ORIGINAL ARTICLE

Diagnostic Validity of Clinical Provocative Tests in Carpal Tunnel Syndrome

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Abstract

Introduction: Carpal tunnel syndrome (CTS) is the most prevalent mononeuropathy worldwide. Clinical diagnosis of CTS is important for screening of the condition and selecting cases to be confirmed with nerve conduction study (NCS), considering the limited availability of the latter. Numbers of clinical provocative tests have been designed for CTS. This study was conducted to compare the diagnostic validity of five widely used clinical provocative tests for CTS.

Methods: This was a case-control diagnostic accuracy study conducted on NCS-proven 140 CTS cases and 202 controls. Five clinical provocation tests – Phalen's test, reverse Phalen's test, Tinel's test, Durkan's test and arm raising test were performed on all participants. Sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios, overall accuracy and weighted kappa coefficient were calculated.

Results: Phalen's test, reverse Phalen's test, and Tinel's test showed low sensitivity (48-50%) despite their high specificity (91-92%) and moderate accuracy (73-75%). Durkan's test demonstrated 73% sensitivity, 86% specificity and 80% accuracy. Arm raising test results exhibited a poor sensitivity of 42%, despite a high specificity of 89%. Durkan's test had the strongest degree of agreement with the NCS diagnosis with a weighted kappa coefficient of 0.6.

Conclusion: Durkan's test exhibited the best diagnostic performance among five most commonly used clinical provocative tests for CTS.

Keywords: Carpal tunnel syndrome, Clinical provocative tests, Diagnostic validity

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Received: 20.02.2026 **Accepted:** 21.05.2026

Introduction:

Carpal tunnel syndrome (CTS) is the symptomatic compressive neuropathy of the median nerve at wrist.[1] It is the most common mononeuropathy, accounting for more than 90% cases.[2] Prevalence of CTS is 3.8% in general population with a female predominance and a peak age from 40 to 60 years.[3-5] CTS causes a high economic burden because of high number of days away from work and the cost of surgical treatment.[3,6]

The pathophysiology of CTS involves a combination of mechanical trauma, increased pressure and ischemic injury to the median nerve within the carpal tunnel.[7] CTS commonly presents with tingling, numbness and pain in the hand and a reduction of the grip strength and function of the affected hand.[8,9] Symptoms get worse at night and activities that need wrist flexion.[10] Common differential diagnoses of CTS are cervical radiculopathy, brachial plexopathy, proximal median neuropathy and thoracic outlet syndrome.[2] Nerve conduction study (NCS) is the

gold standard diagnostic investigation for CTS, despite its limitations.[11,12]

Several provocative tests are developed to aid the clinical diagnosis of CTS. Phalen's test, reverse Phalen's test, Tinel's test, Durkan's test and arm raising test (ART) are the most widely used clinical provocative tests for CTS.[13-17]

The sensitivity and specificity of Phalen's test, reverse Phalen's test, Tinel's test, Durkan's test and ART are 50-85% and 33-96%, 50% and 79%, 42-53% and 56-96%, 71-87% and 22-96%, and 76-88% and 60-98%, respectively.[18-23]

Numbers of researchers have questioned the validity of these provocative tests.[24-26] However, there is no published research work on the validity of all these provocative tests in Bangladeshi population.

This study was conducted to evaluate the diagnostic validity of the clinical provocative tests in CTS among Bangladeshi people.

Methods:

This was a case-control diagnostic accuracy study conducted on 140 CTS cases and 202 controls attending the Medicine and Physical Medicine outpatient at Shaheed Monsur Ali Medical College Hospital from July 2023 to June 2024. CTS was defined as presence of both 1. One or more of tinging, numbness or pain in hand, and 2. Electrophysiological evidence of CTS in nerve conduction study (NCS).[26] The control group comprised individuals who did not complain of any tingling, numbness or pain in hands.

Five clinical provocation tests – Phalen's test, reverse Phalen's test, Tinel's test, Durkan's test and arm raising test were performed on all participants following standard protocols. Phalen's test was performed by maximal wrist flexion held for 60 seconds while elbow is extended.[27] Reverse Phalen's test was done by keeping the wrist and fingers in extended position for 60 seconds.[14] Tinel's test was conducted with percussion over the median nerve just proximal to the wrist crease.[19] The procedure for the Durkan's test involved maintaining manual compression of the carpal tunnel for 30 seconds.[19] In the Arm Raising Test (ART), participants elevated both hands above their heads and sustained this posture for 120 seconds.[22] A test was recorded as positive if paresthesia developed in the fingers in the median nerve distribution.

