Sensitivity and specificity of clinical testing for carpal tunnel syndrome

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OBJECTIVE: The present study evaluated the sensitivity, specificity and predictive values of six clinical tests in the diagnosis of carpal tunnel syndrome (CTS).
METHODS: There were 29 carpal tunnel syndrome (CTS) subjects (mean age 48 years) and 30 control subjects (mean age 45 years). The six clinical tests included Tinel's sign, wrist flexion with fingers extended, wrist flexion with fingers flexed, wrist extension, combined wrist extension/median nerve pressure and combined wrist flexion/median nerve pressure.
RESULTS: The highest sensitivity and highest negative predictive value was found with wrist flexion with pressure (96%) and wrist extension with pressure (94%) at 60 s. The highest specificity was found with wrist flexion with fingers flexed for 30 s (95%). The highest positive predictive values were found with the wrist flexion with fingers flexed test for 30 s (91%) and the wrist extension test for 30 s (90%).
CONCLUSION: No one test possesses all the qualities necessary to be the ideal clinical test for the detection of carpal tunnel syndrome.

Key Words: *Carpal tunnel syndrome; Evaluation*

La sensibilité et la spécificité des épreuves cliniques pour le syndrome du canal carpien

OBJECTIF : La présente étude a évalué la sensibilité, la spécificité et les valeurs prédictives de six épreuves cliniques dans le diagnostic du syndrome du canal carpien.
MÉTHODOLOGIE : Il y avait 29 sujets atteints du syndrome du canal carpien (SCC) (âge moyen de 48 ans) et 30 sujets témoins (âge moyen de 45 ans). Les six épreuves cliniques incluaient le signe de Tinel, la flexion du poignet les doigts dépliés, la flexion du poignet les doigts fléchis, l'extension du poignet, l'extension du poignet combinée à la pression du nerf médian et la flexion du poignet combinée à la pression du nerf médian.
RÉSULTATS : La sensibilité la plus élevée et la valeur prédictive la plus négative ont été découvertes au moyen de la flexion du poignet avec pression (96 %) et de l'extension du poignet avec pression (94 %) pendant 60 s. La spécificité la plus élevée a été établie avec la flexion du poignet les doigts fléchis pendant 30 s (95 %) et avec l'épreuve d'extension du poignet pendant 30 s (90 %).
CONCLUSION : Aucune épreuve ne possède toutes les qualités nécessaires pour constituer l'épreuve clinique idéale permettant de déceler le syndrome du canal carpien.

Carpal tunnel syndrome (CTS) is a compressive neuropathy of the median nerve that is associated with numbness and tingling in the median nerve distribution of the hand. The diagnosis of CTS is made clinically by history and physical examination and confirmed with electrodiagnostic studies. The most useful clinical tests are those tests that have a high sensitivity (proportion of true positive tests to all diseased subjects) and specificity (proportion of true negative tests to all healthy subjects). Traditionally, Tinel's sign and Phalen's tests have been used to clinically diagnose CTS. The reported sensitivity and specificity of these clinical tests vary from 30% to 100% (1). Other clinical tests, including the pressure provocative tests, have been described with varying reported sensitivity and specificity (1-16).

The purpose of the present study was to evaluate the sensitivity, specificity and predictive values of six clinical tests in the diagnosis of CTS.

MATERIAL AND METHODS

Subjects

The study and control sample included adult subjects. The study group included patients from a single surgeon's practice (SEM) with complaints of sensory alteration in the median nerve distribution and abnormal nerve conduction studies across the carpal tunnel were used to confirm the diagnosis of CTS. Patients with previous surgery on the median nerve including carpal tunnel release, median nerve repair, median nerve graft or distal radius fractures were excluded.

The control group included subjects with no history of paraesthesia or numbness in the median nerve distribution of the hand. Electrodiagnostic testing was not performed on the subjects in the control group.

