

## VALIDITY OF SPHYGMOMANOMETER TEST COMPARED TO DURKAN AND PHALEN TESTS IN DIAGNOSIS OF CARPAL TUNNEL SYNDROME WITH NERVE CONDUCTION STUDY CORRELATION. A PROSPECTIVE CROSS SECTIONAL ANALYTICAL STUDY

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### ABSTRACT

**Background:** Carpal Tunnel Syndrome (CTS) is primarily diagnosed through clinical history and provocative physical examination, with confirmation by nerve conduction studies (NCS). Among bedside tests, Phalen's wrist-flexion maneuver and Durkan's carpal compression test are most frequently used. The sphygmomanometer (arm cuff) test has been proposed as a standardized, pressure-controlled alternative that utilizes readily available clinical equipment. **Aim:** To evaluate the diagnostic performance of a standardized sphygmomanometer test in CTS and to determine its sensitivity, specificity, and clinical validity compared with established provocative tests, assessing its potential role as an adjunct in routine evaluation. **Methods:** This prospective cross-sectional analytical study included 50 female patients (73 symptomatic hands) with clinically suspected CTS. All participants underwent three provocative tests: sphygmomanometer test, Durkan's carpal compression test, and Phalen's wrist-flexion test. Nerve conduction studies were subsequently performed as the reference standard. Diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each clinical test. **Results:** The sphygmomanometer test demonstrated a sensitivity of 86.2% and specificity of 75.0%. The positive predictive value was 96.6%, while the negative predictive value was 40.0%. Overall, its diagnostic performance was comparable to that of Durkan's and Phalen's tests. **Conclusion:** The sphygmomanometer test provides diagnostic accuracy similar to established provocative maneuvers. It is simple, inexpensive, standardized, and easily applicable in outpatient settings, making it a useful adjunctive tool, particularly in resource-limited environments where immediate access to NCS is unavailable.

**KEYWORDS:** Carpal, Tunnel, Syndrome, Sphygmomanometer, Diagnostic, Durkan, Carpal, Phalen, Wrist-Flexion.

### INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy of the upper limb, accounting for nearly 90% of focal compression neuropathies.<sup>[1]</sup> It results from compression of the median nerve within the rigid fibro-osseous canal formed by the carpal bones dorsally and the transverse carpal ligament volarly. The median nerve traverses the tunnel alongside nine flexor

tendons and provides sensory innervation to the thumb, index, middle, and radial half of the ring finger, as well as motor supply to the thenar muscles essential for thumb opposition and fine pincer grip.<sup>[2,3]</sup> Clinically, CTS presents with nocturnal pain, paresthesia, and numbness in the median nerve distribution, often sparing the little finger and thenar eminence.<sup>[4,5]</sup> The condition affects approximately 3–3.8% of the general adult population

and may reach higher rates in occupational groups exposed to repetitive wrist motion. It is more common in women (female:male ratio 3:1) and typically occurs between 40 and 60 years of age.<sup>[1,5]</sup> Established risk factors include obesity, pregnancy, hypothyroidism, rheumatoid arthritis, diabetes, distal radius fractures, chronic renal failure, and repetitive manual activities.<sup>[5]</sup> Beyond its high prevalence, CTS carries substantial socioeconomic impact due to healthcare utilization and productivity loss.<sup>[1,4,6]</sup> Pathophysiological, CTS is a pressure-dependent neuropathy. Normal intracarpal tunnel pressure ranges from 2–10 mmHg but may exceed 30 mmHg in affected individuals, compromising intraneural microcirculation.<sup>[7,8]</sup> Sustained compression leads initially to venous congestion and endoneurial edema, followed by segmental demyelination—the principal mechanism underlying slowed nerve conduction.<sup>[9,10]</sup> Prolonged or severe compression may progress to axonal degeneration and irreversible motor deficits, including thenar atrophy.<sup>[11,12]</sup> Diagnosis relies on clinical history and physical examination, supplemented by nerve conduction studies (NCS), which are widely regarded as the reference standard for confirming median neuropathy at the wrist and grading severity.<sup>[7–10]</sup> However, NCS require specialized equipment and may not be readily accessible. Bedside provocative tests, particularly Phalen's wrist-flexion maneuver and Durkan's carpal compression test, are therefore commonly employed, though their reported sensitivity and specificity vary considerably.<sup>[2,13,14]</sup> The sphygmomanometer (arm cuff) test offers a pressure-controlled, standardized alternative that may enhance reproducibility by regulating stimulus intensity and duration.<sup>[15,16]</sup> Evaluating its diagnostic accuracy relative to established maneuvers could provide a practical adjunct for outpatient assessment, particularly in resource-limited settings.

