Is There an Association between Electroneuromyography and Ultrasound in the Diagnosis of Carpal Tunnel Syndrome?*

Existe associação entre a eletroneuromiografia e a ultrassonografia no diagnóstico da Síndrome do Túnel do Carpo?

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Abstract

Objective To verify whether there is an association between the results of the severity in electroneuromyography and the positivity in ultrasound in the diagnosis of carpal tunnel syndrome.

Methods Sixty-eight patients were included in the study, 61 women and 7 men, with a mean age of 54.4 years. The ultrasound results (positive or negative) were crossed with the results of electroneuromyography (mild, moderate or severe), and the existence of association was verified.

Results One hundred and thirty-six hands with suspicion or symptoms of carpal tunnel syndrome were evaluated. Positive ultrasound diagnosis was observed in 72 hands and negative in 64; 123 hands presented positive electroneuromyography for carpal tunnel syndrome, and there were 13 negative results. The severe degree in electroneuromyography was prevalent.

Conclusion There was a statistically significant association between electroneuromyography and ultrasonography ($p < 0.05$), and ultrasound positivity was higher for more severe levels of carpal tunnel syndrome given by electroneuromyography.

Keywords
- electroneuromyography
- compressive neuropathy
- carpal tunnel syndrome
- ultrasonography

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Resumo

Objetivo Verificar se existe associação entre os resultados da gravidade da eletroneuromiografia e a positividade da ultrassonografia no diagnóstico da síndrome do túnel do carpo.

Métodos Sessenta e oito pacientes foram incluídos no estudo, sendo 61 mulheres e 7 homens, com média de idade de 54,4 anos. Os resultados da ultrassonografia (positivo ou negativo) foram cruzados com os resultados da eletroneuromiografia (leve, moderado ou grave) e verificada a existência de associação.

Resultados Cento e trinta e seis mãos com suspeita ou sintomas de síndrome do túnel do carpo foram avaliadas. O diagnóstico ultrassonográfico positivo foi observado em 72 mãos e negativo em 64; 123 mãos apresentaram eletroneuromiografia positiva para síndrome do túnel do carpo e 13 apresentaram resultado negativo. O grau grave da eletroneuromiografia foi prevalente.

Conclusão Houve associação estatisticamente significativa entre eletroneuromiografia e ultrassonografia ($p < 0,05$), sendo que a positividade da ultrassonografia foi maior para níveis mais graves de síndrome do túnel do carpo dados pela eletroneuromiografia.

Palavras-chave

- eletroneuromiografia
- neuropatia compressiva
- síndrome do túnel do carpo
- ultrassonografia

Introduction

Carpal tunnel syndrome (CTS) is the most common peripheral neuropathy due to compression of the median nerve in the carpal tunnel.[1] Diagnosis is usually made through clinical history and physical examination,[2] while electroneuromyography (ENMG) assists in the diagnostic confirmation of dubious cases and in the establishment of severity.[3]

Ultrasonography (US) was introduced as a diagnostic tool for CTS in the early 1990s[4] and was also used to diagnose some musculoskeletal disorders, such as ulnar nerve and fibular nerve neuropathy.[5–7] One of the typical findings related to CTS is the increase in the cross-sectional area of the median nerve proximal or distal to the compression site.[8] Other findings that can be identified by this examination are decreased echogenicity and nerve mobility, increased vascularization and anatomical variations of the median nerve, which may contribute to the compressive clinical picture. Electroneuromyography, in turn, is considered the diagnostic method of choice for people suspected of having peripheral neuropathies, providing additional information on myelin dysfunction and axonal loss.[9]

Studies directly comparing the classification of ENMG and US positivity for the diagnosis of CTS are scarce. Moreover, we observed in our clinical practice a large number of people with clinical picture compatible with CTS and results of divergent tests. Our study aims to verify whether there is an association between the results of the ENMG and the positivity of US in the diagnosis of CTS.

Casuistry and Methods

An observational, cross-sectional, quali-quantitative study was conducted with evaluation of 68 patients scheduled consecutively in a 4-month period in a regional reference hand surgery outpatient clinic. All procedures were performed according to ethical standards determined by the Research Ethics Committee for research in human beings, and by the Helsinki Declaration of 1964. The free and informed consent form was obtained from all participants by signing a specific term.

