Effectiveness of the Six-Item Carpal Tunnel Symptoms Scale (CTS-6) Questionnaire for the Diagnosis of Carpal Tunnel Syndrome

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ABSTRACT

Introduction: The Six-Item Carpal Tunnel Symptoms Scale (CTS-6) is a a short 6-item scale based on the Boston Carpal Tunnel Questionnaire (BCTQ). **Objective:** To evaluate the CTS-6 to identify patients with peripheral neuropathy of the median nerve using surgical criteria. **Materials and Methods:** A prospective descriptive observational study was conducted on a group of patients diagnosed with carpal tunnel syndrome. The CTS-6 was employed, and the diagnosis was confirmed with electromyography. The patients then underwent surgery. The differences in the CTS-6 score between the various severity levels measured by electromyography were examined. **Results:** 106 patients were analyzed and a total of 126 hands were evaluated. 20.75% had bilateral carpal tunnel syndrome. The median CTS-6 score was 21 (min. 16.5; max. 26). According to electromyography results, 24.22% of CTS cases were severe. When comparing the CTS-6 score according to the severity of carpal tunnel syndrome assessed by electromyography, the median CTS-6 score was 16.5 in mild cases, 21 in moderate cases, and 26 in severe cases. **Conclusions:** Electromyography revealed a higher CTS-6 score in patients with severe carpal tunnel syndrome. This raises the possibility that it could be used as a noninvasive diagnostic tool in carpal tunnel syndrome to determine which patients would benefit from surgical therapy.

Keywords: Carpal tunnel syndrome; CTS-6 scale; carpal tunnel release; electromyography.
Level of Evidence: IV

Efectividad de la *Six-Item Carpal Tunnel Symptoms Scale* para el diagnóstico del síndrome del túnel carpiano

RESUMEN

Introducción: A partir del *Boston Carpal Tunnel Questionnaire* (BCTQ), se desarrolló una escala corta de 6 ítems llamada *Six-Item Carpal Tunnel Simptoms Scale* (CTS-6). **Objetivo:** Evaluar la CTS-6 para detectar pacientes con neuropatía periférica del nervio mediano con criterio quirúrgico. **Materiales y Métodos**: Se realizó un estudio descriptivo prospectivo observacional en un grupo de pacientes con diagnóstico clínico de síndrome del túnel carpiano. Se utilizó la CTS-6, y se corroboró el diagnóstico mediante electromiografía. Posteriormente, los pacientes fueron operados. Se analizaron las diferencias en el puntaje de la CTS-6 entre los distintos niveles de gravedad determinados por electromiografía. **Resultados:** Se analizaron 106 pacientes. El 20,75% tenía síndrome del túnel carpiano bilateral. Se evaluaron 126 manos. La mediana del puntaje de la CTS-6 fue de 21 (mín. 16,5; máx. 26). Según los resultados de la electromiografía, el 24,22% de los casos de STC eran graves. Al comparar el puntaje de la CTS-6 según la gravedad del síndrome del túnel carpiano evaluada por electromiografía, la mediana del puntaje de la CTS-6 fue de 16,5 en los casos leves, de 21 en los casos moderados y de 26 en los casos graves. **Conclusiones**: El puntaje de la CTS-6 fue mayor en los pacientes con síndrome del túnel carpiano grave según la electromiografía. Esto plantea la hipótesis de que podría ser útil como herramienta diagnóstica no invasiva en el síndrome del túnel carpiano para definir pacientes que se beneficien con el tratamiento quirúrgico.

Palabras clave: Síndrome del túnel carpiano; escala de síntomas CTS-6; liberación del túnel carpiano; electromiografía.
Nivel de Evidencia: IV

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INTRODUCTION

Carpal tunnel syndrome (CTS) is a common compressive neuropathy with an estimated prevalence of 6% in men and 9.2% in women.[1] It is characterized by an initial clinical picture of pain, numbness and paresthesias in the thumb, index, middle and radial side of the ring finger that can lead to hand weakness, decreased fine motor coordination and thenar atrophy.[2] It is diagnosed clinically by anamnesis and physical examination, and is usually confirmed by nerve conduction studies such as electromyography.

Within the range of diagnostic possibilities, multiple clinical scales have been implemented, such as the *Boston Carpal Tunnel Questionnaire* (BCTQ), developed in 1993, to assess median nerve symptoms and functional impairment.[3] The BCTQ consists of a symptom severity scale with 11 items that assess pain, paresthesias, numbness, weakness, nocturnal symptoms, and difficulty with grip, as well as a functional status scale containing 8 items that assess functional deficits in the following domains: writing, buttoning clothes, holding a book while reading, gripping a telephone handle, opening jars, performing household chores, carrying a grocery basket, bathing and dressing.