The results of the provocative tests were documented in case record forms. Sensitivity (SEN), specificity (SPE), positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), negative likelihood ratio (LR-) and overall accuracy were calculated. The agreement between NCS results and individual clinical provocative test results was evaluated with weighted kappa coefficient (WK). Microsoft Excel 2016 and Statistical Package for the Social Sciences (SPSS) 26.0 were used for the final analyses.

The study received formal approval from the Institutional Ethical Review Board (IERB) of Shaheed Monsur Ali Medical College Hospital (Ref: SMAMC/04/2023/1787, dated 04/10/2023).Written informed consent was taken from all participants. The nature & aim of the study were explained to every study participant in simple understandable language before requesting their consent. The identity of the study participants were kept confidential. Every participant had the right to withdraw from the study at any time.

This study was carried out at a single center with a limited number of participants, which might constrain the generalizability of the study's results.

Results:

The mean age of the CTS group was significantly higher than that of the control group (44.5±10.3 years versus 37.6±10.6 years, p-value <0.0001). Among the CTS group, 132(94.3%) were females, and 8(5.7%) were males. The control group comprised 126(62.4%) females and 76(37.6%) males.

Table I shows the number results of the five provocative tests. Phalen's test, reverse Phalen's test, Tinel's test, Durkan's test and ART were positive in 50%, 49%, 48%, 73% and 42% CTS cases, respectively. In the control group, positive results were obtained in 8% Phalen's test, reverse Phalen's test and Tinel's test each, 14% in Durkan's test and 11% in ART, respectively.

Table I

Results of different clinical provocative tests for CTS

Test	CTS		Controls	
	Positive[1]	Negative[1]	Positive[1]	Negative[1]
Phalen's test	70 (50.0)	70 (50.0)	16 (7.9)	186 (92.1)
Reverse Phalen's test	69 (49.3)	71 (50.7)	17 (8.4)	185 (91.6)
Tinel's test	67 (47.9)	73 (52.1)	18 (8.9)	184 (91.1)
Durkan's test	102 (72.9)	38 (27.1)	28 (13.9)	174 (86.1)
Arm raising test	59 (42.1)	81 (57.9)	23 (11.4)	179 (88.6)

1 – percentages are given within parentheses

Diagnostic validities of the provocative test are illustrated in Table II. Phalen's test showed 50% sensitivity, 92% specificity, 81% PPV, 73% NPV, 6.3 LR+, 0.5 LR- with 75% accuracy. A sensitivity of 49%, specificity of 92%, PPV of 80%, NPV of 72%, LR+ of 5.9, LR- of 0.6, and an accuracy rate of 74% was observed in the reverse Phalen's test. In the assessment of Tinel's test, the findings revealed a sensitivity of 48%, specificity of 91%, PPV of 79%, NPV of 72%, LR+ of 5.3, LR- of 0.6, and accuracy of 73%. The evaluation of Durkan's test revealed 73% sensitivity, 86% specificity, 79% PPV, 82% NPV, 5.3 LR+, 0.3 LR-, and 81% accuracy. Arm raising test results exhibited a sensitivity of 42%, specificity of 89%, PPV of 72%, NPV of 69%, LR+ of 3.7, LR- of 0.7, and accuracy of 70%.

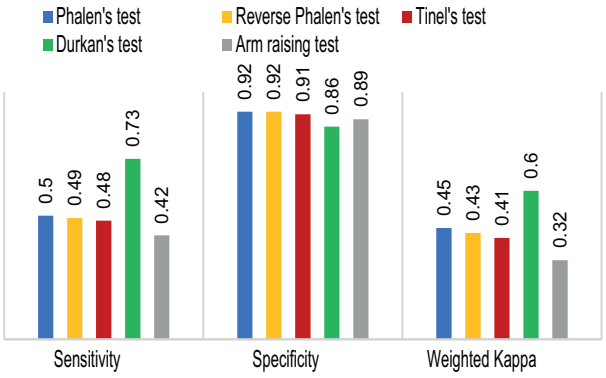

Figure 1: *Sensitivity, specificity and weighted kappa coefficient of provocative test for CTS*

