

# Journal of Biomedical Practitioners

## JBP

Periodico per le professioni biomediche a carattere tecnico - scientifico - professionale

*Titolo articolo / Article title:*

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

*Autori / Authors:* Lara Gallicchio, Valentina Recchia, Pietro Guida, Anna De Luca, Luigi Didonna, Marianna Cipriani, Eleonora Vecchio, Laura Ruiz Marquez, Antonella Petruzzellis, Filippo Tamma.

*Pagine / Pages:* 130-137, N.1, Vol.8 - 2024

*Submitted:* 15 January 2024 – *Revised:* 22 January 2024 –

*Accepted:* 5 May 2024 – *Published:* 10 June 2024

*Contatto autori / Corresponding author:* Lara Gallicchio

[l.gallicchio@miulli.it](mailto:l.gallicchio@miulli.it)



Opera distribuita con Licenza Creative Commons.  
Attribuzione – Condividi allo stesso modo 4.0 Internazionale.

Open Access journal – [www.ojs.unito.it/index.php/jbp](http://www.ojs.unito.it/index.php/jbp) – ISSN 2532-7925

Questa Rivista utilizza il [Font EasyReading®](#), carattere ad alta leggibilità, anche per i dislessici.

Periodico per le professioni biomediche e sanitarie a carattere tecnico - scientifico – professionale

**Rivista scientifica ideata e fondata da / Scientific journal founded by:**

Francesco Paolo SELLITTI

**Direttore responsabile/Editor in chief:** Francesco Paolo SELLITTI

**Direzione di redazione/Editorial management:** Iliaria STURA, Elisa PICCOLO, Domenico Riccardo CAMMISA.

**Comitato di redazione/Editorial team:**

Simone URIETTI, Elena DELLA CERRA, Luciana GENNARI,  
Patrizia GNAGNARELLA, Alessandro PIEDIMONTE, Luca CAMONI,

**Editors:** Claudio POBBIATI, Iliaria STURA, Cristina POGGI, Antonio  
VEROLINO, Elisa PICCOLO, Domenico Riccardo CAMMISA, Irene  
NIERI, Alessia BORRELLI.

**Journal manager e ICT Admin:** Francesco P. SELLITTI, Simone URIETTI.

**Book manager:** Francesco P. SELLITTI

**Graphic Design Editor:** Francesco P. SELLITTI, Simone URIETTI, Alessia BORRELLI.

**Comitato scientifico/Scientific board:**

Dott. Anna Rosa ACCORNERO  
Prof. Roberto ALBERA  
Dott. Massimo BACCEGA  
Dott. Alberto BALDO  
Prof. Nello BALOSSINO  
Prof. Paolo BENNA  
Prof. Mauro BERGUI  
Dott. Salvatore BONANNO  
Prof. Ezio BOTTARELLI  
Prof. Gianni Boris BRADAC  
Dott. Gianfranco BRUSADIN  
Dott. Luca CAMONI

Prof. Alessandro CICOLIN  
Dott. Laura DE MARCO  
Dott. Patrizio DI DENIA  
Dott. Chiara FERRARI  
Prof. Diego GARBOSSA  
Dott. Luciana GENNARI  
Dott. Ramon GIMENEZ  
Prof. Caterina GUIOT  
Prof. Leonardo LOPIANO  
Dott. Giovanni Malferrari  
Prof. Alessandro MAURO  
Prof. Daniela MESSINEO

Dott. Sergio MODONI  
Dott. Alfredo MUNI  
Dott. Grazia Anna NARDELLA  
Dott. Christian PARONE  
Prof. Lorenzo PRIANO  
Dott. Fabio ROCCIA  
Dott. Carlo SCOVINO  
Dott. Saverio STANZIALE  
Dott. Lorenzo TACCHINI  
Prof. Silvia TAVAZZI  
Dott. Irene VERNERO

