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Research article

The effectiveness of ultrasonography and ultrasonographic elastography in the diagnosis of carpal tunnel syndrome and evaluation of treatment response after steroid injection

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ABSTRACT

Purpose: To evaluate if there is a place for ultrasonography (US) and ultrasonographic elastography (UE) in the diagnosis and follow up of carpal tunnel syndrome treatment.

Materials and methods: The study was performed on 25 patients (study group) and 17 healthy volunteers (control group). Measured US and UE criteria were median nerve area (MNA), proximal median nerve area (pMNA), difference between MNA and pMNA (dMNA) and strain values of carpal tunnel content (CTC) and median nerve (MN). Patients in the study group were also evaluated using the Boston questionnaire, Visual Analogue Scale (VAS) and nerve conduction studies. Thirty-three wrists in 23 patients received steroid injections on the same day. Patients were re-evaluated 6 weeks after steroid injection. To establish a cut off value for MNA, ROC Curve analysis was used.

Results: Mean MNA and dMNA values in the control group were significantly lower than in the study group (7.33 ± 1.31 vs. 15.44 ± 5.10; p= < 0.05 and 1.58 ± 0.75 vs. 8.91 ± 4.93; p = 0.00 respectively). Median nerve and CTC strain indices were significantly higher in the control group (p = 0.00 and p = 0.036). Decrease in MNA and dMNA values after treatment was meaningful (p = 0.00).

While there was no significant change in MN elasticity, mean CTC strain index of the study group (4.680 ± 1.664) decreased significantly after treatment (3.621 ± 1.054 p = 0.002). This decrease in the CTC index was more pronounced in patients who benefited from treatment (p = 0.001).

Conclusion: US and UE can be useful in the diagnosis of CTS and its response to treatment, if used together with clinical and electroneurophysiological tests.

1. Introduction

Carpal Tunnel Syndrome (CTS) is the result of compression of the median nerve as it passes through the carpal tunnel and is the most common entrapment neuropathy [1]. It is mostly seen between the third and fifth decades and is three times more common in women than in men. Its prevalence is reported to be between 0.1–0.5% [2,3]. Although, the etiology of CTS is diverse and conditions such as amyloidosis, trauma, endocrine disorders, rheumatological diseases, tumors, anatomical variations and infection have been attributed as its cause, most cases are idiopathic.

There is no one gold standard method for diagnosing CTS. Diagnosis is established by combining clinical symptoms, physical examination and electroneurophysiological data [4]. Electroneurophysiological methods only evaluate neural function. Ultrasonography (US), on the other hand, can depict morphological anomalies like the increase in cross sectional area due to edema. US findings in CTS have first been defined by Buchberger et al [5]. They reported an increase in the cross-sectional area of the median nerve at the level of the pisiform, which was also significantly enlarged when compared to measurements taken at the level of the distal radius, flattening of the nerve at the level of the hook of hamate and bulging of the flexor retinaculum towards the palmar side on grayscale US examination.

The use of US in the diagnosis of CTS has increased in the last two

Abbreviation: CT, Carpal Tunnel; CTS, Carpal Tunnel Syndrome; UE, Ultrasound Elastography; MN, Median Nerve; MNA, Median Nerve Area; pMNA, Proximal Median Nerve Area; dMNA, Difference of Median Nerve Areas

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decades [5–8]. Currently US is used to support the diagnosis of CTS, where sensitivity and specificities have been reported between 57–97.9% and 51–100%, respectively [7–11]. Klauser et al. reported that the severity of CTS was correlated with the difference of the median nerve areas measured ultrasonographically at two different levels [12].

Whereas US enables morphologic evaluation, Ultrasound Elastography (UE) provides clues about the composition of a given tissue. Elasticity is the ability to maintain size and form against an external force. Elasticity of peripheral nerves has been previously evaluated with UE [13]. The elasticity of the median nerve (MN) and the contents of the carpal tunnel (CT) and their value in the diagnosis of CTS have also been researched [13–15]. In addition, US and UE have been used to evaluate response to treatment in CTS [16].

The aims of this study were to evaluate if there is a place for US/UE in the diagnosis and follow up of CTS treatment, by comparing them to clinical and electroneurophysiological measurements.

2. Material and methods

2.1. Patient selection

The study was conducted in a tertiary center between August-October 2014. Twenty-five consecutive patients with suspected CTS constituted our study group. The number of patients were limited by study duration. Our study was approved by the local ethics committee and written informed consent was obtained from every patient.

Patients with prior wrist trauma or operation, prior corticosteroid injection, gout, chronic renal failure, uncontrolled diabetes or other systemic disease were excluded from the study. In addition, patients with bifid median nerve variation were excluded. CTS severity was classified on the basis of the electrophysiological results as mild, moderate and severe according to the modified scoring system by Padua et al [17]. Severe cases of CTS were excluded as well, since these patients are treated surgically. Of the 25 patients in the study group, two (8%) were male and 23 (92%) were female with an age range between 29–68 years (mean age 45.68 ± 10.16).

