

Reliability of provocative tests in determining the severity of carpal tunnel syndrome

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Abstract

Background & Objectives: Electrodiagnostic study is the most frequently used diagnostic tool in confirming and grading carpal tunnel syndrome (CTS) severity. However, limited availability of electrodiagnostic tools in rural areas hinders its applicability in CTS diagnosis and grading. This study intends to seek the relationship between CTS provocative tests and the degree of CTS severity. **Methods:** This is a cross-sectional study. Patients with symptoms of CTS were included in the study. Provocative tests (Tinel sign and Phalen's test) were done in clinical setting followed by electroneurography in both hands of each patient. The Phalen test was performed with the wrist held in maximum passive flexion for 60 seconds, and the Tinel sign was elicited by tapping over the volar wrist crease. Both tests were considered positive if paresthesia or numbness in the median nerve distribution was reproduced. CTS diagnosis was confirmed by electroneurography (ENG) using standard nerve conduction criteria, and CTS severity was graded using Bland's Neurophysiological grading scale. The relationship between provocative tests and CTS severity were analyzed using bivariate chi-square analysis. **Results:** Forty-eight patients (87 hands) were included in this study. Most patients had bilateral CTS. Neurophysiological study confirmed 87 median nerve impingements, mostly of grade III. Positive provocative test (either Tinel/Phalen or both) was significantly related to CTS severity. The number of positive provocative tests according to CTS severity were as follows: 1/18 (5.6%) positive for one test in grade I, 14/17 (82.4%) positive for one test in grade II, 25/30 (83.3%) positive for one test and 5/30 (16.7%) positive for both tests in grade III, and 17/17 (100%) positive for both tests in grade IV and 5/5 (100%) in grade V.

Conclusions: Positive results of both provocative tests are consistent with more severe CTS.

Keywords: Carpal tunnel syndrome, severity, electroneurography, Tinel sign, Phalen test

INTRODUCTION

Carpal tunnel syndrome (CTS) comprises the most frequently encountered form of entrapment neuropathy.^{1,2} Previous studies have found that CTS commonly affects the adult population with a global prevalence of 1 to 6%.³ Although there were not any published CTS prevalence in Indonesia, a study showed an incidence as high as 80% in garment workers in one of the top travel destinations in Indonesia.⁴ Establishing a definitive diagnosis as well as determining the severity of CTS is important in considering appropriate treatment. CTS can be diagnosed clinically (through careful

history taking and provocative tests) followed by electroneurography.^{1,5,6} Electroneurography (ENG) is the gold standard in diagnosing and determining the severity of CTS.⁷⁻⁹ However, ENG modalities are not available in all healthcare facilities, especially in rural areas in Indonesia. Studies attempting to find a correlation between ENG results with simple clinical diagnostic maneuvers were limited in quantities and have never been conducted in Indonesia.^{10,11} The aim of this study is to evaluate the relationship between provocative tests in CTS and its severity as well as identifying variables related to CTS severity.

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METHODS

This is a cross-sectional study conducted in Siloam General Hospital between 2019 and 2021. Patients with clinical diagnosis of CTS below 65 years old, who had performed the provocative test (Tinel sign and Phalen's test) before ENG, and had undergone ENG testing were included in the study. Patients with diabetes mellitus were excluded.

The unit of analysis for all neurophysiological and provocative test findings is the individual hand. Demographic characteristics are reported at the patient level ($n = 48$), while all clinical findings and ENG results are reported at the hand level ($n = 87$ hands).

The Phalen test was performed by having the patient hold both wrists in maximum passive flexion (approximately 90°) for 60 seconds. The test was considered positive if the patient reported reproduction of tingling, numbness, or paresthesia in the median nerve distribution (thumb, index, middle, and radial half of the ring finger) within the 60-second period. The Tinel sign was elicited by the examiner tapping lightly over the carpal tunnel at the volar wrist crease using a reflex hammer. The sign was considered positive if tapping produced paresthesia or an electric sensation radiating into the median nerve distribution. Both tests were performed in a standardised sequence by a trained examiner (neurologist) and evaluated in a consistent manner across all patients.