Linee guida e buone pratiche cliniche / Guidelines and good clinical practice

1	<p><i>Noi refertiamo così... voi? Guida rapida per la valutazione sonologica della stenosi carotidea.</i></p> <p><i>We perform like this... how about you? Quick guide for the sonological assessment of carotid stenosis.</i></p>
	<p>Giovanni Malferrari, Andrea Zini, Giorgia Arnone, Ludovica Migliaccio, Matteo Paolucci, Mauro Gentile, Mariateresa Lefemine, Franco Accorsi, Attilia Maria Pizzini, Mauro Silingardi, Nicola Carraro, Vittoria Maria Sarra, Giorgio Meneghetti, Claudio Baracchini, Giuseppe Pistollato, Patrizio Prati, Luciano Marchionno, Daniela Monaco, Maria Vittoria De Angelis, Chiara Vincenzi, Simone Quintana, Amedeo Bianchini, Giuseppe Pulito, Donatella Mastria, Francesco Paolo Sellitti, Fabrizio Calliada, Domenico Laterza, Lorenzo Coppo, Daniela Mastroiacovo, Francesco Prada, Sabrina Rossi, Cristiano Azzini, Nicola Merli, Maura Pugliatti, Francesco Ciccirillo, Antonio Siniscalchi, Enzo Sanzaro, Fabio Melis, Michele Pacilli, Vincenzo Inchingolo.</p>

Scienze economiche e dell'organizzazione aziendale sanitaria / Health Economics and Management Science

48	<p><i>Competenze avanzate del Professionista Sanitario Esperto: un modello di alta formazione complementare applicato all'ecosonografia vascolare.</i></p> <p><i>Advanced skills for the Senior Healthcare Professional: a high-level complementary training model applied to vascular echography.</i></p>
	<p>Francesco Paolo Sellitti</p>

Scienze logopediche / Logotherapy and speech therapy

67	<p><i>Il Ruolo del Logopedista nei Corsi di Accompagnamento alla Nascita della Regione Marche: proposta di Percorso Diagnostico Terapeutico Assistenziale.</i></p>
	<p>Paola Biocca, Sofia Tittarelli, Antonio Verolino, Federica Lucia Galli.</p>
89	<p><i>The role of the Speech Therapist in the Birth Support Courses of the Marche region: proposal for a diagnostic therapeutic assistance pathway.</i></p>
	<p>Paola Biocca, Sofia Tittarelli, Antonio Verolino, Federica Lucia Galli.</p>

Scienze infermieristiche / Nursing sciences

111	<i>Effetto placebo ed effetto nocebo: implicazioni per la pratica infermieristica.</i> <i>Placebo effect and nocebo effect: implications for nursing practice.</i>
	Antonella Silvestrini, Davide Dini, Federico Guerra, Tiziana Benedetti, Matteo Cesaretti, Stefania Nicoletti, Franca Riminucci, Davide Sanchioni.

Neuroscienze / Neuroscience

121	<i>Ulnar Goniometer Device: Confronto tra elettro-neurografia ed ecografia.</i>
	Lara Gallicchio, Valentina Recchia, Pietro Guida, Anna De Luca, Luigi Didonna, Marianna Cipriani, Eleonora Vecchio, Laura Ruiz Marquez, Antonella Petruzzellis, Filippo Tamma.

130	<i>Ulnar goniometer device: comparison between electroneurography and ultrasound.</i>
	Lara Gallicchio, Valentina Recchia, Pietro Guida, Anna De Luca, Luigi Didonna, Marianna Cipriani, Eleonora Vecchio, Laura Ruiz Marquez, Antonella Petruzzellis, Filippo Tamma.

Scienze fisiatriche, fisioterapiche e riabilitative / Physical medicine, physiotherapy and rehabilitation

138	<i>Efficacia della Riabilitazione Cardiovascolare in soggetti diabetici: Revisione Sistemica della letteratura.</i> <i>Efficacy Of Cardiovascular Rehabilitation In Diabetic Subjects: Systematic Review Of The Literature.</i>
	Rossana Cuscito, Laura Sanrocchi, Annamaria Servadio, Matteo Tamburlani.

161	<i>Intervento preventivo e terapeutico nell'osteoartrosi degli arti inferiori: revisione sistematica della letteratura.</i> <i>Preventive and therapeutic intervention in osteoarthritis: systematic review of the literature.</i>
	Matteo Tamburlani, Rossana Cuscito, Francesca Santini, Alessio D'Angelo, Edoardo Tirelli, Annamaria Servadio.

