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Ulnar Goniometer Device: Comparison between electro-neurography and ultrasound.

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ABSTRACT

OBJECTIVE

Our study aims to extend the previous research and compare two diagnostic methods performed on the ulnar nerve to validate the use of the ulnar goniometer in electromyographic diagnostic practice. Comparing the electroneurographic method, obtained through conduction velocity (CV) studies with ultrasound of the ulnar nerve in the area above the elbow and at the wrist, we aim to quantify the reliability of the ulnar goniometer compared to the diagnostic method ultrasound of the nerve.

MATERIALS AND METHODS

The operator examined with the use of the Ulnar Goniometer, detecting the wrist-below-elbow motor conduction speed and the above-elbow speed (AE), below-elbow speed (BE) and subsequently performed an ultrasound examination of the ulnar nerve in the forearm and elbow. We calculated the degree of homogeneity between measurements.

RESULTS

Evaluating 30 participants of both genders with typical paresthetic symptoms of ulnar nerve compression at the elbow, 100% of the measurements show that a decrease in Motor Conduction Velocity (MCV) below 50 m/s is associated with an increase in Cross-Sectional Area (CSA). Additionally, in 89% of cases, a reduction in MCV wBE and BEAE by more than 10 m/s is correlated with an increase in CSA.

DISCUSSION AND CONCLUSIONS

The measurement of the angle below the elbow (BE) and above the elbow (AE) using the Ulnar Goniometer provides us with a slowed Motor Conduction Velocity (MCV) that is by ultrasound data showing an increase in the Cross-Sectional Area (CSA) of the ulnar nerve in that segment, as observed in Cubital Tunnel Syndrome (CTS).

Keywords: ulnar nerve, ulnar goniometer, nerve ultrasound, cubital canal syndrome.

INTRODUZIONE

Electroneurography (ENG) is considered the reference test for the functional evaluation of the ulnar nerve, one of the most superficial in the human body and, for this reason, vulnerable to acute or repeated trauma to the elbow. Ulnar nerve neuropathy at the elbow is second only to carpal tunnel syndrome in incidence and is defined as Cubital Canal Syndrome (CTS) [1]. This is composed of a bony base formed by the medial epicondyle of the humerus and the olecranon of

the ulna and by a ligament roof, made up of a tenacious fibrous stretched between the olecranon and the medial epicondyle which can have a thickness known as Osborne's band [1]. After crossing the cubital canal, the ulnar nerve enters a fibrous tunnel formed by a ligament that unites the two muscular heads of the flexor carpi ulnaris muscle, also anchored to the medial epicondyle of the humerus and the olecranon. This fibrous band may also have a thickness that generates compressive effects on the ulnar nerve that runs inside. In some cases, the symptoms may be associated with a phenomenon of dislocation or subluxation of the ulnar nerve outside the epitrochlea-olecranon groove during elbow flexion-extension movements. The nerve may also suffer focal lesions in the wrist and hand and even less frequently in the armpit, upper arm, or forearm.

Distinguishing between these different compression sites is not always easy. Characteristic symptoms of CCS include pain and sensitivity disturbances on the ulnar side of the hypothenar eminence (the portion of the palm in the last two fingers). Symptoms may occur at night and are typically more pronounced upon awakening. Prolonged flexion of the elbow can aggravate them. In most cases, the first electrodiagnostic findings are the discovery of a demyelinating entrapment neuropathy characterized by a slowing of nerve conduction velocity in the area above the elbow (above the elbow, AE) and below the elbow (below the elbow, BE). A reduction in motor conduction velocity in the AE-BE segment greater than 10 m/s, compared to that calculated in the underlying elbow-wrist segment, is considered pathological [2].

According to the guidelines of the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) and, as several studies have demonstrated [4], for the most precise possible detection of the motor conduction velocity (VCM) of the ulnar nerve in the AE-BE tract, the elbow must have an angle between 70 and 90°, and the above-below-elbow measurement should be approximately 11 cm [3.5]. In a previous study, it was demonstrated that the use of the Ulnar Goniometer device [6,7] (fig.1) reduces the difference in measurements between different operators, increases the reproducibility of the measurement, and increases the specificity of the test. The current study aims to compare the electro-neurographic diagnostic method with the further ultrasound evaluation of the transverse area of the ulnar nerve evaluated at the cubital canal and in correspondence with the middle third of the forearm, in patients suffering from the typical symptoms of CTS.