Electroneurography (ENG) was performed according to standard nerve conduction study protocols. The diagnosis of CTS was confirmed by ENG when there was evidence of median nerve conduction abnormality at the wrist, defined as: (1) prolonged median nerve distal motor latency (>4.2 ms), (2) prolonged median nerve distal sensory latency (>3.5 ms) or reduced sensory nerve action potential amplitude, or (3) a median-to-ulnar distal sensory latency difference of >0.4 ms.

CTS severity was graded using Bland's electrophysiological grading scale classification, graded from I (very mild), to VI (extremely severe).⁷⁻⁹ Specifically: Grade I (very mild): abnormal comparison studies only; Grade II (mild): abnormal comparison studies with absent sensory nerve action potential; Grade III (moderate): absence of sensory response with preserved motor response; Grade IV (severe): prolonged distal motor latency; Grade V (very severe): undetectable median nerve response; Grade VI (extremely severe): undetectable

response with evidence of severe axonal degeneration.

Data was analyzed using IBM SPSS 25.0 for Windows. A bivariate chi-square test was utilized for categorical variables, and an independent t-test was conducted for continuous variables with normal distribution. The statistical significance cut-off for the two-tailed p-value was <0.05 . This study has received ethical approval from Universitas Pelita Harapan, Faculty of Medicine, Research Ethics Committee.

RESULTS

There were 48 patients included in the study (Table 1), in which most were female (66.7%) with a mean age of 46.35. In clinical examination, the Tinel test was elicited in 38/87 (43.7%) of all hands, and the Phalen test was elicited in 56/87 (64.4%) of all hands. Both provocative tests were positive in 27/87 (31.0%) of hands, one of the two (either Tinel or Phalen) was positive in 40/87 (46.0%) of hands, and negative in both tests was seen in 20/87 (23.0%) of hands (Table 2).

Among 48 patients, 39 patients (81.2%) had CTS in both hands, as confirmed by ENG. In total, 87 hands were confirmed as CTS, in which 18/87 (20.7%) were classified as grade I (very

Table 1: Demographic characteristics of the population sample in this study

Variable	Demographic
Patients, n (%)*	48 (100)
Age, mean (standard deviation)	46.35 (± 11.64)
Sex, n (%)*	
Male	16 (33.3)
Female	32 (66.7)
CTS distribution, n (%)*	
Unilateral	9 (18.8)
Bilateral	39 (81.2)
Hands affected, n (%)†	87 (100.0)
Severity, n (%)†	
Very Mild (Grade I)	18 (20.7)
Mild (Grade II)	17 (19.5)
Moderate (Grade III)	30 (34.5)
Severe (Grade IV)	17 (19.5)
Very Severe (Grade V)	5 (5.7)
Extremely Severe (Grade VI)	0 (0.0)

CTS: Carpal Tunnel Syndrome. *relative to the total number of patients. †relative to the total number of hands affected.

Table 2: Patients' characteristics according to CTS severity (hand-level analysis, n = 87 hands)