Clinical evaluation

The clinical testing included six provocative maneuvers: Tinel's sign, wrist flexion with fingers extended, wrist flexion with fingers flexed, wrist extension, combined wrist extension/median nerve pressure and combined wrist flexion/median nerve pressure. Following the institutional Human Studies Committee's approval and the subject's informed consent, one examiner (IMW) did all clinical testing in a random testing order for each subject. Each provocative maneuver was held for a total of one minute with a one minute rest between tests. A positive response was recorded with reported sensory alteration in the median nerve distribution.

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TABLE 1
Sensitivity, specificity and predictive values of carpal tunnel syndrome provocative tests

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Tinel's sign	62%	93%	88%	76%
Phalen's test (60 s)	85%	90%	87%	89%
Wrist flexion with fingers flexed (60 s)	74%	92%	87%	82%
Wrist flexion with fingers flexed (30 s)	66%	95%	91%	78%
Wrist flexion with pressure (60 s)	96%	80%	79%	96%
Wrist flexion with pressure (30 s)	92%	85%	83%	93%
Wrist extension (60 s)	89%	83%	81%	91%
Wrist extension (30 s)	79%	93%	90%	85%
Wrist extension with pressure (60 s)	94%	75%	75%	94%
Wrist extension with pressure (30 s)	91%	82%	80%	92%

The time to symptom onset was recorded. The Tinel's sign was performed by applying four digital taps to the median nerve just proximal to the distal wrist crease. The wrist flexion test was performed by placing the subject's wrist in maximal wrist flexion with the forearm in a position of neutral rotation and the fingers extended. The wrist flexion test was repeated with the fingers flexed into a fist. The wrist extension test was performed by placing the subject's wrist in maximal wrist extension, fingers extended and the forearm in a position of neutral rotation. The combined wrist flexion/median nerve pressure test was performed by placing the subject's wrist in maximal wrist flexion with the forearm in neutral rotation and with digital pressure placed on the median nerve just proximal to the distal wrist crease. The combined wrist extension/median nerve pressure test was performed by placing the subject's wrist in maximal wrist extension with the forearm in neutral rotation and with digital pressure placed on the median nerve just proximal to the distal wrist crease.

Statistical analysis

The data were analyzed using two by two tables to determine the sensitivity, specificity, positive predictive value and negative predictive value of each provocative test. A *t*-test analysis was used to compare the ages between the CTS and control groups (Statistica 5.5, StatSoft Inc, USA).

RESULTS

Demographics

In the CTS group, there were 29 subjects (16 were women) with an average age of 48 years (standard deviation 10 years). The experimental group included 47 hands with a confirmed diagnosis of CTS. The control group consisted of 30 subjects (17 were women) with an average age of 45 years (standard deviation 10 years). There was no statistically significant difference between the mean ages of the two groups (P=0.18).

Sensitivity, specificity and predictive values

The sensitivity, specificity and predictive values were calculated using two by two tables. Sensitivity is calculated as the proportion of true positive tests in those patients with CTS (ie, those CTS patients that were correctly identified by the clinical test). Specificity is calculated as the proportion of true negative tests in those subjects without CTS (ie, the control subjects without CTS that were correctly identified by the clinical test). The predictive value indicates the probability of disease given the test results.

The highest sensitivity was found with the wrist flexion with pressure test for 60 s (96%) and the wrist extension with pressure test for 60 s (94%) (Table 1). The highest specificity was found in the wrist flexion with fingers flexed test for 30 s (95%), the wrist extension test for 30 s (93%) and Tinel's sign (93%). The highest positive predictive values were found in the wrist flexion with fingers flexed test for 30 s (91%) and the wrist extension test for 30 s (90%). The highest negative predictive values were for the wrist flexion with pressure test for 60 s (96%) and the wrist extension with pressure test for 60 s (94%).

DISCUSSION

Carpal tunnel syndrome is the most commonly treated compression neuropathy and continues to be controversial in both diagnosis and treatment (17-19). The prevalence of carpal tunnel syndrome has been reported to be as high as 2.7% in the general population (20). While CTS is a clinical diagnosis, many clinical tests have been described for its detection. However, no one clinical test has been universally accepted (1-8,10,13-15,21). Our study supports the conclusion that no one test possesses all the qualities needed to detect or rule out CTS.

