Diagnosing Carpal Tunnel Syndrome

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Learning Objectives

- Appraise the available literature relevant to the incidence of carpal tunnel syndrome (CTS).
- Discuss the evidence regarding the demographic and psychosocial factors related to CTS.
- Review the literature related to methods of diagnosing CTS.
- Describe the best evidence regarding the symptoms and findings that are most relevant in diagnosing CTS.
- Suggest diagnostic algorithms and predicting rules that approach the diagnosis of CTS.

Deadline: Each examination purchased in 2014 must be completed by January 31, 2015, to be eligible for CME. A certificate will be issued upon completion of the activity. Estimated time to complete each month's JHS CME activity is up to 2 hours.

THE PATIENT

A 39-year-old, healthy, right hand–dominant woman presents with a progressive 4-month history of tingling and numbness in both hands. Her symptoms are worse at night, she awakes with discomfort and tingling affecting the whole hand, and she shakes her hands for relief. She reports increased numbness using a computer at work, but she does not report neck pain or stiffness. No systemic symptoms are noted and she does not mention clumsiness of the hand or problems with balance. On examination, there is normal light touch sensibility and no weakness or muscle wasting in either hand. She has tingling and numbness over the radial 3 digits of both hands with Tinel and Phalen maneuvers. There is no evidence of ulnar and radial nerve pathology.

THE QUESTION

How is the diagnosis of idiopathic median neuropathy at the carpal tunnel (ie, carpal tunnel syndrome [CTS]) established?

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CURRENT OPINION

In the absence of a universally agreed-upon reference standard test, clinicians use 1 of 3 methods to diagnose CTS: (1) symptoms and signs alone, (2) electrodiagnostic testing, or (3) both. The optimal method is debated.

THE EVIDENCE

Demographic and psychosocial factors

The prevalence of CTS is estimated to be 50 cases per 1,000 population per year in the United States, ranging from 0.1% to 9.2%.[1,2] The lack of a reference standard for the diagnosis of CTS and the tendency to misuse the diagnosis for people with activity-related pain means that many of these may not be accurate diagnoses, and may have led to a wide range of prevalence reported in the literature. A large cross-sectional survey analyzed 2,466 randomly selected adults (stratified to be representative of the entire population) for symptoms of CTS and found that 14% reported pain, numbness, and tingling in the hand and wrist; but after electrodiagnostic tests of symptomatic participants, only 4% of the study population had abnormal tests.[3]

Jenkins et al[4] analyzed 1,564 patients diagnosed with CTS and reported an annual incidence of 72 cases per 100,000 population per year, with CTS twice as common in females.[4] The mean age in that study was 55 years, which was consistent with previous studies, with the highest incidence generally reported in females in the sixth decade.[5,6] That study also found that increased socioeconomic deprivation correlated with an increased incidence of CTS (81/100,000 versus 62/100,000), increased baseline functional impairment, and greater occupation vibration exposure.

A comprehensive review found that structural, genetic, and biological factors were most associated with CTS; environmental and occupational factors were less prominent.[7]

Symptoms

The characteristic symptom of CTS is intermittent nocturnal paresthesia in the radial 3.5 digits.[8–10] Katz et al[11] analyzed 110 patients with suspected CTS (44 confirmed on electrodiagnostic tests) and found that 77% with nocturnal paresthesia had a positive electrodiagnostic study. The Katz–Stirrat self-administered hand diagram was tested in a prospective study of 100 patients with upper limb symptoms.[12] Using electrodiagnostic testing as the reference standard, a "classic" or "probable" rated diagram resulted in a sensitivity of 64%, a specificity of 73%, and a positive predictive value of 58%, whereas the negative predictive value of an "unlikely" diagram was 91%.

Shaking of the hand to relieve paraesthesia (sometimes referred to as the flick sign or maneuver) was assessed in 142 patients (95 with electrodiagnostically confirmed CTS).[13] The sensitivity was 37%, specificity was 74%, positive predictive value was 74%, and negative predictive value was 37%. From a recent systematic review of 60 studies, the pooled sensitivity for the hand diagram was 75%, with a specificity of 72%, and for the flick sign the sensitivity was 47% and the specificity was 62%.[10]

Pain is not a characteristic symptom of CTS, although some patients describe intense paresthesia as pain rather than numbness or tingling. In a prospective study of 275 patients considered for the diagnosis of CTS, there was no association between pain intensity (assessed using the Short Form–McGill Pain Questionnaire) and electrodiagnostic findings.[14] Nunez and colleagues[15] analyzed 54 patients with electrodiagnostically confirmed CTS and found that pain and pain intensity were associated with depression and misinterpretation of nociception, but not with sex, age, or electrodiagnostics measures. In a prospective study of 98 patients using nerve conduction studies (NCS) as the reference standard for CTS, Makanji et al[16] found the CTS-6 (which does not include pain) had better diagnostic performance than the Boston Carpal Tunnel Questionnaire (which includes pain).