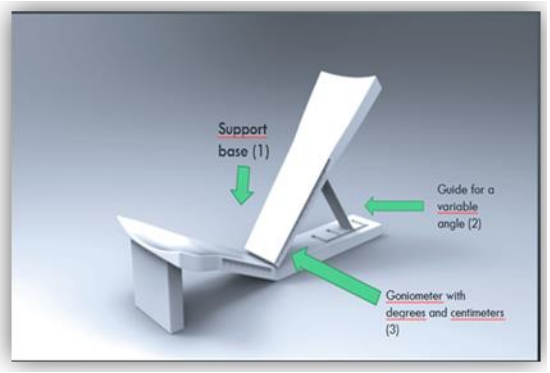

Figure 1: Ulnar Goniometer Model

MATERIALS AND METHODS

Electroneurography

Ulnar electroneurography (ENG) represents the study of the neurophysiological parameters of nerve conduction and measures the ability to transmit impulses along the course of peripheral nerves. Stimulation of the ulnar nerve occurs with the hand pointing upwards, the recording electrodes are placed on the abductor brevis muscle of the fifth finger at the midpoint of the muscle belly, the reference electrode on the middle phalanx of the fifth finger, and the mass on the medial region of the wrist or dorsum of the hand [7]. The arm is positioned on the Ulnar Goniometer device (fig.2). The objective of this device is to standardize the method of detecting the motor conduction velocity of the ulnar nerve, in particular in the AE-BE segment (Fig. 2).

Positioning the arm at a fixed angle (Fig. 3), partially immobilizing it, with the use of this device, recording with surface electrodes from the abductor brevis muscle of the fifth finger and, in some cases, also from the first dorsal interosseous muscle, shows that the measurements are homogeneous with each other (VC AE-BE and VC-BE-Pulse are almost the same or vary slightly). The ulnar goniometer appears as a support composed of a base and an adjustable arm based on the angle (70° or 90°) chosen for our measurement, using a "stepped guide" (Fig. 2).

The stimulation points are at the wrist, approximately 80 mm away from the recording electrode, below the elbow (BE), approximately 6-10 mm away from the medial epicondyle, above the elbow (AE), approximately 110 mm from the point below the elbow, armpit and Erb's point [8]. The normal VCM values in all stimulation sites are greater than 50 m/s (according to the normative values of our Laboratory), excepted the AE-BE section where the VCM can be reduced to less than 10 m/s. Another derivation point for calculating the VCM of the ulnar nerve is the first Dorsal Interosseus muscle, which is more sensitive to speed drops in the AE-BE tract [9]. It is known that the contingent of nerve fibers destined for the first dorsal interosseous muscle runs closer to the typical compression site of the ulnar nerve.