Clinica medica e chirurgica / Clinical and surgical medicine

183

*Valutazione dei disturbi del sonno in pazienti affetti da Long Covid: valutazione delle qualità psicometriche della versione italiana della General Sleep Disturbance Scale (GSDS).*

*Evaluating sleep disorders in patients with Long Covid: assessment of psychometric qualities of the Italian version of the General Sleep Disturbance Scale (GSDS).*

Matteo Tamburlani, Tiziana Trequattrini, Simona Rossi, Maria Cristina Zappa, Rossana Cuscito, Leonardo Papi, Arianna Colelli, Giovanni Galeoto, Ilaria Ruotolo, Fabrizio Ciaralli, Annamaria Servadio.

OPEN ACCESS JOURNAL

<http://www.ojs.unito.it/index.php/jbp>

ISSN 2532-7925



A Scientific, Technical and Professional Practice Journal for Biomedical Practitioners

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

Lara Gallicchio<sup>1</sup>, Valentina Recchia<sup>1</sup>, Pietro Guida<sup>2</sup>, Anna De Luca<sup>2</sup>, Luigi Didonna<sup>1</sup>, Marianna Cipriani<sup>1</sup>, Eleonora Vecchio<sup>1</sup>, Laura Ruiz Marquez<sup>1</sup>, Antonella Petruzzellis<sup>1</sup>, Filippo Tamma<sup>1</sup>.

<sup>1</sup>UOC Neurologia, Ente Ecclesiastico Ospedale Generale Regionale "F. Miulli", Acquaviva delle Fonti (BA)

<sup>2</sup>UOC Direzione Sanitaria Ente Ecclesiastico Ospedale Regionale "F. Miulli", Acquaviva delle Fonti (BA)

Corresponding author: Lara Gallicchio - [l.gallicchio@miulli.it](mailto:l.gallicchio@miulli.it)

N. 1, Vol. 8 (2024) - 130:137

Submitted: 15 January 2024

Revised: 22 January 2024

Accepted: 5 May 2024

Published: 10 June 2024

### Come citare / How to Cite:

L. Gallicchio, V. Recchia, P. Guida, A. De Luca, L. Didonna, M. Cipriani, E. Vecchio, L. Ruiz Marquez, A. Petruzzellis, F. Tamma (2024) Ulnar Goniometer Device: Comparison between electro-neurography and ultrasound. *Journal of Biomedical Practitioners*, 8(1).

<https://doi.org/https://doi.org/10.13135/2532-7925/10352>

Think **green** before you print



Distribuita con Licenza Creative Commons. Attribuzione - Condividi 4.0 Internazionale

## 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.

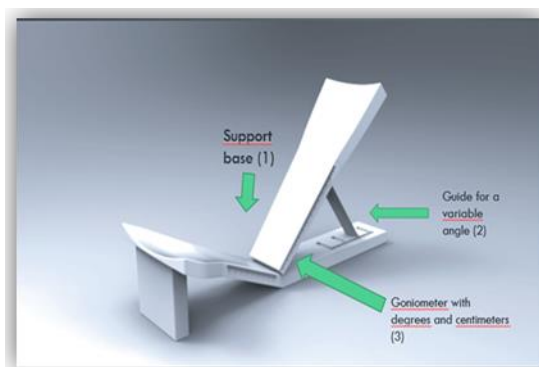


Figure 1: Ulnar Goniometer Model



## 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 interosseus 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 ( $70^\circ$  or  $90^\circ$ ) 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 interosseus muscle runs closer to the typical compression site of the ulnar nerve.