## METHOD

This prospective cross-sectional analytical study was conducted from 1 April 2024 to 1 April 2025 at the orthopedic outpatient clinic of Al-Imamain Al-Kadhumain Medical City. Fifty consecutive female patients presenting with symptoms suggestive of carpal tunnel syndrome (CTS) were enrolled. Both unilateral and bilateral cases were included, and each symptomatic hand was analyzed independently, yielding a total of 73 hands. Participants were aged 20–65 years (mean age 45 years). Inclusion criteria comprised the presence of tingling, numbness, or pain in the median nerve distribution (thumb, index, middle, and radial half of the ring finger), nocturnal awakening, and activity-related symptom exacerbation. Exclusion criteria included cervical radiculopathy, vascular conditions contraindicating cuff inflation, previous CTS surgery, diabetic neuropathy, rheumatoid arthritis, pregnancy, and acute wrist trauma. All participants underwent three bedside provocative tests: Durkan's carpal compression test, Phalen's wrist-flexion maneuver, and a standardized sphygmomanometer test. The order of testing was

randomized using permuted blocks, with 2–3 minutes' rest between tests to minimize symptom carry-over. Examiners performing nerve conduction studies (NCS), the reference standard, were blinded to clinical test results. For the sphygmomanometer test, a blood pressure cuff was inflated to diastolic pressure plus 5 mmHg for up to 2 minutes. Reproduction of characteristic symptoms within 30–120 seconds that resolved upon deflation was considered positive. Binary outcomes and latency to symptom reproduction were recorded. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated using two-by-two contingency tables against NCS findings. Overall diagnostic performance was summarized using the Youden index. Paired comparisons were analyzed with McNemar's test ( $p < 0.05$ ). The study adhered to STARD recommendations and QUADAS-2 bias control principles.

## RESULTS

A total of 50 women (73 symptomatic hands) were included, with a mean age of 45 years (range 20–65). Nerve conduction studies (NCS) confirmed median neuropathy at the wrist in 65 of 73 hands (89.0%), while 8 hands (11.0%) were classified as NCS-negative.

**Sphygmomanometer Test:** Overall, 58 of 73 hands (79.5%) tested positive. Among NCS-positive cases, 56 of 65 were correctly identified (sensitivity 86.2%), with 9 false negatives (13.8%). Among NCS-negative cases, 6 of 8 were correctly classified as negative (specificity 75.0%), with 2 false positives (25.0%). The positive predictive value (PPV) was 96.6% (56/58), and the negative predictive value (NPV) was 40.0% (6/15).

**Durkan's Carpal Compression Test:** Fifty-seven of 73 hands (78.1%) were positive. True positives were 55 of 65 (sensitivity 84.6%), with 10 false negatives (15.4%). Specificity was 75.0% (6/8), with 2 false positives. PPV was 96.5%, and NPV was 37.5%.

**Phalen's Wrist-Flexion Test:** Fifty-five of 73 hands (75.3%) tested positive. Sensitivity was 81.5% (53/65), with 12 false negatives (18.5%). Specificity was 75.0% (6/8), with 2 false positives. PPV reached 96.4%, and NPV was 33.3%.

Given the high prevalence of NCS-confirmed CTS in this cohort (89%), PPV values were predictably high, while NPV values were comparatively low, reflecting sample composition rather than inherent test limitations.

