Diagnosis of carpal tunnel syndrome: The effectiveness of ultrasonographic elastography

Ki Jin Jung, Sin Hyung Park[1], Kyoung-Hwan Koh[2], Yoon Sang Jeon[3], Kee Jeong Bae[4]
[1]Soon Chun Hyang University Bucheon Hospital, [2]Asan Medical Center, University of Ulsan College O, [3]College of Medicine, Inha University, [4]Seoul National University Boramae Medical Center

INTRODUCTION:

Carpal tunnel syndrome (CTS) is a common compression neuropathy affecting the median nerve at the wrist level . CTS is the most common and widely studied nerve entrapment syndrome; however, no established standard for its diagnosis exists. CTS diagnosis relies on clinical information such as signs and symptoms and physical examinations, with electrodiagnostic testing (EDT) being the most useful. EDT has relatively high sensitivity (86%) and specificity (95%) for CTS diagnosis ; however, it can cause pain or discomfort in patients owing to its invasiveness, time consumption, and high cost. Many studies [3, 4, 5] have questioned the added value of EDT in CTS diagnosis when compared with clinical diagnosis alone, with EDT studies yielding normal results in 16–34% of patients with clinically diagnosed CTS. As ultrasound technology has advanced, methods for measuring tissue elasticity have been incorporated in addition to methods for measuring the CSA of nerves. Ultrasound elastography, an imaging technology sensitive to tissue stiffness, was first described in the 1990s and has since been further developed and refined to enable quantitative assessments of tissue stiffness [10].

With the development of SWE technology, many studies are being conducted to assess its diagnostic value in various areas, such as liver cirrhosis and breast cancer. Therefore, we aimed to investigate the diagnostic role of SWE, which is more accurate and less affected by the method for evaluating median nerve stiffness.

METHODS:

Our institutional review board approved this prospective study. Written informed consent was acquired from all patients and healthy volunteers. This study included 65 consecutive patients with a definitive clinical diagnosis of CTS who underwent EDT **.**Both wrists of 65 patients (13 men and 52 women) were examined using ultrasound and SWE; however, we only included the measurements on symptomatic wrists (98 wrists). CTS was observed in 98 wrists (46 right side and 52 left side). The mean age for the patient group was 58.1 years. Patients with prior wrist trauma or operation, prior corticosteroid injection, space-occupying lesions, systemic neurologic disorders, and uncontrolled diabetes were excluded from this study. Patients were further grouped based on severity into mild and moderate-severe CTS using Bland's electrophysiological grading scale.

The control group covered 30 wrists of 15 healthy volunteers (5 men and 10 women) with no clinical symptoms of CTS. The mean age for the control group was 51.9 years. Both wrists were examined in each volunteer in the control group. EDTs were not evaluated in the healthy volunteers

RESULTS:

mean CSA and SWE measurements for the patient and control groups. The CSA of the median nerve in the patient and control groups were 10.3 mm^2 and 5.9 mm^2, respectively. Patients with CTS had a significantly higher median nerve CSA than the control group ($P<0.001$).

Thirteen and 85 wrists had mild and moderate-severe CTS, respectively. In the moderate-severe group, the median nerve CSA (11.2 mm^2) was not substantially higher than that in the mild group (9.1 mm^2). The MN mean stiffness was higher in the CTS group (61.2 kPa) than in the controls (30.1 kPa) ($P<0.001$) and higher in the moderate-severe group (98.3 kPa) than in the mild group (52.3 kPa) ($P<0.001$). the receiver operating characteristic (ROC) curves for CTS diagnosis based on CSA and median nerve stiffness data. In our study, the CSA cut-off value for diagnosing CTS was 9.5 mm^2, and its sensitivity and specificity were 79.02% and 58.88%, respectively. A 40 kPa cut-off value on SWE revealed sensitivity and specificity of 70.34% and 83.33%, respectively. The combination of CSA (9.1 mm^2) and stiffness (38.4 kPa) cut-off values yielded sensitivity and specificity of 82.91% and 78.33%, respectively**.**

DISCUSSION AND CONCLUSION:

Compared with using CSA alone, combining CSA and SWE improved diagnostic accuracy. A cut-off value of 9.1 mm on CSA and 38.4 kPa on SWE revealed a sensitivity and specificity of 82.91% and 78.33%, respectively, with logistic regression in CTS diagnosis. This result is similar to that of the study by Cingoz et al. , which reported that patients with CTS had higher stiffness values of the median nerve (53.0 kPa) than the controls (36.8 kPa). The SWE cut-off value for diagnosing CTS with maximum accuracy was 38.25 kPa, with sensitivity and specificity of 78.6% and 62.5%, respectively. Kantarci et al. [16] found a cut-off value of 40.4 kPa on SWE, resulting in a sensitivity and specificity of 93.3% and 88.9%, respectively, in CTS diagnosis. Another study by Moran et al. [10] revealed that SWE and ultrasound can be an alternative to EDT in clinical management. The cut-off value of 14 mm^2 for CSA and 57 kPa for the Eu Eo determined via SWE resulted in specificities of 89% and 89.6%, respectively. The result of our study revealed a relatively low specificity than the results of these two studies.

The SWE cut-off values reported by Cingoz et al. (38.25 kPa) and Kantarci et al. (40.4 kPa) are similar to the cut-off value of 38.4 kPa in our study. Consistent with our study, the above studies revealed higher elasticity values in severe CTS than in patients with mild CTS. In a recent study, Ardakani et al. [17] utilized artificial intelligence techniques with quantitative features extracted from SWE and conventional ultrasound imaging of MN obtained from 100 CTS wrists and 100 control wrists to diagnose CTS. The convolutional neural network achieved the best performance with an accuracy of 98%, whereas CSA and stiffness measurements achieved 95% and 94% accuracy, respectively, indicating an elevation in accuracy with artificial intelligence technology.