Atroshi et al. have developed a short version of the BCTQ symptom scale which they called the *Six-Item Carpal Tunnel Symptoms Scale* (CTS-6). The CTS-6 contains 6 items measuring the severity and frequency of numbness and tingling, as well as nighttime and daytime pain,[4] with scores ranging from 0 to 26. If a patient has a score ≥12 and CTS is clinically suspected, it is not recommended to perform median nerve conduction electromyography to confirm or rule out the diagnosis, as the probability of a positive diagnosis is 80%. However, a score between 12 and 5 decreases the probability to 25%, so the study is recommended.[5]

Electromyography measures focal nerve demyelination, and is considered the gold standard for diagnosis. A drawback of this diagnostic method is the discomfort for the patient, because needles are introduced at the subcutaneous level and the sensation produced by the electricity during measurements is often described as uncomfortable. At present, it has not been replaced by less invasive methods, as detailed in various publications that attempted to compare it to ultrasonography or nerve conduction studies with electrodes.[6]

Today, the decision to initiate treatment is based on the severity of symptoms and the results of electromyography. Generally, nocturnal immobilization of the wrist is recommended if CTS is mild and surgery (median nerve release by dissection of the transverse carpal ligament) is chosen in moderate and severe cases, and mild cases that do not respond to non-surgical management.[7]

However, in view of the 16% to 34% false-negative rates obtained in various series, electromyography cannot be considered as a reference study for the diagnosis of CTS.[8] Furthermore, it has been independently demonstrated that electromyography does not provide additional information, nor does it change clinical outcomes after carpal tunnel decompression surgery to a clinically relevant extent. [9]

The aim of this study was to evaluate the use of CTS-6 to detect patients with surgical criteria for peripheral neuropathy of the median nerve. The findings could provide evidence to reduce the use of electromyography while also allowing health professionals to identify patients who could benefit from surgical treatment in a simple and minimally invasive manner.

MATERIALS AND METHODS

This study was approved by the institution's Research Ethics Committee.

A prospective descriptive observational study was conducted in a group of patients with a clinical diagnosis of CTS, who attended the Outpatient Clinic of our institution, between February 2019 and July 2022. Patients >18 years old with suspected CTS, who gave their consent to participate in the study, were consecutively included. Pregnant women, patients operated on for CTS, with a history of fractures in the wrist region or with other associated neuropathy were excluded.

A variant of the CTS-6 (Table 1), in its Spanish translation, was used.[10] The CTS-6 was used during the first medical consultation with the upper limb specialist after recording the symptoms and the findings of the physical examination, together with the two-point discrimination test, and then the patient was asked to undergo electromyography to corroborate the diagnosis. Given the observed high sensitivity and specificity, a CTS-6 cutoff point >12 was established.[5]

Table 1. Six-Item Carpal Tunnel Symptoms Scale (CTS-6).

CTS-6 component	Description	Score
Numbness in the median nerve territory	Sensory symptoms are mostly in the thumb, index, middle or ring finger.	3.5
Nocturnal numbness	Symptoms are prominent when the patient sleeps, and numbness awakens the patient.	4
Thenar atrophy or weakness	Most of the thenar area is reduced or the manual motor test shows a strength of grade 4 or less.	5
Positive Phalen's test	Wrist flexion reproduces or worsens numbness symptoms in the median nerve territory.	5
Loss of 2-point discrimination	A failure to discriminate 2 points held 5 mm or less apart on fingers innervated by the median nerve is a positive test suggestive of CTS.	4.5
Positive Tinel sign	Light tapping over the median nerve at the level of the carpal tunnel causing paresthesia radiating to the fingers innervated by the median nerve (not proximally) is a positive test.	4

Electromyography was performed in the same facility to avoid bias, as it is an operator-dependent study. CTS was classified into mild, moderate and severe stages based on the severity of median nerve demyelination, according to the Padua classification:[11] mild (compromised sensory conduction velocity >0.8 ms), moderate (compromised sensory conduction velocity and motor latency >1.5 ms) and severe (no sensory conduction velocity and prolonged motor latency).

The patients were then operated on using the same surgical approach by different resident surgeons under the supervision of specialists in Traumatology and Hand Surgery. Following surgery, the wound was covered with soft bandages, and patients were given oral and written instructions on postoperative exercises and a gradual return to activity.