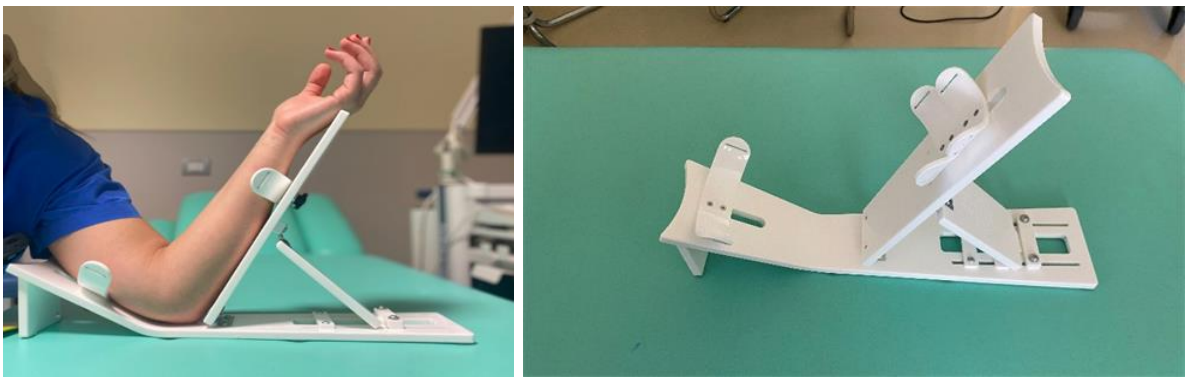

Figure 2: How to use the Ulnar Goniometer

Nerve Ultrasound

Adding ultrasound (US) to electrodiagnostic testing (EDX) can significantly increase the accuracy of testing for ulnar neuropathy at the elbow (UNE). An essential method for evaluating the UN is the measurement of its Transverse Area-Cross Sectional Area (CSA) along the outer hyperechoic border (Figures 4-5). The upper CSA reference value of the UN at the ME level should be considered to diagnose UNE. Mean values of 18.3 mm2 in CSA have been reported in severe cases with axial leakage [10]. All US measurements were performed using a Voluson ultrasound machine with a linear probe at 13–24 mHz. With the elbow flexed at approximately 90° and the hand resting on a surface (Figure 3) with the probe positioned transversely. The measurement of the area was detected by tracing the circumference of the ulnar nerve on the external hyperechoic edge of the ulnar nerve measured in millimeters (mm).

Figure 3: Ulnar nerve Ultrasound of the elbow

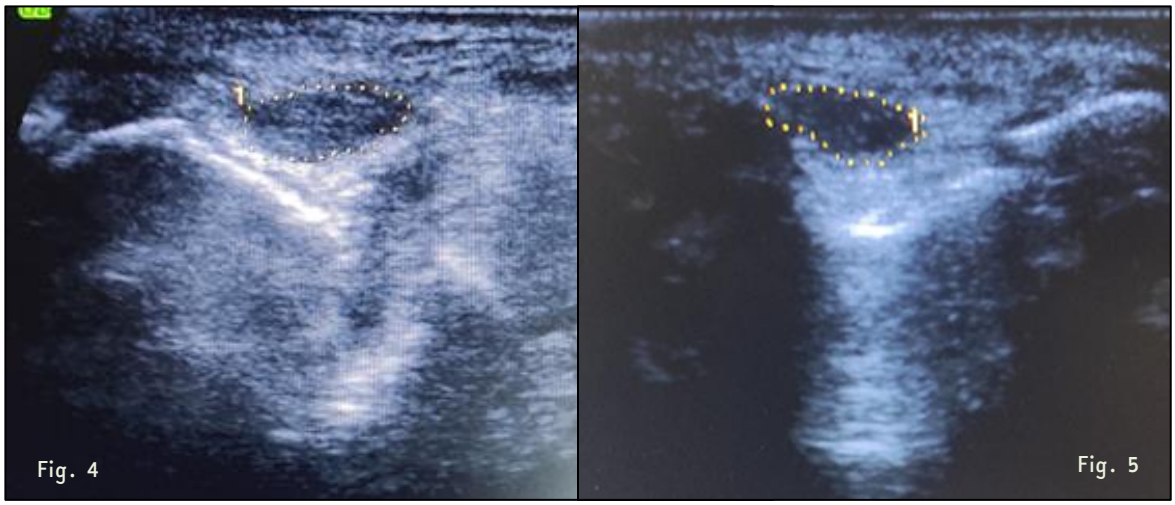

Figure 4: Cross section of the ulnar nerve with increased size; Figure 5: Cross section of the ulnar nerve with increased size.

Statistical analysis

Data are expressed as mean values ± standard deviation or absolute frequency with percentage. All analyses were performed using Stata version 16 (StataCorp, College Station, Texas).

RESULTS

30 patients of both sexes with paresthetic symptoms of the upper limbs were enrolled.

23 patients agreed to undergo testing for one limb only, 7 subjects for both limbs. Motor and sensory conduction velocities were assessed using the Ulnar Goniometer and an ultrasound of the ulnar nerve from the wrist to the supra elbow was performed.

