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Concoradance of clinical and neurophysiologic diagnoses of carpal tunnel syndrome

Podudarnost kliničke i neurofiziološke dijagnoze sindroma karpalnog kanala

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Abstract

Introduction/Aim. Clinical presentation and neurophysiological examination are crucial in diagnosing carpal tunnel syndrome (CTS). The aim of this study was to determine sensitivity and specificity of clinical examination for diagnosing of CTS in relation to neurophysiological evaluation. **Methods.** The sample included 181 patients referred to the neurologist for further diagnosis of pain and parestesias in the arm (81 women and 100 men mean age 42 ± 14 years and 52 ± 16 years, respectively). All the patients were neurophysiologicly tested. **Results.** Out of 181 patients, clinical findings were considered positive for CTS in 37 patients. The neurophysiological findings for CTS were positive in 60 patients. Both clinical and neurophysiological findings were positive in 31 patients and both findings were negative in 115 patients (sensitivity 0.51; specificity 0.95). **Conclusion.** Low sensitivity and high specificity suggest that it is easier to exclude rather than to accurately diagnose CTS based on clinical examination alone. Thus, there is the need for neurophysiological evaluation of patients with complains in the arm.

Key words:
carpal tunnel syndrome; diagnosis; signs and symptoms; sensitivity and specificity.

Apstrakt

Uvod/Cilj. Klinička slika i neurofiziološko ispitivanje veoma su značajni za postavljanje dijagnoze sindroma karpalnog tunela (KTS). Cilj ovog istraživanja bio je da se odredi senzitivnost i specifičnost kliničke dijagnoze sindroma karpalnog tunela (KTS) u odnosu na neurofiziološki nalaz. **Metode.** Ispitivanjem je bio obuhvaćen 181 bolesnik (81 žena, prosečne starosti 42 ± 14 godina, i 100 muškaraca, prosečne starosti 52 ± 16 godina). Bolesnici su bili upućeni na neurološki pregled za dalju dijagnostiku tegoba u vezi sa bolovima i parestezijama u ruci. Svi bolesnici su potom neurofiziološki ispitani. **Rezultati.** Od ukupno 181 bolesnika, klinički nalaz za KTS bio je pozitivan kod 37, dok je neurofiziološki nalaz za KTS bio pozitivan kod 60 bolesnika. Kod 31 bolesnika bili su pozitivni i klinički i neurofiziološki nalaz, a oba nalaza su bila negativna kod 115 bolesnika (senzitivnost 0,51, specifičnost 0,95). **Zaključak.** Niska senzitivnost i visoka specifičnost ukazuju na to da je samo na osnovu kliničkog pregleda pouzdanije isključiti, nego potvrditi dijagnozu KTS. Ovo upućuje na potrebu za neurofiziološkom procenom bolesnika sa tegobama u ruci.

Ključne reči:
karpusni tunel, sindrom; dijagnoza; znaci i simptomi; senzitivnost i specifičnost.

Introduction

Common causes of pain in the arm are musculoskeletal disorders and neurological disorders, such as polyneuropathies and compressive mononeuropathies. The most prevalent compressive mononeuropathy is an entrapment of the median nerve as it runs from the forearm through the carpal tunnel into the palm of the hand [1]. This is known as the carpal tunnel syndrome (CTS).

Differentiating CTS from the causes of pain in the arm is complicated by the fact that patients with CTS, in addition to classic symptoms of tingling and pain in the fingers and hand, often complain of pain in other areas (forearm, 21%; elbow 14%; shoulder 8%; cervical spine 0.6%) [2].

Most investigators agree that there is no perfect test for diagnosing CTS. It is believed, however, that CTS is highly probable when typical symptoms are associated with specific objective findings and positive provocative tests. Neurophysiological assessment of propagation of electrical impulses along the median nerve as it passes through the carpal tunnel is considered the "gold standard" for diagnosis of CTS [2].

Since pain in the arm may be of different origin, and CTS may have more or less specific clinical presentation, it is important for clinical practice to ascertain whether the di-

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agnosis of CTS can be reliably established on clinical grounds [3]. Therefore, the objective of this study was to evaluate to what extent clinical diagnosis agrees with neurophysiological diagnosis of CTS. The specific aim was to determine sensitivity and specificity of clinical diagnosis of CTS in comparison to neurophysiological findings as the "gold standard".

Methods

Over a 4-year period (2007–2011) 181 patients were referred to the neurologist at the Military Medical Academy in Belgrade for further diagnosis of pain and parestesias in the arm. The sample consisted of 81 women (mean age 42 ± 14 years) and 100 men (52 ± 16 years).