Statistical analysis

The sample was described with measures of central tendency and dispersion for continuous numerical variables and percentage for categorical variables. The sample was described over the total number of patients and the results over the total number of hands evaluated. Comparison of the CTS-6 results between severity levels assessed with electromyography was performed using the Kruskall-Wallis test. Statistical analysis and calculations were performed with the SPSS version 22 program with an authorized license. A p value <0.05 was considered statistically significant.

RESULTS

A total of 106 patients were analyzed, the average age was 64.90 years (min 13, max 82). 20.75% (n = 22) had bilateral CTS (Table 2) and 76.42% of the sample were women. There was a slight increase in right over left hand involvement, and 22% had bilateral involvement.

In total, 128 hands were evaluated, and the mean score of the questionnaire was 21. In general, all had typical symptoms, such as numbness, nocturnal paresthesias, and positive Tinel and Phalen signs (Table 3). Only 26% (34 hands) had thenar atrophy. The two-point discrimination test yielded an altered result in 120 patients.

The electromyography results indicated a mostly moderate stage (69%). A correlation was observed between these findings and the questionnaire score, since, in patients with a test indicating a mild stage, the score was, on average, 16; for moderate cases, the average was 21; and severe cases reached the maximum score of 26 (Table 3), which represent statistically significant values.

In the comparison of CTS-6 score and CTS severity assessed with electromyography, a higher CTS-6 score was observed in cases with higher severity (Table 4).

Table 2. Description of the sample.

	Total (n = 106)
Age, years, mean (SD)	64.90 (13.82)
Sex, n (%) Male Female	 25 (23.58) 81 (76.42)
Laterality,* n (%) Left Right Bilateral	 41 (38.67) 43 (40.56) 22 (20.75)

SD = standard deviation. *A total of 128 median nerves were evaluated in 106 patients.

Table 3. Description of results.

	Total hands (n =128)
CTS-6 score, mean (IQR)	21 (21-26)
Symptoms, n (%) Numbness Nocturnal symptoms Positive Phalen's test Positive Tinel sign Loss of 2-point discrimination Thenar atrophy	 128 (100) 128 (100) 128 (100) 128 (100) 120 (93.75) 34 (26.56)
Electromyography, n (%) Mild stage Moderate stage Severe stage	 8 (6.25) 89 (69.53) 31 (24.22)

CTS = Six-Item Carpal Tunnel Symptoms Scale; IQR = interquartile range.

Table 4. Comparison of CTS-6 assessment and electromyography results.

	Total	Mild	Moderate	Severe	p
CTS-6 score, median (range)*	21 (16.5-26)	16.5 (16.5)	21 (21-26)	26 (26)	0.0001

CTS-6 = *Six-Item Carpal Tunnel Symptoms Scale*. *Median and ranges reported on a total of 128 hands.

DISCUSSION

CTS is the most prevalent compressive neuropathy, and while electromyographic studies are the most reliable diagnostic tool, it should be noted that the diagnosis is primarily dependent on anamnesis and clinical symptoms. Furthermore, it has been shown that routine electrodiagnostic testing has low sensitivity and specificity for mild CTS. Clinical and neurophysiological dissociation are frequently observed. Patients with a mild or moderate stage according to electromyography have normal hand function but may become severely symptomatic, whereas severe CTS has severely reduced hand function and milder symptoms. This suggests that the patient's point of view is reliable. Even if only minor electrophysiological abnormalities or functional impairments are observed, a sizable proportion of the CTS population experiences significant symptoms in the early stages of nerve impairment. The CTS-6 is a subjective measure, and assesses symptoms and function from the patient's point of view. It determines function and symptoms in patients with CTS through questions related to numbness and tingling sensation, pain, and functional status.[12]

Often, there is a discrepancy between the severity of CTS as reported by the patient and the clinical assessment of the physicians. As the treatment protocol to be applied in CTS is connected to the severity of compression, the study findings revealed a statistically significant relationship between CTS-6 and nerve conduction study results.[13] It was observed that the scores of patients with normal electromyography were very close to those of patients with mild CTS. Moreover, the scores were higher as the severity of compression increased. Based on these findings, we believe that the use of CTS-6 can provide insight into the severity of compression more effectively, rather than assessing symptoms separately.

