Contralateral electrodiagnosis in patients with abnormal median distal sensory latency

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Abstract

Background We hypothesized that electrodiagnostic evidence of carpal tunnel syndrome (CTS) on the contralateral, less-severe side correlates with disease severity.

Methods We retrospectively reviewed 285 adults that had bilateral electrodiagnostic testing and a median distal sensory latency (DSL) greater than 3.6 ms on at least one side. Variables associated with abnormal contralateral median DSL were analyzed in bivariable and multivariable analysis.

Results Patients with a nonrecordable median DSL on the worst side were significantly more likely to have electrodiagnostic evidence of contralateral CTS compared to patients with a prolonged DSL on the worst side (90 versus 65 %, respectively; $p < 0.001$). Bilateral symptoms were reported by 75 % of patients. The best logistic regression model for electrodiagnostic evidence of contralateral CTS included nonrecordable median DSL of the worst side and polyneuropathy ($p < 0.001$ and $p = 0.14$, respectively).

Conclusions The finding that disease severity relates to the probability of contralateral abnormalities is consistent with the concept that CTS is typically bilateral. Patients with CTS on one side should be advised of the likelihood that it can be present or may develop on the other side.

Keywords Bilateral · Carpal tunnel syndrome · Electrodiagnostic testing · Electromyography · Etiology · Median nerve distal sensory latency

Introduction

Carpal tunnel syndrome (CTS) is an idiopathic median nerve dysfunction at the carpal tunnel. The best available evidence suggests that CTS is a structural, genetically mediated disorder [6]. The available evidence is also consistent with the theory that CTS is inevitably bilateral and progressive [1, 9], although this is difficult to prove. For instance, studies to date have shown that 38 % [2] to more than 50 % [1, 9] of patients with unilateral CTS-related symptoms have electrodiagnostic evidence of CTS on the contralateral, asymptomatic side. In addition, there is a correlation between bilateral CTS-related symptoms and the duration of symptoms [1, 9]. The occurrence of bilateral CTS symptoms is around 60 % in most studies [1, 2, 4, 5, 7, 11, 13], but both higher (87 %) [9] and lower percentages (22 %) [10] have been reported.

This study addresses the primary null hypothesis that patients with a nonrecordable median distal sensory latency (DSL) on electrodiagnostic testing are equally likely to have electrodiagnostic findings suggestive of CTS on the contralateral side when compared to patients with a prolonged, recordable DSL on electrodiagnostic testing. Secondary study questions addressed the percentage of patients with prolonged, recordable and nonrecordable DSL on electrodiagnostic testing that have clinical symptoms of CTS on the contralateral side and the predictors of CTS on the contralateral side.

Methods

Study Design

Using billing records, we identified 602 electrodiagnostic test reports of 599 patients that were referred to our institution for electrodiagnostic testing to rule out CTS between

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November 2006 and June 2010. Electrodiagnostic testing was conducted in clinical setting using a TECA Synergy N2 EMG by Oxford Instruments Medical, Inc. Patients who were (1) 18 years or older; (2) who had electrodiagnostic testing of both hands; and (3) had median nerve DSL greater than 3.6 ms on at least one side were included. Patients were excluded based on the following criteria: (1) systemic inflammatory illness that can involve the upper extremities; (2) trauma of the wrist less than 2 months ago; (3) history of median nerve surgery; and (4) pregnancy. Investigators not involved in patients' care retrospectively studied the medical records. Approval of our Human Research Committee was obtained.

The following variables were recorded from patient's medical records: sex, age at visit, symptomatic side, median nerve DSL, previous electrodiagnostic testing of the upper extremity, myelopathy, stroke, diabetes mellitus, thyroid disease, and wrist fracture of the worst side more than 2 months ago. The presence of the following conditions at time of electrodiagnostic testing or conditions were recorded from electrodiagnostic testing: cubital tunnel syndrome, polyneuropathy, and cervical radiculopathy.

The worst-affected side and the contralateral or least-affected side were defined based on the median nerve DSL on electrodiagnostic testing. The worst-affected side was defined as the side with the most prolonged or nonrecordable median nerve DSL, and subsequently the contralateral side was defined as the side with the least prolonged or normal median nerve DSL. In case of nonrecordable median nerve DSL on both sides, the worst-affected side was determined based on the side with the worst documented clinical symptoms.

Median nerve DSL was considered abnormal and suggestive of CTS if equal to or larger than 3.6 ms. Consequently, median nerve DSL of the worst-affected side was divided into the following categories: (1) prolonged DSL; and (2) nonrecordable DSL. Median nerve DSL of the contralateral side was divided into two categories: (1) normal DSL; and (2) abnormal DSL by combining prolonged and nonrecordable DSL.

Diabetes mellitus was divided into the following categories: (1) no diabetes mellitus; (2) insulin-dependent diabetes mellitus; (3) non-insulin-dependent diabetes mellitus (NIDDM), on diet; (4) NIDDM, treated with oral medications; and (5) NIDDM, treated with insulin. Thyroid disease was divided into the following categories: (1) no thyroid disease; (2) hypothyroidism; (3) hyperthyroidism; and (4) other thyroid disease.

