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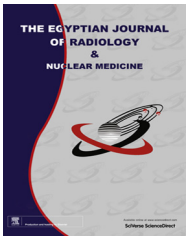

ORIGINAL ARTICLE

Contribution of power Doppler and gray-scale ultrasound of the median nerve in evaluation of carpal tunnel syndrome

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KEYWORDS

Power Doppler;
Gray-scale;
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Abstract *Aim of the work:* To assess the role of gray-scale and power Doppler ultrasound (US) of the median nerve at the wrist in evaluating carpal tunnel syndrome (CTS).
Materials and methods: Seventy-one wrists in 51 patients with CTS in addition to 50 healthy volunteers that served as the control group were enrolled in this study. The following sonographic parameters were evaluated in both patients and controls: cross sectional area of the median nerve just proximal to the tunnel inlet (CSA1), at the pisiform bone level (CSA2), the CSA difference (ΔCSA), flattening ratio of the median nerve and bowing of the flexor retinaculum. The power Doppler US was used to assess the number of nerve vessels with estimation of the vascularity score.
Results: The ΔCSA revealed an excellent discriminative ability (AUC = 0.988) in differentiating patients with CTS at an optimal cut-off value of 3.9 mm^2. Intraneural hypervascularization was significantly correlated with the ΔCSA of the median nerve ($P < 0.001$), while not significantly correlated with the age of patients, median nerve flattening ratio and bowing of flexor retinaculum.
Conclusion: The ΔCSA and vascularity score of the median nerve are important and useful sonographic parameters in evaluation of CTS.

Abbreviations: CTS, carpal tunnel syndrome; CSA, cross sectional area; CSA 1, cross sectional area of the median nerve just proximal to the carpal tunnel inlet; CSA 2, cross sectional area of the median nerve at the level of the pisiform bone; ΔCSA, delta CSA = CSA 2 − CSA 1

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1. Introduction

The carpal tunnel is an anatomical passage way compartment located at the middle third of the base of the palm. Nine flexor tendons and the median nerve pass through it. It is surrounded on three sides by the carpal bones that form an arch and restrict the tunnel dorsally, while the flexor retinaculum restricts it ventrally. The proximal boundary is the distal wrist skin crease, and the distal boundary is approximated by a line known as Kaplan's cardinal line (1). This line uses surface landmarks, and is drawn between the apex of the skin fold between the thumb and index finger to the palpated hamate hook along the axis of the ring finger (2).

Carpal tunnel syndrome (CTS) occurs when the median nerve becomes pressed at the wrist in the carpal tunnel. In fact, women are three times more likely than men to develop CTS, which usually occurs only in adults. Most cases are idiopathic (3). However, CTS is often the result of a combination of factors that increase pressure on the median nerve and tendons in the carpal tunnel (4). Although painful sensations may indicate other conditions, CTS is the most common and widely known of the entrapment neuropathies in which the peripheral nerves are compressed (5).

Early diagnosis and treatment are important to avoid permanent damage to the median nerve. Symptoms usually start gradually in one or both hands during the night, with tingling or numbness in the palm and fingers, especially the thumb, index and middle fingers. Some feel swollen hands. Typical times include while holding a phone or a newspaper, gripping a steering wheel, or waking up during the night. As symptoms worsen, people might feel tingling during the day with difficulty to form a fist, grasp small objects, or perform other manual tasks. Long-standing CTS leads to permanent nerve damage with constant numbness, atrophy of the thenar muscles and weakness of palmar abduction (6,7). Pressure on the median nerve at the wrist, produced by either bending the wrist to 90° (Phalen or wrist-flexion test), tapping the skin over the flexor retinaculum (Tinel test), or firmly pressing the palm over the nerve (Durkan or carpal compression test), can bring on the symptoms within 1 min (8–10).

Electrodiagnostic studies are useful in making the decision for surgical decompression and in differentiating less typical cases such as entrapment of other nerves, cervical radiculopathy, demyelinating disease, diabetes or peripheral neuritis which could be confused with CTS. Although they are highly specific, they have a substantial false-negative rate of 10–20% (11).

Ultrasonography (US) is a simple, non-invasive and valuable tool for confirming the diagnosis of CTS because it can detect the median nerve compression characteristics and space-occupying lesions such as ganglia, neural tumors and tenosynovitis (12). Moreover, the power Doppler US might be a useful imaging method for evaluating the degree of severity of CTS especially before surgical decompression is warranted (7).

The aim of the present study was to assess the role of gray-scale and power Doppler US of the median nerve at the wrist in evaluating CTS.

2. Materials and methods

This study was performed in the period between January, 2012 and March, 2013 on 71 wrists from 51 patients (34 females and 17 males), referred from the Neurology department of our institution, with clinically characterized idiopathic CTS lasting for at least one month. Symptoms were unilateral in 31 patients and bilateral in 20 patients. Clinical diagnosis of CTS was confirmed by the electrodiagnostic tests that were performed within 5 days before the imaging examination was done. The control group included 50 normal healthy volunteers (32 females and 18 males) with no clinical signs or symptoms suggestive of CTS. One wrist from every individual in the control group was chosen for imaging tests while electrodiagnostic testing was not done in this group. Exclusion criteria included pregnancy, previous wrist surgery or injury, clinical suspicion of any other neuropathies e.g., cervical spondylosis, and bifid median nerve on US. All patients and controls were investigated to exclude disorders that might be associated with neuropathy as diabetes mellitus, thyroid disease, connective tissue disorders, renal and hepatic disease. All patients were educated about the study design and procedures. Written consent was obtained from all study participants and approval from the local ethics committee was obtained.

The diagnosis of CTS was reached through the characteristic clinical history (nocturnal hand discomfort and sensory impairment in the median nerve distribution), clinical examination (positive Tinel, Phalen and/or Durkan tests), and then confirmed by the electrodiagnostic tests.

2.1. Electrodiagnostic tests

Electrodiagnostic tests were done by Neuropack X1/EMG/EP measuring system, MEB-2300 in the Physical medicine, Rheumatology and Rehabilitation department of our institution. The median nerve sensory action potential amplitude, latency, and sensory conduction velocity (CV) were measured. The median nerve motor amplitude, distal motor latency (DML), and motor conduction velocity were measured using standard techniques of supramaximal cutaneous stimulation and surface recording electrodes. F-response latency of the median nerve was also obtained to exclude proximal affection of the median nerve roots. Additional ulnar nerve sensory and motor conduction studies were also performed using similar standard techniques. Needle EMG was done in the abductor pollicis brevis muscle to determine the severity of CTS and additional muscles in the upper limb to exclude proximal median neuropathy, brachial plexopathy or radiculopathy.

The diagnostic criteria of electrodiagnostic tests for CTS were reduction in the median nerve sensory CV of less than 50 m/s across the carpal tunnel, prolongation of median nerve DML more than 4 ms, no abnormalities in the ulnar nerve, and no abnormalities in the proximal median nerve. The absence of any electrical diagnostic criterion resulted in defining the wrist as normal. Mild CTS was considered when reduction of the sensory CV with normal motor responses and EMG results. Moderate CTS was considered when sensory abnormalities were combined with prolonged DML but normal EMG. Severe CTS was considered when absence of sensory responses was associated with motor nerve changes and abnormal EMG (13).

2.2. Imaging

All imaging examinations were performed by using a linear array transducer of 12 mega-Hertz (MHz) frequency connected to a real-time ultrasound machine (Biomedical P-K, Denmark)