Clinical diagnosis was based on the history and clinical examination. The mandatory symptoms considered specific for CTS [1] were tingling in the first three fingers and along inside of the fourth finger mainly present in the evening or morning hours or accompanied by waking up to shake the hand (Flick's sign) followed by relief. Clinical examination considered muscle strength and trophic changes, reflex activity and impaired sensation. The provocative tests used were Bickeles and Tinnel sign [4].

Neurophysiological evaluation was performed on the median, ulnar, and radial nerves according to the standards of the American Association of Electrodiagnostic Medicine [5]. Motor nerve studies included measurements of the latency and amplitude of the motor nerve action potential, conduction velocity, and latency of the F-wave. In sensory nerve studies, we measured the latency and amplitude of the sensory nerve action potential and conduction velocity.

For motor studies, recording electrodes were placed over the thenar (median) nerve and hypotenar (ulnar) nerve with the stimulation electrode at the wrist, 8 cm proximally. For sensory studies, recording electrodes were placed on the second finger (median nerve) and the fifth finger (ulnar nerve) with stimulation electrodes at the wrist, 14 cm proximally [6].

The most sensitive neurophysiological parameter for the diagnosis of CTS is considered the difference between terminal latencies of the sensory responses recorded from the fourth finger after stimulation of the median and ulnar nerves at the wrist 14 cm proximally. CTS is considered present if the median response is at least 0.5 ms longer than the ulnar response.

Needle electromyography was used for the muscles innervated by C5-Th1 roots (*deltoid*, *biceps brachii*, *extensor digitorum communis*, *abductor policis brevis*, and *abductor digiti minimi*). Based on features of motor unit potential (shape, duration), the findings were classified as normal or neurogenic [7].

The data were tabulated in a 2 × 2 table where rows and columns included the frequecies of positive and negative clinical and neurophysiological findings (Clinical +, Clinical -, EMG +, EMG -). Based on the frequency distribution, we calculated sensitivity, specificity, positive predictive value, and negative predictive value using standard formulas.

Sensitivity is the ratio between the true positive findings (EMG CTS +) and the sum of true positive (EMG CTS +) and false negative (Clinical CTS -) findings. Specificity is the ratio between the true negative findings (EMG CTS -) and the sum of true negative (EMG CTS -) and false positive (Clinical CTS +) findings. The positive predictive value is the ratio between the true positive findings (EMG CTS +) and the sum of true positive (EMG CTS +) and false positive (Clinical CTS -) findings. Lastly, the negative predictive value is the ratio between the true negative findings (EMG CTS -) and the sum of true negative (EMG CTS -) and false negative (Clinical CTS -) findings. The statistical software Prism 5 (GraphPad Software Inc., La Jolla, CA) was used for statistical analysis.

The results were compared with the literature data.

Results

In 181 patients clinical findings were considered positive for CTS in 37 patients and negative in 144 patients. The neurophysiological findings for CTS were positive in 60 patients and negative in 121 patients. Both clinical and neurophysiological findings were positive in 31 patients and both findings were negative in 115 patients (Table 1).

Table 1

Distribution of patients (n, %) with positive (+) and negative (-) clinical and neurophysiological diagnoses of carpal tunnel syndrome (CTS)

Clinical diagnosis	Neurophysiological diagnosis		Total
	CTS +	CTS -	
CTS +	31 (17)	6 (3)	37 (20)
CTS -	29 (16)	115 (64)	144 (87)
Total	60 (33)	121 (67)	181 (100)

Sensitivity = 31/(31 + 29) = 51%;
Specificity = 115/(115 + 6) = 95%;
Positive predictive value = 31/(31 + 6) = 84%;
Negative predictive value = 115/(115 + 29) = 80%.

The results indicated moderate sensitivity (51%) and high specificity (95%) of clinical evaluation (Table 2).

One patient diagnosed with CTS on both clinical and neurophysiological grounds also had polyneuropathy. Among 114 with clinical diagnosis negative for CTS, symptoms and signs suggested cervicobrachialgia in 85 patients and polyneuropathy in the remaining 29 patients (Figure 1).

In cases of disagreement between clinical and neurophysiological diagnoses, clinical diagnosis of CTS was made

Table 2

Diagnostic utility of the clinical diagnosis of carpal tunnel syndrome (CTS) with the corresponding 95% confidence intervals (CI) and the definition of each diagnostic parameter

Parameters	Value	95% CI	Definition
Sensitivity	0.51	0.38–0.65	Fraction of patients with CTS correctly diagnosed based on clinical findings.
Specificity	0.95	0.90–0.98	Fraction of patients without CTS correctly diagnosed based on clinical findings.
Positive prognostic value	0.84	0.68–0.94	Fraction of patients with positive clinical findings who have CTS.
Negative prognostic value	0.80	0.72–0.86	Fraction of patients with negative clinical findings who do not have CTS.