Table II

Diagnostic validity of different clinical provocative tests for CTS

Parameters	Phalen's test[1]	R Phalen's test[1]	Tinel's test[1]	Durkan's test[1]	Arm raising test[1]
SEN	0.50	0.49	0.48	0.73	0.42
	(0.41-0.59)	(0.41-0.58)	(0.39-0.57)	(0.65-0.80)	(0.34-0.90)
SPE	0.92	0.92	0.91	0.86	0.89
	(0.88-0.95)	(0.88-0.95)	(0.86-0.95)	(0.81-0.91)	(0.83-0.946)
PPV	0.81	0.80	0.79	0.79	0.72
	(0.73-0.88)	(0.71-0.87)	(0.70-0.86)	(0.72-0.84)	(0.63-0.80)
NPV	0.73	0.72	0.72	0.82	0.69
	(0.69-0.76)	(0.69-0.76)	(0.68-0.75)	(0.78-0.86)	(0.65-0.72)
LR+	6.3	5.9	5.3	5.3	3.7
	(3.8-10.4)	(3.6-9.5)	(3.7-7.5)	(3.7-7.5)	(2.4-5.7)
LR-	0.5	0.6	0.6	0.3	0.7
	(0.5-0.6)	(0.5-0.7)	(0.5-0.7)	(0.2-0.4)	(0.6-0.8)
Accuracy	0.75	0.74	0.73	0.81	0.70
	(0.70-0.79)	(0.69-0.79)	(0.68-0.78)	(0.76-0.85)	(0.64-0.74)
WK[2]	0.45	0.43	0.41	0.60	0.32
	(0.35-0.54)	(0.34-0.53)	(0.32-0.51)	(0.51-0.68)	(0.23-0.43)

1-estimate (95% confidence interval)2-Weighted Kappa Coefficient

Durkan's test exhibited the strongest degree of agreement with the NCS diagnosis, with a WK of 0.6, while ART had the weakest agreement with a WK of 0.32. The other three provocative tests showed WK between 0.41 and 0.45.

Discussion:

The CTS patients examined in this study present a mean age of 44.5 years, with a female representation of 93.4%, comparable to findings from contemporary studies.[3-5]

Phalen's test, reverse Phalen's test, and Tinel's test showed analogous diagnostic potentials, characterized by low sensitivity (48-50%) despite their high specificity (91-92%) and moderate accuracy (73-75%). Recent studies revealed similar sensitivity and specificity of Phalen's and Tinel's tests.[20,21] A study on reverse Phalen's test found 55% sensitivity with 78% specificity.[18] ART demonstrated poor performance metrics, with a sensitivity of 42% and an accuracy of 70%, notwithstanding its high specificity. This finding contrasts with that of two recent studies, conducted in the United Kingdom and South Korea demonstrating very high sensitivity.[22,23]

The Durkan test demonstrated the highest sensitivity at 73%, while also achieving a commendable specificity of 86% and an accuracy rate of 81%. A recent study in USA found a very low specificity of 22% of Durkan's test despite 75% sensitivity.[19] However, Richter et al showed high sensitivity (87%) and specificity (96%) of Durkan's test.[21]

Durkan's test achieved the best results, exhibiting considerably higher sensitivity and weighted kappa coefficient than that of the remaining tests, with a reasonable specificity. (Figure-1)

Conclusion:

Clinical provocative tests are useful in the diagnosis of CTS. Durkan's test outperformed the others.

Conflict of interest:

The authors do not have any conflicts of interest.

Funding:

The study was conducted within a limited budget arranged by the authors, and did not receive any research grant.

References:

