any artificial nerve deformity. The median nerve study at the distal carpal tunnel is quite difficult because the nerve is deep and oblique to the transducer; therefore, no measurement was taken at the level of the hamate bone (distal carpal tunnel). The superficial tendon of the index finger lying deep to the median nerve was used as a landmark. The angle of the ultrasound beam was kept perpendicular to the surfaces of the nerve and the tendons to have the highest echogenic view. Mediolateral and AP diameters of the median nerve and its cross-sectional area (CSA) were calculated. The circumference of the median nerve and its CSA were measured using a continuous boundary trace of the nerve including the surrounding echogenic rim (fig 1A). Area calculations were automatically performed by the software of the device (version P7.03). We preferred to use this direct method for calculating the areas, because its diagnostic accuracy is higher than that of the indirect method.[8] The flattening

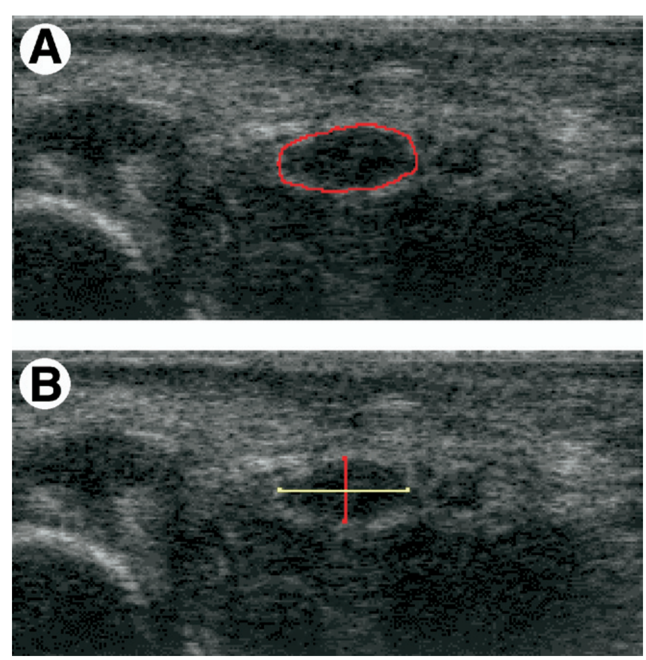

Fig 1. Transverse imaging of an enlarged median nerve at the carpal tunnel entrance in one of the CTS patients showing the measurements of (A) the CSA and (B) the mediolateral and AP diameters.

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