It is hypothesized that CTS is due to increased pressure on the median nerve within the carpal canal and that a further increase in the carpal canal pressure increases patient symptoms. Clinical testing has used this concept to assist in identifying the site of nerve compression. As first described by Phalen (9,10), wrist flexion was used to increase pressure in the carpal canal to increase pressure on the median nerve and thereby elicit symptoms consistent with CTS in affected individuals.

Healthy volunteers have been shown to develop symptoms of CTS after 30 to 90 min of median nerve compression at a pressure of 30 mmHg or greater (22). Patients with CTS have carpal canal pressures significantly higher than patients without CTS; however, there are inconsistencies in the literature as to how high the mean carpal tunnel pressures are in this patient population (23-25). The literature does agree on two points: carpal canal pressures are significantly elevated in patients with CTS compared with normal subjects and that the greatest elevation of carpal canal pressures occurs with the wrist in 90 degrees dorsiflexion when compared with 90 degrees of palmar flexion. Finger posture has also been shown to produce elevated carpal canal pressures (26). Specifically, the metacarpophalangeal joint at zero degree flexion has been found to cause an elevation of carpal canal pressure of greater than 30 mmHg with only moderate wrist extension (10 degrees) (26).

Provocative testing is routinely used as part of the physical exam when trying to determine if a patient has CTS. The basis of the pressure provocative tests can be explained by the 'double crush hypothesis' (27,28); that is the concept that a compromised nerve already has a lower threshold to mechanical pressure than an uncompromised nerve so that any additional pressure will more readily cause symptoms of nerve compression when compared to the response of additional pressure to a normal nerve. Therefore, an early CTS that may not be evident on electrodiagnostic testing should manifest itself with pressure provocative testing.

Tinel's sign was first introduced to predict successful re-innervation after peripheral nerve repair. As such, this provocative test was originally described for severe nerve injuries with at least an axonotmetic injury and not CTS. This likely accounts for the very poor sensitivities, 23% to 67%, throughout the literature for this test (2,14,16,21,29). Our findings were consistent with the literature with poor sensitivity (62%) and high specificity (93%) for this test. In Phalen's original description of 654 patients with CTS, he reported a sensitivity of 74% for the wrist flexion test (9). He felt that the diagnosis of CTS could be made solely on the results of this provocative test. However, deKrom et al (2) and Mondelli et al (30) found low sensitivity for the wrist flexion test (48% and 59% respectively) and they concluded that the diagnosis of CTS could not be aided by the results of this test. Other studies have shown a wide range of sensitivities for this test, 10% to 80% (2,14,16,21,29,30). We found the sensitivity of Phalen's test at 60 s to be higher than most other studies (85%).

The wrist flexion with pressure provocative test had excellent sensitivity and good specificity at 30 s, similar to the finding by Tetro et al (15). In their study, they reported a sensitivity of 82% and specificity of 99% at 20 s. The wrist extension test in our study also had excellent sensitivity at 60 seconds (89%) and specificity at 30 s (83%). deKrom et al (2) reported only 41% sensitivity, with the wrist extension provocative test. From our study, we conclude that this provocative test is a better diagnostic test than it has been previously described.

Due to the greatest elevation of carpal canal pressure occurring with the wrist in extension, we felt that placing a patient in this position and applying pressure over the carpal canal would be a very sensitive test for CTS. This test had excellent sensitivity at 30 seconds (91%) but only modest specificity (82%) at the same time interval.

CONCLUSION

In conclusion, with high sensitivity and negative predictive values both provocative tests that position in wrist extension or wrist flexion with pressure over the carpal canal are valuable diagnostic tools. Due to the modest specificity and positive predictive values of these two tests, it may be necessary to use a combination of tests, specifically ones with higher specificity, to reliably identify those patients with CTS and exclude those patients without CTS. There is no 'gold standard' clinical test with both high sensitivity and specificity to diagnose CTS. The diagnosis of CTS should be made based on patient history, physician clinical evaluation and supported by electrodiagnostic testing if quantification is needed.

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