EDITOR'S CHOICE

Optimal Measurement Level and Ulnar Nerve Cross-Sectional Area Cutoff Threshold for Identifying Ulnar Neuropathy at the Elbow by MRI and Ultrasonography

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Purpose Imaging criteria for diagnosing compressive ulnar neuropathy at the elbow (UNE) have recently been established as the maximum ulnar nerve cross-sectional area (UNCSA) upon magnetic resonance imaging (MRI) and/or ultrasonography (US). However, the levels of maximum UNCSA and diagnostic cutoff values have not yet been established. We therefore analyzed UNCSA by MRI and US in patients with UNE and in controls.

Methods We measured UNCSA at 7 levels in 30 patients with UNE and 28 controls by MRI and at 15 levels in 12 patients with UNE and 24 controls by US. We compared UNCSA as determined by MRI or US and determined optimal diagnostic cutoff values based on receiver operating characteristic curve analysis.

Results The UNCSA was significantly larger in the UNE group than in controls at 3, 2, 1, and 0 cm proximal and 1, 2, and 3 cm distal to the medial epicondyle for both modalities. The UNCSA was maximal at 1 cm proximal to the medial epicondyle for MRI (16.1 ± 3.5 mm^2) as well as for US (17 ± 7 mm^2). A cutoff value of 11.0 mm^2 for MRI and US was found to be optimal for differentiating between patients with UNE and controls, with an area under the receiver operating characteristic curve of 0.95 for MRI and 0.96 for US. The UNCSA measured by MRI was not significantly different from that by US. Intra-rater and interrater reliabilities for UNCSA were all greater than 0.77. The UNCSA in the severe nerve dysfunction group of 18 patients was significantly larger than that in the mild nerve dysfunction group of 12 patients.

Conclusions By measuring UNCSA with MRI or US at 1 cm proximal to the ME, patients with and without UNE could be discriminated at a cutoff threshold of 11.0 mm^2 with high sensitivity, specificity, and reliability. *(J Hand Surg Am. 2018;■(■):■−■. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Diagnostic III.

Key words Elbow, MRI, ulnar nerve, ulnar neuropathy, ultrasonography.

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Ulnar neuropathy at the elbow (UNE) is a common entrapment neuropathy in the upper extremities that is characterized by paresthesia and numbness in the little and ring fingers. Patients with UNE may demonstrate abnormal 2-point discrimination or intrinsic muscle weakness in the later stages, whereas in the early stages, provocation testing may be the only positive sign. In patients who have positive cervical cord or root compression[1–3] upon magnetic resonance imaging (MRI) or similar symptoms from other neuromuscular disease, it is may be difficult to discriminate UNE fully from these conditions.[1,2]

To date, there are no reference standards for objective diagnostic criteria for UNE. The diagnosis of UNE can best be made using clinical provocation testing along with reduced ulnar nerve motor nerve conduction velocity (MCV) across the elbow.[1,2] However, electrodiagnostic study is not universally employed for UNE because these studies are frequently negative in the early stages[4] and often compound motor action potential cannot be detected in the later stages.[5] Recently, high-resolution[6,7] or diffusion-weighted[8,9] magnetic resonance neurography, which qualitatively evaluates pathological changes in the nerve, has been found to be useful for the diagnosis and measurement of enlarged ulnar nerve cross-sectional area (UNCSA) by MRI[10] and ultrasonography (US)[11–20] and has also become a part of modern quantitative diagnostic criteria for this condition. However, studies evaluating UNCSA obtained measurements at either a single site[13,15,19] or only a few of them.[11,12,16,17,20] Consequently, in cases in which the diagnosis of UNE is uncertain and imaging tests are used as a diagnostic modality, clarification of the optimal measurement site, differences in UNCSA between MRI and US, the diagnostic cutoff value, and measurement reliability are all important considerations.

The purpose of this study was to determine the segment level of maximum UNCSA and the cutoff threshold for diagnosing between patients with UNE and those without it by MRI and US.

MATERIALS AND METHODS

The ethics committee of the senior author's hospital approved the study protocol. Subjects were enrolled between 2010 and 2013. Ulnar neuropathy at the elbow was diagnosed by sensory and motor symptoms with clinical provocation testing. Thirty patients with UNE were enrolled in the MRI study and 12 patients with UNE were enrolled in the US study. In addition, 12 patients in the US study were included in the MRI study. Table 1 describes the demographic characteristics of the patients with UNE and controls. Associated elbow lesions in the UNE group consisted of elbow osteoarthritis (OA) in 19 patients and cubitus valgus in 2. Elbows with Kellgren–Lawrence grade 2, 3, or 4 OA,[21,22] as determined using plain anteroposterior and lateral radiographs, were considered to have OA. Motor nerve conduction velocity of the ulnar nerve across the elbow was 50 m/s[1] or more in 10 patients and less than 50 m/s in 17 patients. In the remaining 3 patients, compound muscle action potential from the abductor digiti minimi could not be evoked. The senior author treated patients with UNE surgically by subcutaneous transposition of the ulnar nerve in 27 patients and simple decompression of the ulnar nerve in 3. Patients with UNE associated with acute fracture or dislocation around the elbow, ganglion, or tumor at the cubital tunnel, or recurrence after surgery were excluded. All patients were observed for at least 1 year after surgery and were confirmed to have achieved improvement in symptoms.

Magnetic resonance imaging and determination of UNCSA

We obtained the results of 58 MRI examinations from 30 patients with UNE and 28 control subjects without it (Table 1). Control subjects in the MRI measurement study were patients diagnosed as having lateral epicondylitis of the humerus or soft tissue tumor at the lateral or anterior side of the elbow during the same period, and who had no complications or findings related to UNE.

Imaging examinations were performed with 1 of 2 1.5-T systems (Symphony and Avanto, Siemens Healthcare, Erlangen, Germany). Participants were placed in a supine position with arms at their side, elbows at maximum extension, and forearms supinated. The elbows were placed in a single- or 4-channel, phased-array, receive-only extremity coil. For the measurements described subsequently, transverse T2-weighted, fast spin-echo images without fat suppression were obtained in a plane perpendicular to the bone axis with the following pulse sequences: repetition time was 3,500 to 5,500 ms, echo time was 70 to 95 ms, section thickness was 3 or 4 mm, section interval was 5 mm, field-of-view was 150 × 150 mm, and acquisition matrix was 256 × 320.

The first author, who had 11 years of clinical experience in hand surgery, was blinded to the diagnosis in the UNE and control groups; manually drawn regions of interest on a computer workstation