We made the decision to focus on median nerve DSL rather than the overall electrodiagnostic findings because this is the most important factor with the highest predictive value in the diagnosis of CTS [12] and because it would greatly simplify the analysis.

Table 1 Median nerve DSL worst versus contralateral side ($n=285$)

	DSL on worst side				
	Prolonged (<i>n</i> =191)		Nonrecordable (<i>n</i> =94)		
	Number	%	Number	%	<i>P</i> value
DSL on					<0.001
Contralateral Side					
Normal	66	34.6	9	9.6	
Prolonged	125	65.4	50	53.2	
Nonrecordable	0	0.0	35	37.2	

DSL Distal Sensory Latency, *N* Number

Patient Demographics

Three hundred and seventeen electrodiagnostic test reports were excluded based on the inclusion and exclusion criteria, leaving 285 tests. The cohort included 182 women (64 %) and 103 men (36 %). The mean age was 57 (SD 15) years (range, 22 to 90). Two hundred and thirty-three patients (82 %) were newly diagnosed with CTS. The median nerve DSL on the worst side was considered prolonged in 191 cases (67 %) and nonrecordable in 94 cases (33 %).

Statistical Analysis

An a priori sample size calculation using data known from previous research in a chi-square test suggested that a total sample of 82 patients would achieve 90 % power to detect a moderate effect size of 0.36 at a significance level of 0.05.

To determine differences between two categorical variables, we used Pearson chi-square test, except when the cell frequency was less than five, Fisher's exact test was used. To determine differences between continuous and dichotomous variables, we used unpaired *t* tests. To assess predictors of abnormal median nerve DSL on the contralateral side, variables with a *p* value <0.10 were entered into a

Table 2 Clinical symptoms of CTS on contralateral side for DSL on worst side ($n=285$)

	DSL on Worst Side				<i>P</i> value
	Prolonged (<i>n</i> =191)		Nonrecordable (<i>n</i> =94)		
	Number	%	Number	%	
Symptoms on contralateral side					0.68
No	49	25.7	22	23.4	
Yes	142	74.3	72	76.6	

CTS Carpal Tunnel Syndrome, DSL Distal Sensory Latency, *N* Number

Table 3 Bivariable analysis—median nerve DSL on contralateral side ($n=285$)

Parameter	DSL on Contralateral Side						Association	P value
	Normal DSL (n=75)			Abnormal DSL (n=210)				
	Mean	SD	Range	Mean	SD	Range		
Age (years)	52	15	22–90	58	14	27–89		0.0028
	Number		%	Number		%	Association	P value
Median nerve DSL of worst side								<0.001
Prolonged	66		88.0	125		59.5		
Nonrecordable	9		12.0	85		40.5		
Sex							NS	0.98
Male	27		36.0	76		36.2		
Female	48		64.0	134		63.8		
Result of previous electrodiagnostic test (n=39)							NS	0.67
No CTS	3		30.0	6		20.7		
CTS	7		70.0	23		79.3		
Previous CTS							NS	0.56
Yes	12		16.0	40		19.0		
No	63		84.0	170		81.0		
Cubital tunnel syndrome							NS	0.30
Yes	4		5.3	6		2.9		
No	71		94.7	204		97.1		
Cervical radiculopathy							NS	0.99
Yes	3		4.0	9		4.3		
No	72		96.0	201		95.7		
Polyneuropathy							NS	0.076
Yes	2		2.7	19		9.0		
No	73		97.3	191		91.0		
Myelopathy							NS	0.99
Yes	0		0.0	1		0.5		
No	75		100.0	209		99.5		
Cerebrovascular accident							NS	0.99
Yes	2		2.7	6		2.9		
No	73		97.3	204		97.1		
Diabetes mellitus							NS	0.31
IDDM	0		0.0	1		0.5		
NIDDM, on diet	1		1.3	7		3.3		
NIDDM, treated per os	2		2.7	15		7.2		
NIDDM, treated with insulin	3		4.0	16		7.6		
No	69		92.0	171		81.4		
Thyroid disease							NS	0.13
Hypothyroidism	6		8.0	33		15.7		
Hyperthyroidism	3		4.0	3		1.4		
Other thyroid disease	1		1.3	8		3.8		
No	65		86.7	166		79.1		
Wrist fracture of worst side							NS	0.75
Yes	4		5.3	9		4.3		
No	71		94.7	201		95.7		

DSL Distal Sensory Latency, *N* Number, *SD* Standard Deviation, *NS* Not Significant, *CTS* Carpal tunnel syndrome, *IDDM* Insulin-dependent diabetes mellitus, *NIDDM* Non-insulin-dependent diabetes mellitus

Table 4 Multivariable analyses—median nerve DSL ($n=285$)

Parameter	<i>P</i> value	Odds ratio	95 % CI for Odds Ratio	
			Lower	Upper
Contralateral side				
Nonrecordable DSL worst side	<0.001	4.8	2.3	10.3
Polyneuropathy	0.14	3.2	0.7	14.3
Contralateral side only including nonrecordable DSL on worst side				
Nonrecordable DSL worst side	<0.001	5.0	2.4	10.5

DSL Distal Sensory Latency, *N* Number, *CI* Confidence Interval

backwards stepwise logistic regression analysis. A *p* value of <0.05 was considered to be significant.

