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Original Research

Electrodiagnostic Studies and Ultrasound Cross-Sectional Area of the Median Nerve in Patients With Isolated Cervical Radiculopathy

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Purpose: Although the literature has shown that the cross-sectional area (CSA) of the carpal tunnel on ultrasound is enlarged in patients with carpal tunnel syndrome, it does not provide information regarding whether proximal nerve pathology, such as that seen in cervical radiculopathy, increases the CSA of the median nerve.
Methods: In this study, 15 patients were enrolled who had a clinical diagnosis of cervical radiculopathy but not carpal tunnel syndrome. All patients underwent electrodiagnostic studies and ultrasound measurement of the CSA of the median nerve.
Results: Increased median nerve CSA was seen in 1 of 15 patients (7%). Positive findings of cervical radiculopathy were found in 7 patients (47%) by electrodiagnostic studies.
Conclusions: In patients clinically diagnosed with isolated cervical radiculopathy, the vast majority have normal median nerve CSA measured on ultrasound.
Type of study/level of evidence: Prognostic IV.

Ultrasound measurement of the cross-sectional area (CSA) of the median nerve is an accepted alternative diagnostic modality for carpal tunnel syndrome (CTS).[1–11] Compression of the median nerve within the carpal tunnel results in increased CSA proximal and distal to the level of compression.[12] If the CSA exceeds a predetermined cutoff value, the test is considered positive. Depending on the reference standard chosen, the sensitivity and specificity of ultrasound are subject to change and may be similar to or better than electrodiagnostic studies (EDX).[2,4] Detractors of the use of ultrasound for diagnosis of CTS point to its inability to diagnose other causes of upper-extremity neuropathy such as cervical radiculopathy, polyneuropathy, and a more proximal location of nerve compression.

Cervical radiculopathy is a clinical diagnosis made on the basis of a combination of signs and symptoms. It is manifested by cervical root dysfunction resulting in radiating pain from the neck to a specific distribution.[13,14] Compression of the nerve roots of C6 and C7 may mimic CTS.[15,16] Although a double-crush phenomenon or multifocal neuropathy has been described, most patients with numbness in the median nerve distribution have only compression of the median nerve within the carpal tunnel.[17,18] Despite the low incidence of cervical radiculopathy in association with CTS, a bias remains toward using EDX to rule out this rare association. Proponents of EDX believe that these tests are critical because they can potentially provide objective evidence of nerve root dysfunction.[19] The needle electromyography portion of EDX is typically the most useful part of the test because it can identify motor unit changes such as fibrillations and positive sharp waves in a myotomal pattern.[19-21] A positive test requires abnormal EMG changes in 2 muscles that receive innervation from 2 different peripheral nerves but the same nerve root.[22] Interestingly, Kim et al[22] showed that ultrasound can be used in the diagnosis of cervical radiculopathy through measurements of the CSA of cervical nerve roots. They showed that the CSA of the nerve roots was significantly elevated in patients with cervical radiculopathy.

To our knowledge, the literature does not describe the CSA of the median nerve in patients with cervical radiculopathy. The purpose of this study was to determine CSA of the median nerve in patients

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with clinically defined cervical radiculopathy. We predicted that the CSA of the median nerve would not be increased as it is in cases of compression at the carpal tunnel.

Materials and Methods

We obtained informed consent from each patient and the study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki as noted in the study's institutional review board approval (number PRO14110535). Financial support for this research was provided by clinical grants from the American Foundation for Surgery of the Hand and from the Department of Orthopaedic Surgery, University of Pittsburgh Medical Center. A single hand fellowship–trained surgeon prospectively recruited patients with clinical signs and symptoms consistent with cervical radiculopathy. These patients had negative provocative maneuvers for peripheral nerve compression and a history that did not correlate with peripheral nerve compression. Patients were excluded if they had previous carpal or cubital tunnel release, previous cervical spine surgery, and a known diagnosis of peripheral polyneuropathy. All patients who were invited to participate in the study by the hand fellowship–trained surgeon did so. The diagnosis of cervical radiculopathy was subsequently established by a spine surgeon (orthopedic or neurosurgery) or physiatrist based on the patient presentation with radicular upper-extremity pain and provocative maneuvers consistent with cervical radiculopathy. Patients who met inclusion criteria underwent ultrasound examination by the senior author and were referred for EDX. The EDX were performed and interpreted by examiners at an independent physical medicine and rehabilitation group, according to the standards of the American Association of Neuromuscular and Electrodiagnostic Medicine. The ultrasound examination was performed by the senior author with the patient seated and the dorsal forearm resting on the examining table. The elbow was flexed to approximately 80° and the fingers were in a normal resting position. The CSA of the median neve was measured at the carpal tunnel inlet using a 15-6 MHz linear transducer using the tracer function to measure just inside the hyperechoic epineurium.[23,24] The standard of 10 mm^2 routinely used at our institution was employed as the a priori threshold for median nerve CSA area. Magnetic resonance imaging (MRI) scans were ordered at the discretion of the diagnosing physician in some patients to confirm radiculopathy; they were performed at the standard of our institution and read by board-certified radiologists.