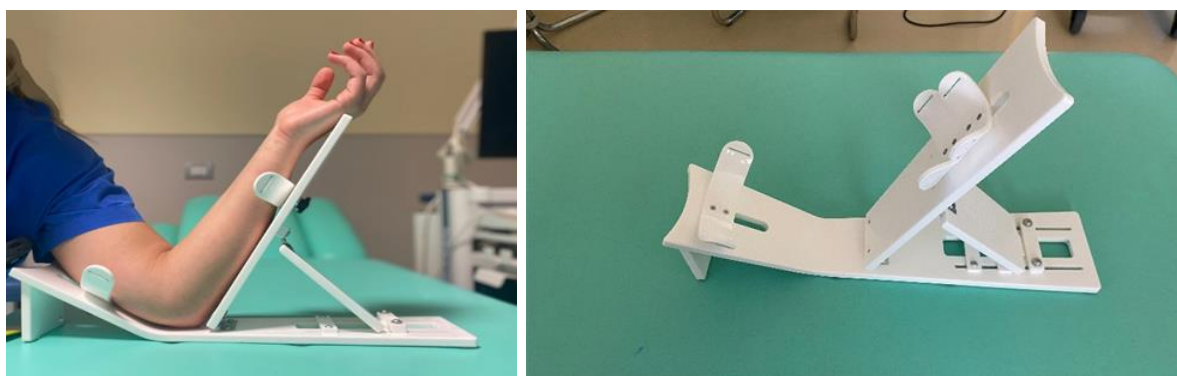


Figure 2: How to use the Ulnar Goniometer

### 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 mm<sup>2</sup> 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

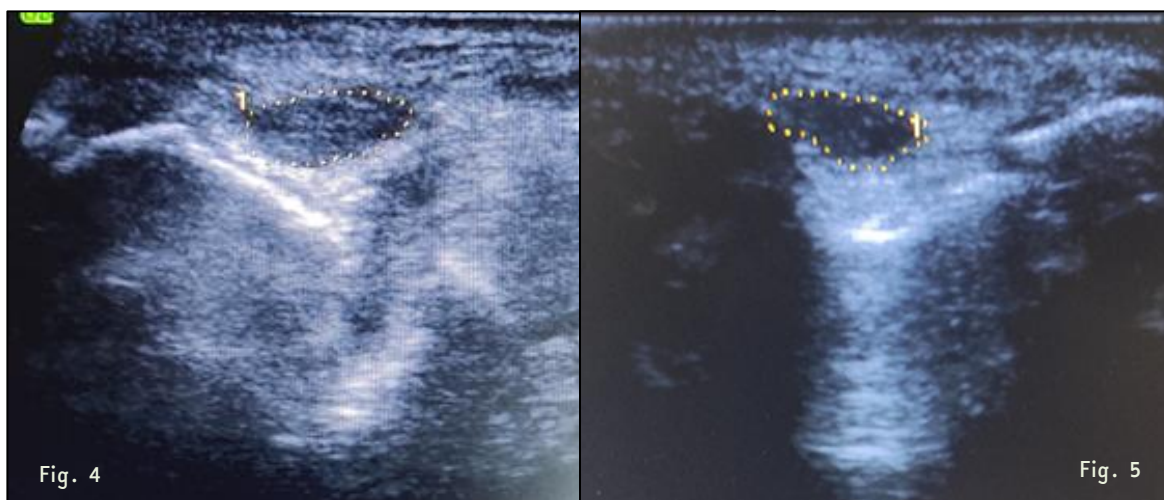


Figure 4: Cross section of the ulnar nerve with increased size; Figure 5: Cross section of the ulnar nerve with increased size.

### Statistical analysis

Data are expressed as mean values  $\pm$  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 $\pm$ Dev. St. N (%)
Below Elbow CSA(mm <sup>2</sup> )	19	7.4 $\pm$ 1.2
SAP ( $\mu$ V)	26	17 $\pm$ 15
SAP ( $\mu$ V)	33	7 (21%)
CSA at the Elbow (mm <sup>2</sup> )	38	16.4 $\pm$ 4.1
MCVWBE (m/s)	38	58 $\pm$ 7
MCVBEAE (m/s)	38	38 $\pm$ 6
MCVWBE-MCVBEAE (m/s)	38	19 $\pm$ 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.