Results

There was a significant difference in the severity of median nerve DSL on the contralateral side between patients with a prolonged and nonrecordable median nerve DSL on the worst side ($p<0.001$; Table 1).

Clinical symptoms on the contralateral side occurred in 77 % of patients with a nonrecordable median nerve DSL on the worst side and in 74 % of patients with a prolonged median nerve DSL on the worst side ($p=0.68$; Table 2).

In bivariable analysis, median nerve DSL of the worst side and age were significantly associated with median nerve DSL on the contralateral side ($p<0.001$ and $p=0.0028$, respectively; Table 3). Among patients with a recordable median nerve DSL on the worst side, there was a strong positive correlation with the DSL on the contralateral side ($r=0.72$, $p<0.001$). Age, polyneuropathy, and nonrecordable median nerve DSL of the worst side met criteria for inclusion into a multivariable logistic regression model. The best model included nonrecordable median nerve DSL of the worst side which significantly contributed to the model ($p<0.001$) and polyneuropathy which did not significantly contribute to the model ($p=0.14$) and explained 13 % of the variance in abnormal median nerve DSL on the contralateral side (Table 4). A model which only included median nerve DSL of the worst side ($p<0.001$) explained 11 % of the variability in abnormal median nerve DSL on the contralateral side (Table 4).

Discussion

Based on previous research studies, we suspected that electrodiagnostic evidence of CTS on the contralateral, less-

severe side is associated with disease severity and our hypothesis was confirmed. Knowledge about bilateral CTS occurrence and associated factors is important because it could influence the diagnosis and treatment of patients with CTS.

The strengths of this study were that all medical records were reviewed by one research assistant who was not involved in patient care; that 82 % of patients were newly diagnosed with CTS; that all electrodiagnostic tests were conducted in one practice and all results were reported in the same format; and that we had adequate power. Potential shortcomings include reliance on the medical record; focus on the median nerve DSL rather than the overall electrodiagnostic findings; the absence of unilaterally tested patients, even though the vast majority of tests are performed bilaterally in our setting; and the use of cross-sectional data from which prognostic and causal relationships should be drawn with caution. On the other hand, we believe our sample is representative because 51 % of the patients were referred by a hand surgeon at our institution.

Significantly, more patients with a nonrecordable median nerve DSL on the worst side had electrodiagnostic evidence of contralateral CTS compared to patients with a prolonged median nerve DSL on the worst side (90 versus 65 %, respectively) and recordable DSLs correlate side to side. The work of the Italian CTS study group documented the same findings in a small prospective cohort, with the exception that neurophysiology can improve in some patients in the short term (10–15 months), which may represent variations in testing or fluctuation of a progressive disease [8]. The findings of our study should be interpreted in light of the fact that electrodiagnostic tests are typically obtained in patients considering surgery in our practice setting, so the spectrum is towards more severe disease. We also usually test both sides, but perhaps not as consistently as it would be in a prospective cohort study, which introduces some bias towards bilateral disease.

The occurrence of symptoms on the contralateral side is about equal in patients with a nonrecordable or prolonged median nerve DSL (77 versus 74 %, respectively). It is striking that only 70 out of 85 patients (82 %) with a nonrecordable median nerve DSL and electrodiagnostic evidence of contralateral CTS had symptoms on the opposite side. This lack of correspondence between pathophysiology and symptoms means that we cannot rely on patients to gauge the presence or severity of disease [3]. This is particularly important for a disease that seems to be inevitably progressive and can lead to permanent damage of a very important nerve.

Studies have shown a correlation between bilateral CTS-related symptoms and the duration of symptoms [1, 9]. The reported occurrence of bilateral CTS-related symptoms averages 60 % [1, 2, 4, 5, 7, 11, 13] but varies widely from 22 to 87 % [9, 10]. The percentage of bilateral electrodiagnostic

abnormalities in patients with unilateral CTS-related symptoms averages about 50 % (range, 38 to 57 %) [1, 2, 9].

The data from this study and all studies to date—interpreted in context and according to these shortcomings—consistently and compellingly suggest that the more severe the disease, the more likely it will be present on the opposite side and the more advanced it will be on the opposite side. Therefore, we recommend that when a patient presents with unilateral symptoms and the median nerve DSL is nonrecordable, the patient should be educated about the risk of CTS on the opposite side, even if there are no symptoms. We prefer to offer the option of bilateral testing to patients being considered for surgery in order to make them aware of the disease on the other side. In our opinion, this step could prevent patients from coming in later with severe, advanced, likely permanent median nerve damage for which surgery can be disappointing.

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Conflict of interest All named authors hereby declare that they have no conflicts of interest to disclose related to this study.

Ethical statement All authors adhere to the ethical standards described by the Committee on Publication Ethics and the International Committee of Medical Journal Editors. The study was completed under an IRB approved protocol.

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