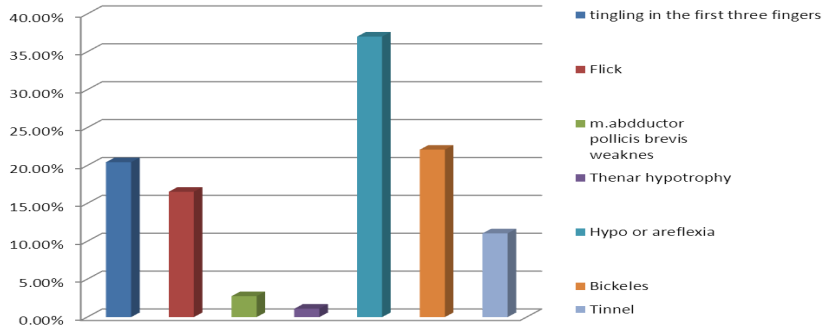

Fig. 1 – Clinical symptoms in patients population

in 6 of the patients where as neurophysiological findings indicated cervicobrachialgia in 4 of the patients (Table 3), ulnar nerve compression in 1 of the patient, and normal results in 1 of the patients.

Table 3

Clinical symptoms in the patients with the clinical diagnosis of carpal tunnel syndrom (CTS) and neurophysiological findings of cervicobrachialgia

Clinical symptoms	Number of patients		Total
	with	without	
Tingling in the first three fingers	4	0	4
Flick sign	0	4	4
M. abdductor pollicis brevis weaknes	0	4	4
Thenar hypotrophy	0	4	4
Hypo or areflexia	2	2	4
Bickeles sign	1	3	4
Neck pain	1	3	4
Hypo-esthesia	1	3	4

The patient with ulnar nerve compression in Guyon canal complained about tingling of the fourth finger of the hand; in his case Tinnel and Flick sings were positive, but reflexes were symmetrical with normal muscle strength in his hand.

Among the 29 patients with neurophysiologically verified CTS that was misdiagnosed on clinical grounds, the assigned clinical diagnoses were cervicobrachialgia in 17, polyneuropathy in 5, paresthesias in 2, polymialgia in 1 and undetermined in 3 of the patients.

Among the patients with cervicobrachialgia, 13 had pain in their forearm, 3 in the shoulder and 1 in the cervical spine.

In all 5 patients with clinically diagnosed polyneuropathia, CTS were present on both sides.

Discussion

The aim of this study was to determine to what extent the diagnosis of CTS can be reliably established on clinical grounds by the neurologist with extensive experience in electrodiagnosis of neuromuscular diseases. The results indicated moderate sensitivitly (51%) and high specificty (95%) of clinical evaluation. In other words, only about half of the patients with positive neurophysiological findings for CTS are likely to be correctly identified on clinical grounds, whereas almost all patients without CTS are likely to be assigned other diagnosis than CTS. This indicates a higher likelihood to exclude rather than to ascertain the diagnosis of CTS based on clinical evaluation alone.

Several factors must be taken into account when interpreting our results. Electrophysiological findings may be false positive (asymptomatic median neuropathy) in almost 18% of the general population, mostly among people with diabetes [3] of whom 25% are expected to eventually develop symptomatic CTS after 6 to 11 years [8, 9]. Although some patients in this study had diabetes, none were asymptomatic. Because all patients complained of pain in the arm, for which they were sent for further work-up, the likehood of false positive neurophysiological findings of CTS confounding the results is rather low.

Differential diagnosis of CTS *versus* other median nerve neuropathy is complicated by the fact that 10% of patients with CTS may show slowing of motor conduction ve-

locity proximally to the wrist, leading to the degeneration of the fastest axons (retrograde axonal degeneration). Still their neurophysiological findings may be within the normative range. To account for this, some authors consider CTS present only if the latency of the median motor response is 1.8 ms as longer as the ulnar nerve response [10].

An alternative criterion is a 1 ms longer latency of the median nerve motor response in the symptomatic hand compared to the opposite hand [11]. This approach, however, is rarely useful because of high prevalence of bilateral CTS.

In this study, only 5 patients with neurophysiological findings consistent with CTS were clinically misdiagnosed as having other type of neuropathy.

Conversely, pain and other symptoms of CTS may be present even when neurophysiological results are normal or minimally abnormal. It is recognized that the degree of motor and sensory nerve involvement is not necessarily proportional to the duration or severity of symptoms [9]. In this study, however, neurophysiological findings were within the normative limits only in 1 patient who was ascribed the diagnosis of CTS on clinical examination.

Conclusion

A relatively low sensitivity (51%) but high specificity (95%) of clinical diagnosis suggests that it is easier to exclude rather than to accurately diagnose carpal tunnel syndrome based on clinical examination alone. Therefore, there is the need for routine and comprehensive neurophysiological evaluation of patients who complain of pain in the arm.

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