Table 1 shows the values of all 38 measurements, both electroneurographic and ultrasound, of the nerve according to the protocol used in this study.

In 38 patients MCV WE-BE is <50 m/s.

In 34 patients the difference between MCV BE and MCV AE was greater than 10 m/s.

100% of the measurements show that, as indicated in Figure 6 a decrease in MCV below 50 m/s is associated with an increase in CSA. Furthermore, in 89% of cases, a reduction in MCV wBE and BEAE of more than 10 m/s is correlated with an increase in CSA.

	N = 38	Tutti Media ± Dev. St. N (%)
Below Elbow CSA(mm^2)	19	7.4 ± 1.2
SAP (uV)	26	17 ± 15
SAP (uV)	33	7 (21%)
CSA at the Elbow (mm^2)	38	16.4 ± 4.1
MCVWBE (m/s)	38	58 ± 7
MCVBEAE (m/s)	38	38 ± 6
MCVWBE-MCVBEAE (m/s)	38	19 ± 7
MCVWBE-MCVBEAE (m/s)>10	38	34 (89%)
>10 or <50	38	38 (100%)

Table 1: The table shows the measurements taken with our study protocol.

Legend: SAP = sensory action potential; CSA = cross sectional area; MCV = motor velocity conduction; WBE = wrist-below elbow; BEAE = below elbow-above elbow.

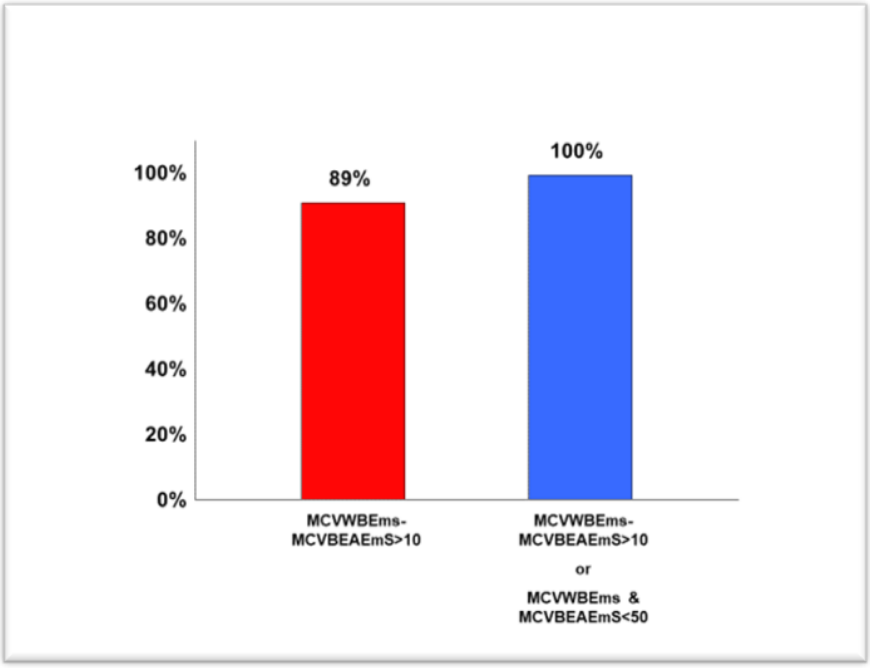

Figure 6: A decrease in MCV below 50 m/s is associated with an increase in CSA.

DISCUSSION AND CONCLUSIONS

To continue the previous validation study of the Ulnar Goniometer, we conducted this study comparing ENG with nerve ultrasound. In all cases examined, a reduction in Motor Conduction Velocity (MCV) in the supra-sub elbow segment corresponds to an increase in the Cross-Sectional Area (CSA) of the ulnar nerve.

This means that, since the ultrasound evaluation of the nerve is of further help in the diagnosis of Cubital Canal Syndrome, the correctness of the measurement of the MCV using the Ulnar Goniometer is further confirmed. A further future step could be the evaluation of the site of greatest lengthening of the distal motor latency, using the Kimura inching technique, and the position of the greatest CSA of the ulnar nerve between above and below the elbow, for a more precise localization of the nerve damage.

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