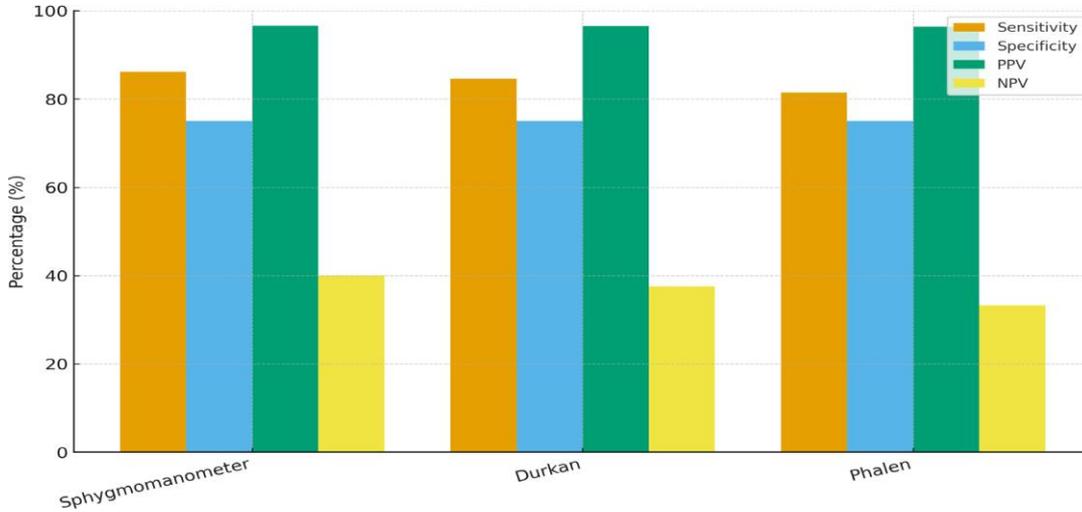
Paired comparisons using McNemar's test revealed no statistically significant differences between the sphygmomanometer and Durkan tests ( $p = 1.000$ ), between the sphygmomanometer and Phalen tests ( $p = 1.000$ ), or between Durkan and Phalen tests ( $p = 1.000$ ). The limited number of discordant pairs reduced statistical power to detect differences.

Using the Youden index to summarize overall diagnostic performance, the sphygmomanometer test achieved the highest value ( $J = 0.612$ ), followed by Durkan’s test ( $J =$

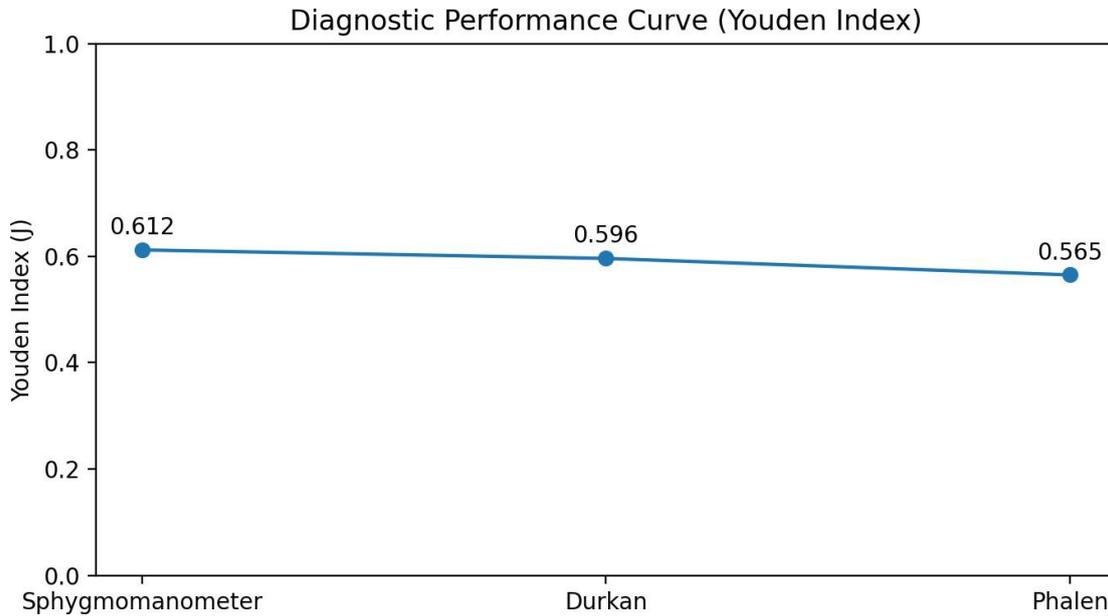
$0.596$ ) and Phalen’s maneuver ( $J = 0.565$ ), indicating slightly superior combined sensitivity and specificity for the cuff-based test. As in table 1 and fig 1-5.