The inclusion criteria were people of both genders, over 18 years of age, who presented, at the initial consultation, ENMG of upper limbs and US of wrist, both with diagnostic hypothesis of CTS. We excluded people with other neuropathies, previous wrist injuries, pregnant women, people with reports of tenosynovitis or tumors in the wrist, those with a known history of uncontrolled systemic comorbidities, and people with reports of current work activities with repetitive movements or hand vibration.

In relation to US, in our service, the medical team specialized in radiology and imaging diagnosis defines the sectional cutoff point of the median nerve suggestive of abnormality at 10 mm or more. The ENMG, in turn, is performed by the same neurologist specialized in electroneuromyographic studies, belonging to the clinical staff of the institution. The classification of ENMG is thus standardized: mild degree (alteration only of sensory conduction), moderate degree (alteration of sensory and motor conduction) and severe degree (altered sensory and motor conduction and signs of denervation to needle electromyography).

The qualitative characteristics were evaluated in all patients and described using absolute and relative frequencies. The quantitative variable age was described using summary measures (mean, standard deviation, median, minimum and maximum).

Seventy-six people were attended and 8 were excluded (1 with previous wrist trauma, 2 with uncontrolled diabetes, and 5 with previous wrist surgeries), totaling 68 participants included in this study.

►**Table 1** shows the clinical characteristics of the 68 people who constituted our sample. Regarding gender, there

Table 1 Description of sample characteristics

Variable	Description (N = 68)
Age (years)	
mean ± SD	54.4 ± 10.1
median (min.; max.)	53.5 (35; 76)
Gender, n (%)	
Female	61 (89.7)
Male	7 (10.3)
Profession, n (%)	
Housewife/retired	24 (35.3)
In work	44 (64.7)
Dominance, n (%)	
Right	65 (95.6)
Lefty	3 (4.4)
Affected side, n (%)	
Right	14 (20.6)
Left	6 (8.8)
Both	48 (70.6)
Comorbidities, n (%)	
One systemic disease	24 (35.3)
Two or more systemic diseases	16 (23.5)
No reported disease	28 (41.2)

Abbreviations: n, number; SD, standard deviation.

were 61 women (89.7%) and 7 men (10.3%). The mean and standard deviation of age was 54.4 years ± 10.1. Regarding the employment situation, 24 people (35.3%) reported being retired or housewives, while 44 (64.7%) were in current work activity. Sixty-five people (95.6%) reported being right-handed and 3 (4.4%) left-handed. Regarding the side affected by symptoms,14 people reported symptoms only on the right (20.6%), 6 (8.8%) only on the left, and 48 (70.6%) reported bilateral symptomatology. When asked about comorbidities, 28 people (41.2%) denied having any comorbidities, while 24 (35.3%) reported having a systemic disease, and 16 (23.5%) 2 or more.

The US results (positive or negative) were crossed with the results of the ENMG (mild, moderate, or severe) and the existence of association with the use of the Chi-squared test was verified. [10] Kappa [11] coefficients of agreement were calculated to verify the degree of agreement between US and ENMG, as well as diagnostic measures sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), to evaluate the prediction of CTS using US.

The SPSS for Windows version 20.0 software (IBM Corp., Armonk, NY, USA) was used to perform the analyses, and Microsoft Excel 2003 software (Microsoft Corp., Redmond, WA, USA) was used to tabulate the data. The tests were performed with a significance level of 5%.

Results

Using the hand as a sampling unit, ►**Table 2** shows the crossing between US and ENMG, and the result of statistical

Table 2 Results of the crossing between US and ENMG

Variable	US for CTS		Total	*p*	Kappa	Sensitivity	Specificity	PPV	NPV
	Negative (N = 64)	Positive (N = 72)	N = 136		95% CI	95% CI	95% CI	95% CI	95% CI
ENMG				**0.036**					
Normal	8 (61.5)	5 (38.5)	13						
Mild	12 (63.2)	7 (36.8)	19						
Moderate	19 (57.6)	14 (42.4)	33						
Serious	25 (35.2)	46 (64.8)	71						
ENMG				0.271	0.058	54.5	61.5	93.1	12.5
Normal	8 (61.5)	5 (38.5)	13		(-0.046; 0.162)	(45.2; 63.5)	(31.6; 86.1)	(84.5; 97.7)	(5.6; 23.2)
Altered	56 (45.5)	67 (54.5)	123						
ENMG				**0.045**	0.150	57.7	62.5	83.3	31.3
Normal/mild	20 (62.5)	12 (37.5)	32		(0.003; 0.297)	(47.6; 67.3)	(43.7; 78.9)	(72.7; 91.1)	(20.2; 44.1)
Moderate/ severe	44 (42.3)	60 (57.7)	104						
ENMG				**0.004**	0.248	64.8	60.0	63.9	60.9
Normal/mild/ moderate	39 (60)	26 (40)	65		(0.085; 0.411)	(52.5; 75.8)	(47.1; 72.0)	(51.7; 74.9)	(47.9; 72.9)
Serious	25 (35.2)	46 (64.8)	71						