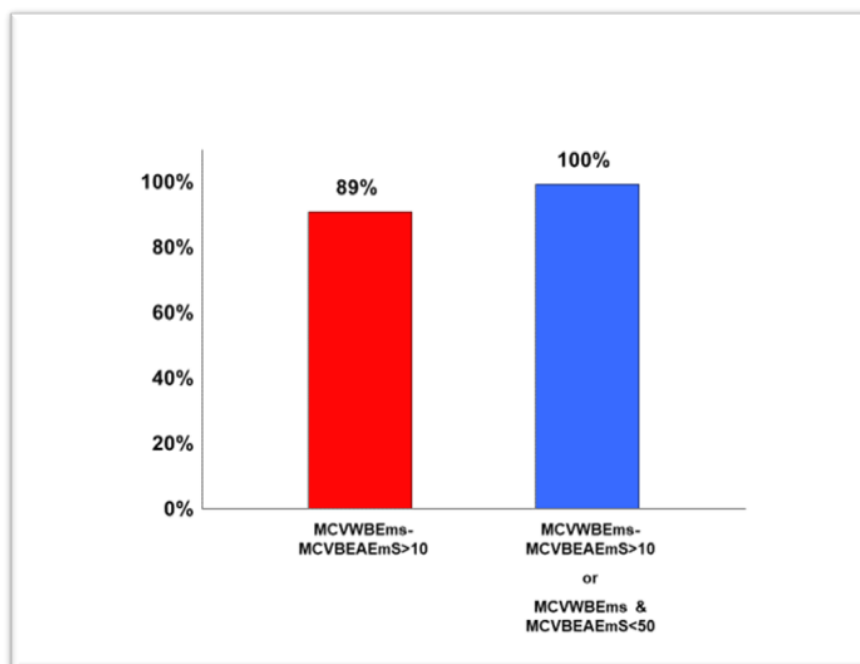


Figure 6: A decrease in MCV below 50 m/s is associated with an increase in CSA.

## 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.

## BIBLIOGRAFIA

- [1] Burahee AS, Sanders AD, Shirley C and Power DM. (2021). Cubital tunnel syndrome. *EFORT Open Reviews*, 6(9), 743-750
- [2] Granger A, Sardi JP, Iwanaga J, et al. (2017) Osborne's Ligament: A Review of its History, Anatomy, and Surgical Importance. *Cureus*. 9(3): e1080

- [3] Raeissadat SA, Youseffam P, Bagherzadeh L, et al. (2019). Electrodiagnostic Findings in 441 Patients with Ulnar Neuropathy - a Retrospective Study. *Orthopedic Research and Reviews*. 11;191—198
- [4] Raeissadat SA, Youseffam P, Bagherzadeh L, et al. (2019). Electrodiagnostic Findings in 441 Patients with Ulnar Neuropathy - a Retrospective Study. *Orthopedic Research and Reviews*. 11;191—198
- [5] Gallicchio L, Recchia VR, Didonna L, Vecchio E, Guida P, Petruzzellis A and Tamma F,(2022) Ulnar Goniometer: a simple device for a better neurophysiological evaluation of the motor conduction velocity of the ulnar nerve. *Journal of Biomedical Practitioners*, 6(1), <https://doi.org/10.13135/2532-7925/6844>
- [6] Ufficio italiano Brevetti e Marchi. Disponibile su [www.uibm.mise.gov.it](http://www.uibm.mise.gov.it) (patent number IT201900009912 (A1) - 2020-12 -26)
- [7] Ehler E, Ridzoň P, Urban P, Mazanec R, et al. (2013). Ulnar nerve at the Elbow-normative nerve conduction studies. *J Brachial Plex Peripher Nerve Inj*. 8:2.
- [8] Ubiali E. *Elettro-neurografia*. Testo atlante. Scienza Medica editore. 2016; 230-35
- [9] Landau M, Diaz M.I, Barner K.C, Campbell K.C. (2002). Changes in nerve conduction velocity across the elbow due to experimental error. *Muscle Nerve*. 26(6):838-40
- [10] Mežian K, Jačisko J, Kaiser R, Machač S, Steyerová P, Sobotová K, Angerová Y, Naňka O. Ulnar Neuropathy at the Elbow: From Ultrasound Scanning to Treatment. *Front Neurol*. 2021 May 14; 12:661441. doi: 10.3389/fneur.2021.661441. PMID: 34054704; PMCID: PMC8160369.