1. **Ibrahim I, Khan WS, Goddard N, Smitham P.** Carpal tunnel syndrome: a review of the recent literature. Open Orthop J. 2012;6(suppl 1):69-76.
2. Alfonso C, Jann S, Massa R, Torreggiani A. Diagnosis, treatment and follow-up of the carpal tunnel syndrome: a review. Neurol Sci. 2010; 31(3): 243-52.
3. Aroori S, Spence RA. Carpal tunnel syndrome. Ulst Med J. 2008;77(1):6-17.
4. Phalen GS. The carpal tunnel syndrome seventeen years' experience in diagnosis and treatment of six hundred fifty-four hands. J Bone Jt Surg. 1966;48A:211-8.
5. Rask MR. Anterior interosseous nerve entrapment: (Kiloh-Nevin syndrome) report of seven cases. Clin Orthop Relat Res. 1979;142:176-81.
6. Prime MS, Palmer J, Khan WS, Goddard NJ. Is there light at the end of the tunnel? Controversies in the diagnosis and management of carpal tunnel syndrome. Hand. 2010;5(4):354-60.
7. Werner RA, Andary M. Carpal tunnel syndrome pathophysiology and clinical neurophysiology. Clin Neurophysiol. 2002;113(9):1373-81.
8. Solomon L, Warwick D, Nayagam S. Apley's Concise System of Orthopaedics and Fractures. NY: Oxford University Press. 2005, 119.
9. Zyluk A, Kosovets L. An assessment of the sympathetic function within the hand in patients with carpal tunnel syndrome. J Hand Surg Eur. 2010;35(5):402-8.
10. Dorwart BB. Carpal tunnel syndrome: a review. Semin Arthritis Rheum. 1984;14(2):134-40.
11. Bland JD. The value of the history in the diagnosis of carpal tunnel syndrome. J Hand Surg Br. 2000;25(5):445-50.
12. Padua L, LoMonaco M, Padua R. Neurophysiological classification of carpal tunnel syndrome assessment of 600 symptomatic hands. Ital J Neurol Sci. 1997;18(3):145-50.
13. Kuhlman KA. Sensitivity and specificity of carpal tunnel syndrome sign. Am J Phys Med Rehabil. 1997;76(6):451-7.
14. Werner RA, Bir C, Armstrong TJ. Reverse Phalen's maneuver as an aid in diagnosing carpal tunnel syndrome. Arch Phys Med Rehabil. 1994;75(7):783-6
15. Naranjo A, Ojeda S, Mendoza D, Francisco F, Quevedo JC, Erausquin C. What is the diagnostic value of ultrasonography compared to physical evaluation in patients with idiopathic carpal tunnel syndrome? Clin Exp Rheumatol. 2007;25(6):853-9.
16. Ahn DS. Hand elevation: a new test for carpal tunnel syndrome. Ann Plast Surg. 2001; 46(2):120-4.
17. Durkan JA. The carpal compression test: an instrumental device for diagnosing carpal tunnel syndrome. Orthop Rev. 1994;23(6):522-5.
18. Cao J, Jia T, Lao J, Leu A, Rui J. Evaluation of different physical examination methods for the diagnosis of carpal tunnel syndrome. World Aca Sci J. 2022;4(5):1-5
19. Zhang D, Chruscielski CM, Blazar P, Earp BE. Accuracy of Provocative Tests for Carpal Tunnel Syndrome. J Hand Surg Glob Online. 2020;2(3):122-5.
20. Rayegani SM, Adybeik D, Kia MA. Sensitivity and specificity of two provocative tests (Phalen's test and Hoffmann Tinel's sign) in the diagnosis of carpal tunnel syndrome. J Orthop Med, 2004;26(2):51-3
21. Richter M, Bruser P. Value of clinical diagnosis in carpal tunnel syndrome. Handchir Mikrochir Plast Chir. 1999;31(6):373-6
22. Ma H, Kim I. The diagnostic assessment of hand elevation test in carpal tunnel syndrome. J Korean Neurosurg Soc. 2012;52(5):472-5
23. Amirfeyz R, Gozzard C, Leslie IJ. Hand elevation test for assessment of carpal tunnel syndrome. J Hand Surg Br. 2005;30(4):361-4.
24. DeKrom MC, Knipschild PG, Kester AD. Efficacy of provocative tests for diagnosis of carpal tunnel syndrome. Lancet. 1990;335(8686):393-5.
25. Graham B. The value added by electro-diagnostic testing in the diagnosis of carpal tunnel syndrome. J Bone Jt Surg Am. 2008; 90(12):2587-93.
26. Demino C, Fowler JR. The sensitivity and specificity of nerve conduction studies for diagnosis of carpal tunnel syndrome: a systematic review. Hand. 2021;16(2):174-8.
27. Heller L, Ring H, Costeff H, Solzi P. Evaluation of Tinel's and Phalen's signs in diagnosis of the carpal tunnel syndrome. Eur Neurol. 1986;25(1):40-2.