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What this paper adds?

Even though consensus case definitions using physical examination have been proposed for epidemiological purposes, there is still disagreement about the value of the physical examination in case definitions of CTS for population based studies.
Our study found that diagnostic strategies using physical examination are minimally useful in research case definitions used in population based studies.

Screening for carpal tunnel syndrome in research settings should be based on specific symptoms, with confirmation by nerve conduction study.

Abstract

Objective. We evaluated the utility of physical examination maneuvers in the prediction of carpal tunnel syndrome (CTS) in a population-based research study.
Methods. We studied a cohort of 1108 newly employed workers in several industries. Each worker completed a symptom questionnaire, a structured physical examination, and nerve conduction study. For each hand, our CTS case definition required both median nerve conduction abnormality and symptoms classified as “classic” or “probable” on a hand diagram. We calculated the positive predictive values and likelihood ratios for physical examination maneuvers, in subjects with and without symptoms.
Results. The prevalence of CTS in our cohort was 1.2% for the right hand and 1.0% for the left hand. The likelihood ratios of a positive test for physical provocative tests ranged from 2.0 to 3.3, and those of a negative test from 0.3 to 0.9. The post-test probability of positive testing was less than 50% for all strategies tested.
Conclusion. Our study found that physical examination, alone or in combination with symptoms, was not predictive of CTS in a working population. We suggest using specific symptoms as a first level screening tool, and nerve conduction study as a confirmatory test, as a case definition strategy in research settings.

Carpal tunnel syndrome (CTS) is a common disorder with a prevalence of 1% among adults. [1] Even though consensus case definitions using physical examination have been proposed for epidemiological purposes,[2] there is still disagreement about the value of the physical examination in case definitions of CTS for population based studies.[3-5] We recently studied the validity of physical examination tests for the case definition of CTS in a large worker population and found these tests had poor performance.[6] Here, we highlight the results most relevant to evaluating the inclusion of physical examination findings in research case definitions for CTS in population studies, and suggest a strategy for constructing such a definition.

Methods

We studied a cohort of 1108 newly employed workers in several industries in St. Louis, USA, between July 2004 and October 2006.[7,8] Subjects were eligible if they were newly hired workers over the age of 18 years, starting a new full-time job (over 30 hours per week) or changing from temporary to permanent employment status. Subjects were excluded if they had a current or previous diagnosis of CTS or peripheral neuropathy, if they reported a contraindication to nerve conduction studies, or were pregnant. Pregnant women were not recruited because nerve conduction results are commonly altered by pregnancy. Recruitment occurred during employee orientations, classes at apprenticeship programs, or at the time of employer mandated post-offer, pre-placement screening. Our subjects were recruited from eight employers and three trade unions, representing manufacturing, construction, biotechnology, and healthcare. Testing included a symptom questionnaire, structured physical examination, and nerve conduction studies (NCS) of the median and ulnar sensory nerves bilaterally. Finger symptoms occurring more than 3 times or lasting more than one week in the last year were classified in three levels of specificity for CTS: (1) any symptoms in the fingers; (2) finger symptoms of burning, pain, numbness or tingling ("specific symptoms in fingers"); (3) distribution of symptoms resulting in a rating of "classic" or "probable" for CTS on a Katz hand diagram.[7,9] The physical examination included two common provocative tests for CTS (Phalen's and Tinel's tests), and Semmes-Weinstein sensory testing using a 2.83 mm monofilament to determine sensitivity to light touch. NCS were performed with the NC-Stat automated nerve conduction testing device (NEUROMetrix, Inc., Waltham, MA) and a conservative definition for median nerve abnormality (sensory median-ulnar latency difference $\geq$ 97.5th percentile, or median distal sensory or motor latency > 99.8th percentile).[10]

Our referent case definition of CTS ("gold standard") required a combination of median nerve abnormality and associated symptoms. Symptoms were classified as "classic" or "probable" on a modified hand diagram described by Katz et al.[2] We compared sensitivities and specificities, pre-test and post-test probabilities, and likelihood ratios [11] (LR) of three diagnostic strategies for each hand compared to the case definition reference: 1) symptoms alone, 2) physical examination testing alone, and 3) physical examination only if symptoms were present.

LRs are an alternative statistic for summarizing diagnostic accuracy. LR is the ratio of the probability of a specific test result in people who do have the disease divided by the probability in people who do not. It can be calculated easily from sensitivity and specificity: for a positive test, sensitivity divided by 1 –specificity; for a negative test, 1- sensitivity divided by specificity. Calculation of post-test probabilities were made by applying the LR to the pre-test probability (prevalence) of disease (box 1).[12]

Results

Thus, 2970 potentially eligible workers were invited to join the study and 1108 (37.3%) participated. The cohort included 435 apprentice construction workers, 478 hospital workers (mostly in housekeeping, food service, or laboratory positions), 158 workers in computer or laboratory jobs, and 37 in other positions. There was wide variability in previous work history, with 258 different job titles reported for the job held prior to our study.[8] The study group was 65.1% male, with a mean age of 30.8 years (SD 10.3) and a mean body mass index of 28.5 (SD 6.6).