**Table 1: Diagnostic Performance of CTS Provocative Tests.**

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Sphygmomanometer	86.2	75.0	96.6	40.0
Durkan	84.6	75.0	96.5	37.5
Phalen	81.5	75.0	96.4	33.3



**Fig 1: Bar chart Combined Sensitivity, Specificity, PPV, and NPV for all tests.**



**Fig 2: Diagnostic performance curve Youden Index.**

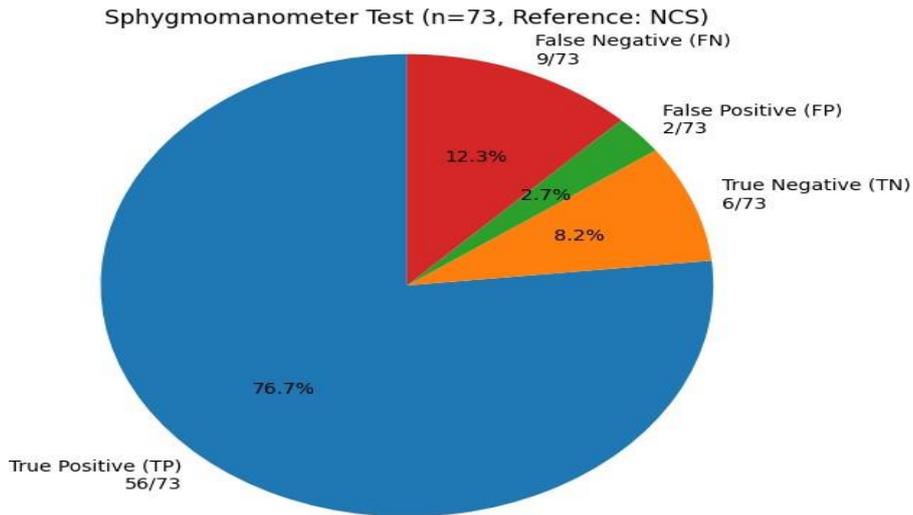


Fig 3: Pie Chart of Sphygmomanometer Test – TP/FP/TN/FN Distribution.

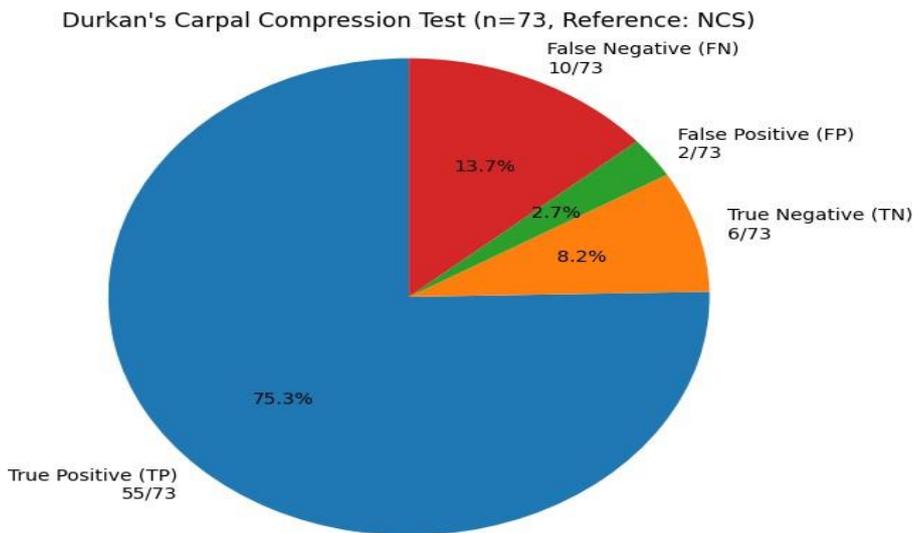


Fig 4: Pie Chart of Durkan Test – TP/FP/TN/FN Distribution.