Both wrists were evaluated in 25 patients (50 wrists). Four wrists in four patients with unilateral complaints were excluded. Two wrists in two patients were excluded due to prior surgery. One wrist was excluded due to bifid median nerve variation. Forty-three wrists in 25 patients constituted our study group, of which 22 (51,2%) were right and 21 (48,8%) were left wrists.

2.2. Control group

Seventeen asymptomatic healthy volunteers, 15 (88.2%) female and two (11.8%) male, between 32–58 years of age (mean age 40.82 ± 7.67) made up our control group. Age and sex were not significantly different between the study and control groups ($p > 0.05$). There was also no statistically significant difference in terms of right and left wrists, as well as total number of wrists between the two groups. One wrist was excluded from the control group because of bifid median nerve variation. Of the 33 wrists in the control group, 17 were (%51.5) right and 16 (%48.5) were left wrists.

2.3. Treatment

Thirty-three wrists in 23 patients in the study group received corticosteroid injection to their wrists (detailed below) on the same day as the first US and UE examination. One patient underwent surgery to both wrists after the first US evaluation and was excluded from the treatment response evaluation. Treatment response was assessed in 31 wrists of 22 patients (bilaterally in nine patients).

Before treatment, 31 wrists were categorized into mild (14–45.1%), moderate (17–54.8%) and severe (none) CTS according to electrophysiologic findings.

After local anesthetic (1 ml of %0.5 bupivacaine) was injected under US guidance, 40 mg of methylprednisolone was injected around the median nerve within the carpal tunnel by a physical therapy and rehabilitation specialist with five years of experience (A.E). Patients were recalled after six weeks for assessing their response to treatment.

2.4. Pre- and posttherapy evaluation

2.4.1. Physical examination and electroneurophysiological evaluation

Electroneurophysiological evaluation consisted of the assessment of distal motor latency of the median nerve and sensory transmission latency. Pain level was assessed using the Visual Analogue Scale (VAS, 0–10 cm). The Boston Questionnaire was used for the evaluation of patient symptoms and function in the affected wrist. These pre-treatment evaluations were repeated after therapy, 6 weeks later.

2.4.2. Ultrasound and ultrasound elastography

Ultrasound (US) evaluation was performed by a single radiologist with 4 years of experience (R.A) using a linear array high frequency 12 MHz probe on a Toshiba Aplio 500 device. Patients were examined in a sitting position facing the examiner with the forearm flexed at 90° angle at the elbow, the wrist in a neutral supine position and fingers in semi-flexed position. To better evaluate superficial structures and to have the same elasticity reference for elastography measurements, a gel pad was used for each US examination.

Care was taken to position the probe perpendicularly to take correct and reproducible measurements. Wrists were evaluated in the transverse and longitudinal planes for variations, anomalies and pathologies that would exclude them from the study (e.g. bifid median nerve, ganglion cyst etc.).

Median nerve area (MNA) was measured in the axial plane at the entrance of the carpal tunnel between the scaphoid and pisiform, using B-Mode US. Proximal median nerve area (pMNA) was measured in the axial plane at the level of the radiocarpal joint, to achieve consistency in measurements among patients (Fig.1). Each measurement was

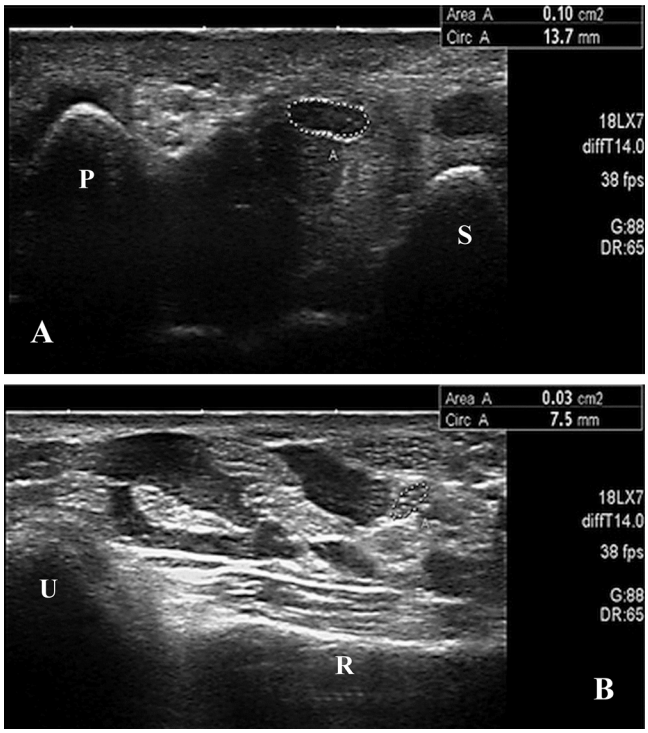

Fig. 1. Median Nerve Cross Sectional Area. (a) Level of the carpal tunnel level inlet. (b) Radioulnar joint level. P-pisiform, S-scaphoid, U-Ulna, R-Radius.