Abbreviations: 95% CI, 95% confidence interval; CTS, carpal tunnel syndrome; ENMG, electroneuromyography; N, number; NPV, negative predictive value; PPV, positive predictive value; US, ultrasound.
Chi-square test.

tests and diagnostic measures. From the 136 hands evaluated, 123 presented positive ENMG for CTS and 13 presented a negative result. Regarding the classification of the ENMG, there were 19 mild (15.5%), 33 (26.8%) moderate, and 71 (57.7%) severe cases. From the 19 hands with mild degree ENMG, 12 (63.2%) had negative US for CTS and 7 (36.8%) had a positive result. In relation to the 33 hands with moderate degree ENMG, 19 (57.6%) had negative US for CTS and 14 (42.4%) positive. From the 71 hands with severe degree ENMG, 25 (35.2%) had negative US for CTS and 46 (64.8%) positive. Finally, from the 13 hands with negative ENMG (normal ENMG), 8 (61.5%) had negative US for CTS and 5 (38.5%) positive.

Discussion

In population-based studies, the prevalence of CTS is higher in women and increases with aging,[10] with an estimated involvement up to three times more than men.[11] This can be explained by the fact that women have a lower size cuff [12] and lower carpal tunnel elasticity, which can contribute to lower compliance and accommodation of structures.[13,14] It is possible that women are predisposed to more rectified tunnels, which may also contribute to the development of CTS.[15] Based on these publications, our work is in agreement with the literature, with a high prevalence of CTS involvement in women.

In the United States, CTS is the third cause of work leave.[16] In our study, 35.3% of people with CTS reported being retired or housewives, while the majority reported being in current work activity.

Some risk factors for CTS include personal and family history, diabetes, obesity, hypothyroidism, pregnancy, and rheumatoid arthritis.[17] In our series, more than half of the people had at least one systemic comorbidity, and the most common among them were hypertension, diabetes and hypothyroidism.

The definition of the sectional cutoff point of the median nerve by US, suggestive of CTS, is controversial. Most articles set the value between 8 and 14 mm.[18] In our institution, the medical team stipulates the value equal to or greater than 10 mm as suggestive of abnormality. According to Özçakar et al.,[19] US has the advantage of being low-cost, user-friendly, noninvasive, portable, available in most health services and well tolerated by patients, an opinion also shared by Horng et al.[20] however, these authors indicate the examination as a complement to the ENMG. In contrast, Mhoon et al.[21] do not find a significant correlation between ultrasound parameters and electrophysiological severity, and conclude that US is not able to determine the severity of CTS. For Abrishamchi et al.,[22] US may be complementary, but not conclusive, in relation to the classification of CTS severity. According to Fowler et al.,[8] US and ENMG have diagnostic accuracy similar to clinical tests, but ENMG can diagnose other etiologies of paresthesia in the hands besides CTS, such as cervical radiculopathy, cubital tunnel syndrome and prone syndrome.[23,24]

Our study demonstrated that there was a statistically significant association between ENMG and US ($p < 0.05$), and US positivity was higher for more severe levels of CTS given by ENMG. Certainly, this fact is related to the sensitivity and scope of the US method. Median nerve changes secondary to more advanced compression are detected, while the more subtle or initial ones are not. It is worth to discuss whether the decision of surgical indication can be made based only on US, since only severe cases were associated with ENMG.

Despite this association, US presented low agreement with ENMG (Kappa < 0.25) and diagnostic measures were mostly low for any groupings used in the severity of ten ENMG.

We agree with Fowler et al.[8] when they state that the comparison between US and ENMG cannot be considered reliable because there is no accepted reference standard. We also emphasize that both are tests that may be influenced by the examiner's experience in what is intended to be investigated.

We believe that decisions regarding the diagnosis of CTS can be made, initially, based on clinical history and thorough physical examination, directed at what is intended to be investigated.

Conclusion

We conclude that, despite the association with statistical significance between US and more severe levels of ENMG, the two tests did not present significant agreements for the diagnosis of CTS.

Conflict of Interests

The authors declare that there is no conflict of interests.

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