Results

A total of 15 patients were enrolled in the study. Mean age was 51 years (range, 33–61 years), 7 were male (47%), and the dominant arm was involved in 10 (67%). Mean median nerve CSA at the carpal tunnel inlet was 7.2 mm^2 (range, 5–10 mm^2). One of 15 patients (7%) had CSA of the median nerve above the standard threshold. The EDX findings were positive for radiculopathy in 7 of 15 patients (47%) and the MRI showed nerve root compression indicative of cervical radiculopathy in 7 of 10 patients (70%). The EDX and MRI were concordant in only 3 of 10 patients (30%).

Discussion

This preliminary study of median nerve CSA in the setting of isolated cervical radiculopathy confirms that the median nerve CSA at the carpal tunnel inlet is within normal limits in the vast majority of patients with this condition. This finding is intuitive because patients with isolated radiculopathy would not have compression within the carpal tunnel and therefore should not have an elevated CSA. This information furthers supports the use of ultrasound in the diagnosis of CTS, because it shows that CSA at the median nerve should not be elevated owing to cervical radiculopathy. If patients have numbness and tingling in the hand and a negative ultrasound, the physician should consider additional testing to evaluate cervical radiculopathy or other nonperipheral nerve compression etiologies further. Future studies could also include a comparison cohort of patients with the rare double-crush syndrome to evaluate how the CSA is affected.

In the current study, only 47% of EDX were positive despite a clinical diagnosis of cervical radiculopathy by board-certified physicians who routinely care for spinal disorders. Although not the aim of this study, this result calls into question the value of EDX in cervical radiculopathy. Nicotra et al[25] reviewed EDX in patients scheduled for surgical treatment of cervical radiculopathy and found positive EDX findings in 48%. Similarly, Soltani et al[26] reviewed 31 patients with cervical radiculopathy and found that EDX were positive in 36%. Anecdotally, physicians assume that EDX is a good test to diagnose cervical radiculopathy; however, the current literature does not support this assumption. Much like CTS, cervical radiculopathy remains a clinical diagnosis without a universal reference standard. A patient may have both a negative MRI and EDX and still be given the diagnosis of cervical radiculopathy based on the clinical evaluation. In addition, a patient may have a positive MRI but be reassured that the positive finding is incidental and not the cause of the current symptoms. We find this second scenario particularly interesting because many patients with incidental positive findings on EDX are said to have CTS despite a lack of symptoms.

There were limitations to this study. First, this was a preliminary, small case series study and it is possible that more positive ultrasound examinations would have been identified if more patients were enrolled. Second, we used a clinical diagnosis of radiculopathy rather than a positive EMG or MRI as a reference standard. However, as pointed out in the discussion, these diagnostic tests are positive in only 50% to 70% of patients with clinically diagnosed cervical radiculopathy, which makes them imperfect reference standards. It is possible that the clinical diagnosis was incorrect, which would potentially raise the average values reported in this study including percentages of patients with enlarged CSA and positive EMG and MRI findings.

Proponents of the routine use of EDX over ultrasound for evaluation of CTS reference the rare occurrence of double-crush syndrome as a justification for this approach. Our study showed that CSA of the median nerve at the carpal tunnel inlet is not elevated in patients with isolated cervical radiculopathy. This information may allow physicians to order additional confirmatory tests for radiculopathy if clinical suspicion persists. Larger clinical series are essential to validate these findings.

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