The prevalence of CTS based on specific symptoms and median nerve abnormalities at the nerve conduction study (reference), in our cohort was 1.2% for the right hand and 1.0% for the left hand. As expected, physical examination alone did not accurately predict CTS; any symptoms in the fingers had higher posttest probabilities and LR than physical examination alone (Table 1). The LR of physical examination was only slightly improved by testing those subjects with finger symptoms. The posttest probability of positive testing, even in subjects with specific symptoms, was far less than 50% (best=33%). If a confirmatory NCS testing strategy was based on questionnaire findings of specific symptoms, it would have led to 97 of 1108 workers receiving NCS (8.8%, 90 right hand, 59 left hand, 2 hands with CTS missed); if based on specific symptoms and Semmes-Weinstein sensory testing, it would have led to 51 NCS (4.6%, 47 right hand, 22 left hand, 10 hands with CTS missed). Even though specificity was high for many tests, there was a low LR for negative testing due to the low pre-test probability of disease (prevalence) meaning that the test did not meaningfully alter the post-test probability of disease.

Discussion

Our study found that physical examination, alone or in combination with symptoms, was not predictive of CTS. Post-test probabilities for all physical examination strategies were far less than 50% when compared to a CTS case definition requiring typical symptoms and median nerve abnormalities. Although some authors have concluded that physical examination is useful for CTS surveillance in epidemiologic studies,[3,4,13] our results and other population based studies of CTS, suggest that physical examination is minimally useful in the case definition of CTS in population based research studies.[2,4,14-16] We suggest using specific symptoms as a first level screening tool, and NCS as a confirmatory test (reference), as a testing strategy for CTS in epidemiologic studies. Actually, our study does not address the utility or yield of physical examination maneuvers in a clinical setting. There are many reviews, books and papers about the utility of physical examination for the diagnosis of carpal tunnel syndrome in the clinical setting.[17-21] Because our data come from a large cohort of workers who had not sought clinical care, our data are relevant to the question of case definition in population studies. These results were based on screening a large population for clinically unreported CTS, and our results may not be applicable to clinical or compensation settings, where the prevalence and severity of disease are higher than in our study population.

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(i) All authors declare that the answer to the questions on your competing interest form are all no and therefore have nothing to declare
(ii) The paper and the data have not previously been published, either in whole or in part (unless as an abstract), and that no similar paper is in press or under review elsewhereThe manuscript has been read and approved by all the authors.
(iii) All authors believe that manuscript is an honest work.
(iv) All authors have participated to the design of the study, analyses, writing and corrections.

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Table 1. Posttest probabilities of a negative test (PostT P-) and of a positive test (PostT P+) and corresponding likelihood ratio (LR- and LR+ respectively).

		PostT P-	PostT P+	LR-	LR+	Ss	Sp
1) Symptoms alone							
Any symptoms in fingers	*Right hand*	0.2%	9.7%	0.2	9.1	84.6%	90.7%
	Left hand	0.0%	14.5%	0.0	16.9	100%	94.1%
Specific symptoms on fingers only	*Right hand*	0.2%	12.2%	0.2	11.7	84.6%	92.8%
	Left hand	0.0%	18.6%	0.0	22.9	100%	95.6%
2) Physical examination testing alone							
Semmes-Weinstein's sensory testing	*Right hand*	0.4%	2.9%	0.3	2.5	76.9%	69.3%
	Left hand	0.6%	2.1%	0.6	2.1	54.5%	74.2%
Phalen's Test	*Right hand*	0.9%	3.8%	0.8	3.3	30.8%	90.7%
	Left hand	0.9%	2.0%	0.9	2.0	18.2%	90.9%
Tinel's Test	*Right hand*	0.9%	2.3%	0.8	2.2	25.0%	88.6%
	Left hand	0.8%	2.5%	0.8	2.6	27.3%	89.4%
3) Physical examination only if symptoms were present							
Semmes-Weinstein if any symptoms in fingers	*Right hand*	0.5%	13.6%	0.4	13.2	61.5%	95.3%
	Left hand	0.5%	20.0%	0.5	24.9	54.5%	97.8%
Phalen if any symptoms if any symptoms in fingers	*Right hand*	0.9%	10.7%	0.8	10.1	23.1%	97.7%
	Left hand	0.8%	10.5%	0.8	11.7	18.2%	98.5%
Tinel if any symptoms if any symptoms in fingers	*Right hand*	1.0%	7.7%	0.9	7.0	15.4%	97.8%
	Left hand	0.7%	21.4%	0.7	27.2	27.3%	99.0%
Semmes-Weinstein if specific symptoms	*Right hand*	0.5%	17.0%	0.4	17.3	61.5%	96.4%
	Left hand	0.5%	27.3%	0.5	37.4	54.5%	98.5%
[2] **Phalen if specific symptoms**	*Right hand*	0.9%	12.0%	0.8	11.5	23.1%	98.0%
	Left hand	0.8%	13.3%	0.8	15.3	18.2%	98.8%
Tinel if specific symptoms	*Right hand*	1.0%	9.1%	0.9	8.4	15.4%	98.2%
	Left hand	0.7%	33.3%	0.7	49.9	27.3%	99.5%

The pretest probability was at 1.2% for right hand and 1.0% for left hand (*ie* prevalence)

Box 1: Calculation of post-test probabilities using likelihood ratios.[12]

Pretest probability = p_1 (ie prevalence)
Pretest odds = $p_1/(1– p_1)$
Posttest odds = (likelihood ratio x pretest odds)= o_2
Posttest probability = $o_2/(1+ o_2)$

For posttest probabilities of a negative test, likelihood ratio of a negative test is used; for posttest probabilities of a positive test, likelihood ratio of a positive test is used