Variable	Total n = 87	Grade I n = 18	Grade II n = 17	Grade III n = 30	Grade IV n = 17	Grade V n = 5	p value
Age, mean (SD)	46.34 (11.64)	48.17 (10.14)	46.24 (9.55)	44.77 (12.55)	47.18 (14.96)	45.60 (4.93)	0.787
Sex							
Hands from male patients†, n (%)	31 (35.6)	7 (38.9)	5 (29.4)	11 (36.7)	6 (35.3)	2 (40.0)	0.98
Hands from female patients‡, n (%)	56 (64.4)	11 (61.1)	12 (70.6)	19 (63.3)	11 (64.7)	3 (60.0)	
Clinical Findings							
Tinel positive‡, n (%)	38 (43.7)	0/18 (0.0)	1/17 (5.9)	15/30 (50.0)	17/17 (100.0)	5/5 (100.0)	<0.001*
Phalen positive‡, n (%)	56 (64.4)	1/18 (5.6)	13/17 (76.5)	20/30 (66.7)	17/17 (100.0)	5/5 (100.0)	<0.001*
Both tests negative, n (%)	20 (23.0)	17/18 (94.4)	3/17 (17.6)	0/30 (0.0)	0/17 (0.0)	0/5 (0.0)	<0.001*
One test positive, n (%)	40 (46.0)	1/18 (5.6)	14/17 (82.4)	25/30 (83.3)	0/17 (0.0)	0/5 (0.0)	
Both tests positive, n (%)	27 (31.0)	0/18 (0.0)	0/17 (0.0)	5/30 (16.7)	17/17 (100.0)	5/5 (100.0)	
Laterality							
Right, n (%)	85 (97.7)	16/18 (88.9)	17/17 (100.0)	30/30 (100.0)	17/17 (100.0)	5/5 (100.0)	0.097
Left, n (%)	80 (92.0)	18/18 (100.0)	15/17 (88.2)	28/30 (93.3)	15/17 (88.2)	4/5 (80.0)	0.516
Bilateral, n (%)	78 (89.7)	16/18 (88.9)	15/17 (88.2)	28/30 (93.3)	15/17 (88.2)	4/5 (80.0)	0.906

*p demonstrates significance <0.05.

†Hands from male/female patients (hand-level reporting; each hand is counted once regardless of the patient's total hand count).

‡Tinel-positive (n=38) and Phalen-positive (n=56) are non-exclusive categories. Hands positive for both tests are counted in each row, which is why the sum (94) exceeds the total number of hands (87). The mutually exclusive categories are presented as 'Both tests negative', 'One test positive', and 'Both tests positive'.

mild), 17/87 (19.5%) as grade II (mild), 30/87 (34.5%) as grade III (moderate), 17/87 (19.5%) as grade IV (severe), and 5/87 (5.7%) as grade V (very severe). None were classified as grade VI (extremely severe).

Statistical analysis showed a significant relation between variables 'Tinel test', 'Phalen test', as well as 'Number of positive tests' with disease severity. No significant relation was found between age or sex and positivity of provocative tests. Among 18 hands with grade I CTS, both tests were negative in 17/18 (94.4%), while 1/18 (5.6%) was positive for Phalen's test only. Among 17 hands with grade II CTS, 14/17 (82.4%) were found positive for one test (13/17 [76.5%] Phalen positive; 1/17 [5.9%] Tinel positive), and 3/17 (17.6%) were negative for both. Among 30 hands with grade III CTS, 25/30 (83.3%) appeared positive for one test (15/30 [50.0%] Tinel positive; 20/30 [66.7%] Phalen positive), and 5/30 (16.7%) were positive for both. All 17/17 (100.0%) hands classified as grade IV and 5/5 (100.0%) hands classified as grade V were found positive for both tests (Figure 1). Number of provocative tests that are positive demonstrated a significant relation toward CTS degree of severity (Table 2).

DISCUSSION

Electroneurography is the mainstay modality in determining CTS, grading its severity, and influencing treatment decisions.⁽⁹⁾ However, while ENG is not readily available in all healthcare facilities, simple clinical provocative tests specific to CTS (i.e., the Tinel and Phalen tests) may be used to predict CTS severity and may provide information to advise the course of management. Our study found a significant relationship between CTS-specific clinical diagnostic maneuvers and CTS severity. This finding is concordant with a previous study by Jeong *et al.*, in which a significant relationship was found between diagnostic maneuvers with CTS severity.¹¹

In grade I (very mild) CTS, the vast majority of hands (17/18, 94.4%) were negative for both tests, though the Phalen test was positive in 1/18 (5.6%). In grade II (mild) CTS, one or both tests were positive in 14/17 (82.4%) of hands, predominantly driven by the Phalen test (13/17, 76.5%), whereas the Tinel test was rarely elicited (1/17, 5.9%). Both tests were simultaneously positive only from grade III onward (5/30, 16.7%), reaching 100% positivity in grades IV and V. These findings suggest that while the