Signs

The physical examination findings associated with CTS are a positive Phalen, Durkan, or Tinel's sign and, in later stages, reduced sensation in the hand, atrophy of the muscles of the thenar eminence, or weakness of thumb palmar abduction.[8,9]

MacDermid and Wessel[10] performed a systematic review of 60 studies to determine the diagnostic performance characteristics of clinical signs associated with CTS. Their reference standard was symptoms consistent with CTS plus 1 or more of the following: a positive electrodiagnostic test, a response to treatment (splinting, injection, or surgery), or a clinical diagnosis performed by an experienced clinician. The Phalen test had a sensitivity of 68%, with a specificity of 73%, and Tinel's sign had a sensitivity of 50% and a specificity of 77%. Carpal compression (pressure directly over the median nerve in the carpal tunnel) with wrist flexion had the highest combined sensitivity and specificity, at 80% and 92%, respectively. Abductor pollicis brevis strength and atrophy both had high specificity (80%

and 94%, respectively) but poor sensitivity (29% and 80%, respectively).

LaJoie et al[17] used latent class analysis to analyze the diagnostic performance characteristics in 162 wrists of 81 patients with suspected CTS. They estimated the prevalence of CTS to be 60% and reported higher estimates for the sensitivity and specificity of Tinel's sign and Phalen tests compared with conventional analysis that used electrodiagnostic testing as the reference standard. Tinel's sign had the highest combined sensitivity and specificity, at 97% and 91%, respectively.

Clinical diagnostic algorithms

Diagnostic algorithms/clinical prediction rules approach the diagnosis of CTS as a probability rather than a binary outcome. Graham et al[1] produced the CTS-6 criteria from an initial list of 20 clinical criteria using expert opinion. Paraesthesia in the median nerve distribution and nocturnal numbness were included, but pain was not. The other 4 criteria included 2 signs of advanced disease (weakness or atrophy of the thenar muscles and diminished 2-point discrimination) and 2 provocative maneuvers (Tinel's and Phalen signs). The correlation between the probability predicted by the model and the ratings of the second expert panel of surgeons (used as the reference standard) was 0.71.

The Kamath questionnaire is an alternate screening questionnaire that gives a categorical probability for the diagnosis of CTS based on a score resulting from answers to questions pertaining to pain and paraesthesia. A score of less than 3 makes the diagnosis of CTS very unlikely, a score greater than 6 is diagnostic, and electrodiagnostic testing is recommended for those with scores between 3 and 6. In a prospective study using symptom relief after decompression as the reference standard, the sensitivity was reported to be 85%, and the positive predictive value, 90%.[18,19]

Wainner et al[20] prospectively studied 82 patients with a mean age of 45 years, who presented with suspected CTS or cervical radiculopathy. The authors identified 5 factors associated with CTS (reference standard electrodiagnostic tests and typical symptoms and signs): age greater than 45 years, the flick maneuver, a ratio of the anteroposterior to the mediolateral width of the wrist greater than 0.67, a Boston CTS questionnaire symptom severity scale score of greater than 1.9, and reduced sensation in the thumb. The likelihood ratio was 18.3 when all 5 tests were positive and the probability of CTS was 90%. With 4 positive factors, the positive likelihood ratio was 4.6 and the probability of CTS was 70%.

Diagnostic tests

Electrodiagnostic tests: The role of electrodiagnostic testing (NCS) as the reference standard is debated. They are used in many studies as the reference standard, have good reported diagnostic performance characteristics on both routine and latent class analysis,[17] and are the only clinical assessment for CTS supported by high-level evidence in the 2007 American Association of Orthopaedic Surgeons evidence-based guideline on the topic.[2] Factors associated with abnormal electrodiagnostic testing for CTS include increasing age, positive examination maneuvers, and high physician confidence in the pretest diagnosis.[16,21,22] Variables that are most strongly associated with normal electrodiagnostic testing include the absence of typical symptoms (paraesthesia) or signs (eg, Phalen test), younger age, and low physician confidence in the pre-electrodiagnostic diagnosis.[16,21,22] Becker and colleagues[23] analyzed prospective data on 130 patients from 2 prospective cohort studies, who underwent electrodiagnostic testing; the authors found that the pretest management plan changed in 19% of patients based on the outcome of electrodiagnostic testing, and the plan for operative treatment decreased significantly from 83% to 72%.[23]

On the other hand, among 143 patients who presented with suspected peripheral nerve pathology, Graham[21] found no significant improvement in the posttest probability of CTS when electrodiagnostic testing was added to the CTS-6. Jordan et al[24] performed a systematic review and examined 4 studies in which patients with suspected CTS underwent both electrodiagnostic testing and surgery. The researchers found no statistical difference in symptom resolution between those with normal or abnormal electrodiagnostic tests.