When evaluating the relationship between CTS-6 and electromyography for the detection of patients with CTS who are candidates for surgery, the CTS-6 score was higher when electromyography indicated greater severity. This raises the hypothesis that CTS-6 could be useful as a noninvasive diagnostic tool in CTS. Grandizio et al.[14] obtained similar results and suggest that CTS-6 can also be used reliably as a screening and diagnostic tool for CTS by physicians without specific training in upper limb surgery. [15]

When CTS-6 was used for the mildest symptoms of CTS, such as numbness of the fingers, nocturnal symptoms, and positive Tinel and Phalen signs, the symptoms were positive in all cases. Two-point discrimination loss was seen in patients with predominantly moderate and severe stages according to electromyography; however, only patients with severe stages had thenar atrophy. Likewise, Levine et al. found an insignificant correlation between median sensory nerve conduction velocity and the overall symptom severity scale in CTS. Furthermore, they suggested that symptom severity cannot be estimated by measuring nerve conduction.[3] Ortiz-Corredor et al.[16] argued that numbness and tingling questions in clinical questionnaires, such as the BCTQ, better reflect the pathophysiology of the median nerve and have a strong and direct statistical correlation with distal sensory and motor latencies of the median nerve and, therefore, may be more useful in the diagnosis, follow-up, and evaluation of therapeutic outcomes in CTS. De la Llave-Rincón et al.[17] found no significant differences in pain parameters between patients with mild, moderate and severe CTS. They suggested that increased pain sensitivity is not related to electrodiagnostic findings or to the presence of unilateral or bilateral symptoms in patients with mild, moderate or severe CTS. CTS involves not only central sensitization (spinal or supraspinal mechanisms) but also peripheral sensitization (afferent impulse from the median nerve). Even if symptoms originate primarily above the median nerve distributions, 50% of patients with CTS experience extramedian sensory symptoms resulting in total hand involvement and proximal pain in the forearm, arm, and shoulder, indicating central sensitization. Central sensitization provides a pathophysiologic explanation for patients with CTS who experience persistent symptoms despite surgical treatment.

Although sensory symptoms are the main problem in CTS, patients often report motor symptoms, such as hand weakness and difficulty grasping small objects. Conventional motor conduction studies may not be sensitive enough to define motor axon abnormality, particularly in mild to moderate CTS. There is a discrepancy between motor symptoms and measures of motor function, even if median nerve motor conduction and motor examination are normal. Pain may be a factor in explaining this discrepancy. Chronic pain can alter the function of the motor control system and influence motor performance through a variety of mechanisms. Tamburin et al.[18] indicated that hand weakness and clumsiness can be detected in 56% and 48% of hands with CTS, respectively. They also demonstrated that hand weakness was related to the severity of sensory symptoms (pain, numbness and tingling), but not to clinical-electrophysiological measures of median nerve involvement, whereas hand clumsiness was subjugated to the severity of sensory symptoms and clinical-electrophysiological measures of median nerve motor damage, but not sensory damage.

The variability between symptoms and nerve conduction study findings suggests that the decrease in nerve conduction threshold required for symptom production varies from person to person.[19] The diagnosis of CTS should be evaluated not only as an electrodiagnostic finding, but also as a whole, depending on the patients' clinical picture. When there are no electrodiagnostic abnormalities and the patient exhibits clinical symptoms and CTS findings on physical examination, the patient can be diagnosed with CTS and treated accordingly. It becomes apparent that evaluating clinical sensory symptoms rather than motor symptoms is a useful tool in the diagnosis of CTS. Ultimately, the correct diagnosis is critical in determining the most effective treatment plan and prognosis.

Regarding the medicolegal issues that may arise as a result of avoiding electromyography, we will refer to the levels of evidence published in the *American Academy of Orthopaedic Surgeons Evidence-Based Clinical Practice Guideline on: Management of Carpal Tunnel Syndrome-2016.*[20] This publication shows that there is limited 2/5 evidence to support that nerve conduction studies could be used for the diagnosis of CTS. In contrast, diagnostic scales (and specifically CTS-6) had a moderate 3/5 evidence. Although some articles[8] suggest that, given the reported evidence of 16% to 34% false negative rates in various series, electromyography should not be used as a reference study for the diagnosis of CTS, our study found a correlation between the severity determined by the questionnaire and the severity determined by electromyography. Based on the analysis of the literature, the evidence showed that changes in probability after electrodiagnostic testing, using any of the electrodiagnostic definitions, were minimal and most likely less than a clinically relevant standard. This suggests that the most appropriate setting for electrodiagnostic testing is one in which there is uncertainty about the clinical diagnosis.

CONCLUSIONS

The CTS-6 can provide a standardized measure of symptom severity and functional status in patients with CTS. It can be used as a supportive tool for the diagnosis and treatment of CTS in this population, as well as to measure the clinical severity of symptoms and predict potential therapeutic behavior.

More studies with higher methodological quality and a larger sample size are required to generate evidence to support the use of CTS-6 in detecting patients who are candidates for CTS surgery.

Conflict of interest: The authors declare no conflicts of interest.

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