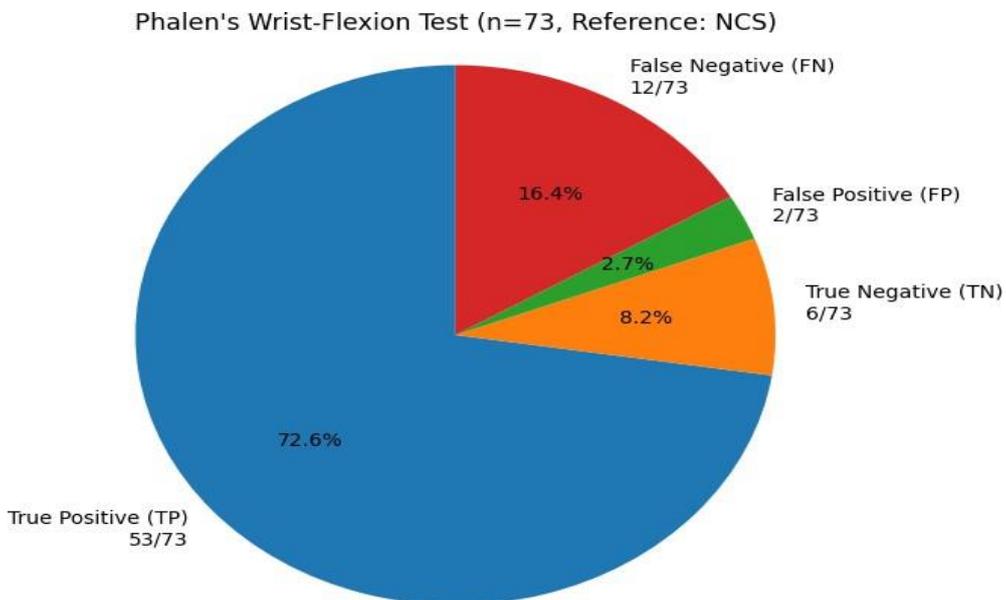


Fig 5: Pie Chart of Phalen Test – TP/FP/TN/FN Distribution.

## DISCUSSION

The primary objective of this study was to compare the diagnostic performance of three provocative tests for carpal tunnel syndrome (CTS) using nerve conduction studies (NCS) as the reference standard. Our findings demonstrated that the sphygmomanometer test achieved the highest sensitivity (86.2%), while specificity was similar across all three maneuvers. These results support the value of a standardized, pressure-controlled stimulus in CTS diagnosis. Phalen's maneuver showed a sensitivity of 81.5%, which lies at the higher end of reported ranges. Lajoie et al. documented a sensitivity of 92% and specificity of 88%<sup>[18]</sup>, whereas the systematic review and meta-analysis by Dabbagh et al. (2023) reported pooled sensitivity and specificity of 57% and 67%, respectively, reflecting moderate overall accuracy in heterogeneous populations.<sup>[7]</sup> The relatively high sensitivity observed in our cohort may be explained by the predominance of clinically moderate-to-severe cases, a factor known to enhance provocative test performance. Durkan's carpal compression test demonstrated a sensitivity of 84.6%, consistent with González del Pino et al., who reported 87% sensitivity and 95% specificity<sup>[19]</sup>, and with Durkan's original description (87% sensitivity, 90% specificity).<sup>[8]</sup> Systematic evidence suggests slightly superior diagnostic odds ratios for Durkan's test compared with Phalen's maneuver.<sup>[16]</sup> In our study, however, performance differences were marginal, possibly reflecting the influence of standardized test sequencing and uniform methodology. The sphygmomanometer test demonstrated the highest sensitivity. Its physiological basis lies in controlled venous occlusion, raising intracarpal pressure and transiently reproducing median nerve ischemia. Boland and Adams (1999) showed that cuff pressures between diastolic -30 mmHg and diastolic +5 mmHg induced significant forearm and hand volume changes in symptomatic individuals, supporting its mechanism as a symptom-provocation model.<sup>[9]</sup> Unlike manual maneuvers, this test operationalizes pressure intensity and duration, potentially reducing inter-examiner variability. In contrast, pneumatic tourniquet techniques such as Gilliat's test have shown limited sensitivity compared with modern provocative tests.<sup>[20,21]</sup> Given variability in reported diagnostic accuracy of bedside tests<sup>[7]</sup>, combining maneuvers rather than relying on a single test is recommended. The sphygmomanometer test may serve as a practical adjunct, particularly in settings where NCS is unavailable or delayed. Limitations include the modest sample size, single-gender cohort, and cross-sectional design. Future multicenter studies including both sexes and incorporating ultrasound correlation may further refine diagnostic thresholds and enhance generalizability.

## CONCLUSION

The sphygmomanometer test demonstrates diagnostic accuracy comparable to Durkan and Phalen maneuvers. With a sensitivity of 86.2% and a specificity of 75.0%, it is a valid, non-invasive screening tool suitable for

first-line evaluation. Clinically, the test is simple, inexpensive, and provides immediate feedback, making it well-suited to outpatient and low-resource settings.

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