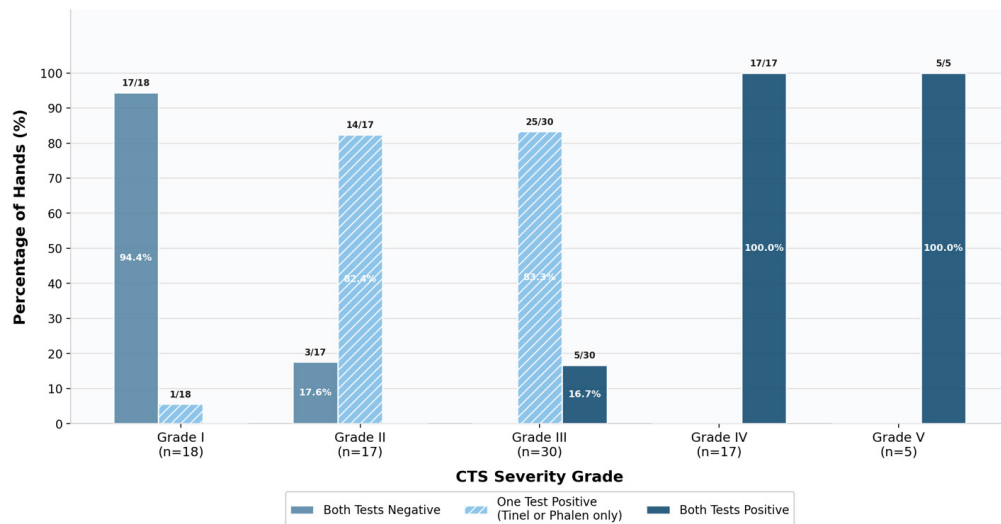


Figure 1. Column chart demonstrating the distribution of elicitable diagnostic maneuvers (as n/N and percentage) across degree of CTS severity (CTS: carpal tunnel syndrome).

Phalen test may be positive even in early-grade CTS, the concurrent positivity of both tests is indicative of moderate-to-severe disease. This delineation may provide important clinical information, as treatment options vary between grades: at very mild and mild CTS severity, conservative treatment is favorable, while in moderate to extremely severe cases, surgical approaches are recommended.⁵

Furthermore, the type of positive diagnostic maneuver may also distinguish disease severity. Previous studies by Bröske *et al.* and Al-Dabbagh *et al.* have evaluated the diagnostic accuracy of the Phalen and Tinel tests for the presence or absence of CTS, reporting higher sensitivity and specificity for the Phalen test compared to the Tinel test (Phalen: sensitivity 85–94%, specificity 78–89%; Tinel: sensitivity 67–77%, specificity 66–68%).^{12,13} While those studies addressed a different research question (CTS diagnosis rather than severity grading), their finding that the Phalen test detects CTS more sensitively is conceptually consistent with our observation that Phalen positivity appears at lower severity grades (grade I–II), whereas Tinel positivity tends to emerge at higher severity grades (grade III and above). Importantly, these are observational parallels only; our study was not designed to assess diagnostic accuracy, and direct comparison of sensitivity/specificity figures is not appropriate. Nevertheless, while the Phalen test's greater sensitivity may be of

further use for the detection/diagnosis of CTS, the presence of Tinel's sign, even in the absence of Phalen's sign, may be predictive of increasing severity.

Therefore, in resource-limited settings without ENG expertise to ascertain CTS grading, the presence of both Tinel and Phalen signs may be used to assist in treatment planning, including aiding in deciding when surgical interventions may be required. The limitations of this study include its retrospective design, which leads to numerous sample exclusions due to incomplete medical record data. A further limitation is the absence of a control group consisting of patients with clinical symptoms suggestive of CTS (positive Phalen or Tinel test) but with normal ENG findings. Such a group would have enabled calculation of the false-positive rates of these provocative tests and would have provided additional context for interpreting the clinical utility of these maneuvers. Future prospective studies should include such a comparison group to fully characterise the diagnostic and prognostic value of provocative tests across the CTS severity spectrum, including ENG-negative cases. The authors recommend further studies be conducted evaluating the relationship between diagnostic maneuvers and disease severity, considering period of illness, frequency of symptoms, presence of atrophy, as well as duration of time in which hypesthesia/paresthesia was present following a positive Tinel or Phalen test.