Other diagnostic tests: Fowler et al[25] performed a meta-analysis of 19 studies, including 3,131 wrists that used ultrasound to diagnosis CTS. Using either clinical diagnosis or electrodiagnostic testing as the reference standard, the overall sensitivity was 78% and the specificity was 87%.

Kwon et al[26] used clinical diagnosis as the reference standard in 41 wrists with suspected CTS to compare the diagnostic performance characteristics of ultrasound (US) with NCS. For US the sensitivity was 66% with a specificity of 63%, and for electrodiagnostic testing the sensitivity was 78% and the specificity was 83%. The sensitivity of US was comparable ($P = .27$), but the specificity was significantly inferior ($P = .02$).

Deniz et al[27] performed a prospective study of 69 patients who presented with suspected CTS, to determine the diagnostic performance characteristics of electrodiagnostic testing, US, computed tomography, and magnetic resonance imaging for diagnosing CTS. Electrodiagnostic testing had the highest sensitivity and specificity, but there was no statistically significant difference between tests.

SHORTCOMINGS OF THE EVIDENCE

The evidence regarding diagnosis of CTS is derived from relatively small and heterogeneous patient series, most of them uncontrolled cohort studies, and many with a spectrum bias (including primarily patients who are likely to have CTS). The absence of a consensus reference standard for the diagnosis of CTS precludes the use of standard diagnostic performance characteristics and makes it difficult to compare the findings of studies that use electrodiagnostic tests as the reference standard and those that use symptoms and signs or the doctor's impression. The limited diagnostic performance of symptoms, signs, clinical impressions, and scores, the variation in the specific factors included in diagnostic scores or prediction rules, and the imperfection of human judgment and heuristics make it difficult to have confidence in a diagnostic tool or reference standard based on clinical criteria or expertise.

DIRECTIONS FOR FUTURE RESEARCH

We need a consensus reference standard for the diagnosis of idiopathic median neuropathy at the carpal tunnel, or we need to use latent class analysis to calculate diagnostic performance characteristics.[28–30] In either case, we should be studying the diagnosis of CTS more as a probability than a certainty, at least in its milder forms. Future work to produce evidence-based clinical prediction rules including both demographic and clinical factors could help focus the use of diagnostic tests on higher-probability patients, which would improve diagnostic performance characteristics and limit false positives that might lead to unnecessary treatment or iatrogenic harm. To avoid bias and overestimation of diagnostic performance characteristics, studies should include a broad spectrum of patients, including a larger proportion expected to be normal.

It is unknown whether we should treat definable and measurable pathophysiology (eg, positive electrodiagnostic testing) or whether diagnosis and management should be primarily guided by patient symptoms and disability. Although they would likely be difficult to perform, useful studies would define the natural history of CTS using young healthy volunteers at baseline and collecting long-term observational data to determine whether electrodiagnostic pathology correlates with the positive clinical findings of CTS.

OUR CURRENT CONCEPTS FOR THIS PATIENT

We routinely perform electrodiagnostic tests in patients with suspected CTS to provide a baseline measure of nerve function and inform the management decision. When electrodiagnostic testing indicates a mild compression, we would discuss management options with the patient, including both nonsurgical (including steroid injection) and operative intervention. If electrodiagnostic tests were normal, we would advise nonsurgical treatment and consider repeating the test if paraesthesia in the median nerve distribution and the presence of a positive Tinel's sign or Phalen test were still present 6 to 12 months later. When a patient presents with advanced atrophy, we forego electrodiagnostic testing before urgent decompression.

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JOURNAL CME QUESTIONS

Diagnosing Carpal Tunnel Syndrome

A 39-year-old woman complains of activity induced and nocturnal paresthesias in the distribution of the median nerve. According to the best available evidence in the literature, which of the following statements is most accurate for diagnosing carpal tunnel syndrome (CTS)?

a. Ninety percent of patients with CTS have positive electrodiagnostic tests.

b. The hand diagram has 95% sensitivity and 92% specificity for diagnosing CTS.

c. Ultrasound has greater sensitivity and specificity as compared to electrodiagnostic testing in diagnosing CTS.

d. Electrodiagnostic testing has statistically significant higher sensitivity and specificity than ultrasound, computed tomography, and magnetic resonance imaging for diagnosing CTS.

e. There is no reference standard for diagnosing CTS.

According to high level-of-evidence studies, the incidence of CTS is related to which of the following?

a. Socioeconomic deprivation has no correlation with the incidence of CTS.

b. Environmental and occupational factors are more prominent, whereas structural, genetic, and biological factors are not associated with CTS.

c. Females are more often affected than males.

d. The mean age of onset of CTS in females is 40 years.

e. The mean age of onset of CTS in in general is 44 years.

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