In conclusion, this study shows a significant relationship between the Tinel, Phalen tests, and a combination of these tests towards CTS severity as measured by Bland electroneurography criteria. The delineation provides important clinical information, and presence of both Tinel and Phalen signs may be beneficial in assisting and deciding when surgical interventions may be required. However, additional studies should be conducted to further evaluate this relationship, taking into account duration of illness, frequency of symptoms, presence of motor impairment, and atrophy.

DISCLOSURE

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Conflict of Interest: None

REFERENCES

1. Genova A, Dix O, Saefan A, Thakur M, Hassan A. Carpal tunnel syndrome: A review of literature. *Cureus* 2020;12(3):e7333. doi: 10.7759/cureus.7333
2. Garcia JO, Scott D, Parikh P, Curley K, Turkmani A. Understanding carpal tunnel syndrome. *JAAPA* 2022;35(12):19-26. doi: 10.1097/01.JAA.0000892708.87945.f6
3. Rhee SY, Cho HE, Kim JH, Kim HS. Incidence and reappraisal of known risk factors associated with carpal tunnel syndrome: A nationwide, 11-year, population-based study in South Korea. *J Clin Neurol* 2021;17(4):524-33. doi: 10.3988/jcn.2021.17.4.524
4. Paramita TI, Tini K, Budiarsa IGNK. Samatra DPGP. Prevalensi dan Karakteristik Carpal Tunnel Syndrome pada pekerja Garmen di Kota Denpasar. *Jurnal Medika Udayana* 2021;10(2):6-11. doi: 10.24843/MU.2021.V10.i2.P02
5. Vázquez-Sánchez F, Gómez-Menéndez AI, López-Veloso M, et al. A Proposal for neurography referral in patients with carpal tunnel syndrome based on clinical symptoms and demographic variables of 797 patients. *Diagnostics* 2024;14(3):297. doi: 10.3390/diagnostics14030297
6. Šošić L, Bojnec V, Lonžarić D, Jesenšek Papež B. An advanced stage of carpal tunnel syndrome — is night-time splinting still effective? *Int J Occup Med Environ Health* 2020;33(6):771-80. doi: 10.13075/ijomeh.1896.01611
7. Bland JDP. A neurophysiological grading scale for carpal tunnel syndrome. *Muscle Nerve* 2000;23(8):1280-3. doi:10.1002/1097-4598(200008)23:8<1280::AID-MUS20>3.0.CO;2-Y
8. Kanikannan M, Boddu D, Umamahesh, Sarva S, Durga P, Borgohain R. Comparison of high-resolution sonography and electrophysiology in the diagnosis of carpal tunnel syndrome. *Ann Indian Acad Neurol* 2015;18(2):219. doi: 10.4103/0972-2327.150590
9. Zhang JH, Yuan B, Yan FL. Application of the calculated electrophysiological parameters in early diagnosis of carpal tunnel syndrome. *Neurol Asia* 2020;25(2):139-43.
10. Hussein N, Desmaretts T, Seth M, Vilchez R. Correlation between clinical and electrophysiological findings of carpal tunnel syndrome. *Int Phys Med Rehab J* 2018;3(3). doi: 10.15406/ipmrj.2018.03.00109
11. Jeong DH, Kim CH. The quantitative relationship between physical examinations and the nerve conduction of the carpal tunnel syndrome in patients with and without a diabetic polyneuropathy. *Ann Rehabil Med* 2014;38(1):57. doi: 10.5535/arm.2014.38.1.57
12. Bröske J, Bednarski M, Grzelec H, Zyluk A. The usefulness of the Phalen test and the Hoffmann-Tinel sign in the diagnosis of carpal tunnel syndrome. *Acta Orthop Belg* 2002;68(2):141-5.
13. Al-Dabbagh KAO, Mohamad SA. Sensitivity and specificity of Phalen's test and Tinel's test in patients with carpal tunnel syndrome. *Diyala J Med* 2013;5(1):1-14.