Longer Distal Motor Latency Predicts Better Outcomes of Carpal Tunnel Release

Jack Tigh Dennerlein, PhD
F. Sharonah Soumekh, MD
Anne H. Fossel
Benjamin C. Amick, III, PhD
Robert B. Keller, MD
Jeffrey N. Katz, MD

The association of preoperative median nerve distal latencies with surgical outcomes of carpal tunnel release is unclear. A total of 109 surgically treated workers with carpal tunnel syndrome across the state of Maine completed questionnaires assessing preoperative levels of symptom and functional limitations and general physical health (SF-12). A second questionnaire assessed the 6-month postoperative outcomes of symptom severity, functional limitations, and satisfaction with surgery. Univariate analyses indicated that longer preoperative distal motor and sensory latencies were associated with less postoperative levels of symptom, less postoperative functional limitations, and more satisfaction with surgery. The associations persisted in multiple linear regression analysis; however, better general health preoperatively was a better predictor of favorable outcomes. The results suggest that workers with prolonged preoperative distal motor latencies and who are in good general health preoperatively have a higher rate of successful carpal tunnel release surgery. (J Occup Environ Med. *2002;44:176–183*)

From Environmental Health, Harvard University, School of Public Health (Dr Dennerlein, Dr Katz); Anesthesiology, Perioperative, and Pain Medicine (Dr Soumekh), and Rheumatology, Immunology, and Allergy (Ms Fossel, Dr Katz), Brigham and Women's Hospital; the University of Texas, School of Public Health (Dr Amick); the Institute for Work and Health, Toronto (Dr Amick); and the Maine Medical Assessment Foundation (Dr Keller).

Address correspondence to: Jack Tigh Dennerlein, PhD, Harvard University, 665 Huntington Avenue, Boston, MA 02115; jax@hsph.harvard.edu.

Carpal tunnel syndrome (CTS) is among the top 10 occupational injuries and illnesses associated with work disability in the US workforce in terms of both reported frequency and days away from work. In 1994, over 39,000 work-related cases were reported, at an incidence rate of 4.8 new cases per 10,000 workers. These cases represented a median of 20 days away from work.[1] Carpal tunnel release is a well-established treatment for CTS and is usually performed after the failure of conservative therapies, such as activity modification, use of splints, and corticosteroid injection. However, the surgical procedure is not always successful in reducing symptoms. Many factors other than the technical success of surgery can affect the extent of pain relief and functional improvement after the procedure. For example, symptoms and function may fail to improve or may reoccur among patients who return to a job without altering the exposure to the physical risk factors.[2] Better data on the associations between specific presurgical clinical variables and surgical outcomes would help physicians and patients decide whether to proceed with carpal tunnel surgery.

Nerve conduction tests are often considered the definitive diagnostic test for CTS. Longer distal sensory and motor latencies (DSL and DML, respectively) reflect worse nerve dysfunction. However, findings in the literature on whether and how presurgical nerve conduction tests are associated with surgical outcomes are inconsistent.[2–8] Some studies conclude that preoperative

nerve conduction testing is not a useful indicator of surgical outcomes,[2,5] whereas others suggest that worse distal latencies may be associated with better surgical outcomes.[3,7] One prospective study did find that worse distal latencies were associated with better outcomes. However, this study included a limited number of potential confounders.[3] To clarify this issue, we analyzed data from a prospective observational study of patients undergoing carpal tunnel release,[9] with a broad range of clinical and sociodemographic variables that might be associated with the surgical outcome. The goal of the analysis is to test the null hypothesis that preoperative distal latencies of the median nerve are not associated with the level of upper extremity symptom, functional limitations, and satisfaction with surgery.

Methods

The data used in these analyses were obtained from the Maine Carpal Tunnel Study II, a prospective observational community-based study of patients who underwent carpal tunnel release between April 1997 and October 1998 in the state of Maine. The goal of the Maine Carpal Tunnel Study II study was to examine in detail a multidimensional model of the predictors of clinical and occupational disability after carpal tunnel release.[10] The details of the forerunner study, Maine Carpal Tunnel Study I, are presented in Keller et al[11] and Katz et al.[12]

Patients were eligible for enrollment if they presented to 1 of 15 participating surgeons—representing orthopedic, plastic surgery, and neurosurgical specialties—with symptoms including numbness or tingling in at least two of the first four digits (the thumb and the first three fingers) of at least a 1-month duration. Furthermore, the physician had to have the diagnostic impression of CTS, and the diagnosis had to be confirmed in each case by nerve conduction testing. Patients had to have been employed at least 20 hours per week at the time symptoms developed. Finally, patients must have been scheduled for carpal tunnel release. Subjects were excluded if they were younger than 18 years of age, had previous carpal tunnel release of the same side, or were pregnant, retired, or full-time students.

Eligible patients completed questionnaires preoperatively and at 2, 6, and 12 months postoperatively. The Brigham and Women's Hospital Human Investigations Committee approved the protocol. Of the patients referred to the coordinating center, 197 agreed to participate in the study and completed baseline preoperative questionnaires. At 6 months postoperatively, 158 (80%) completed a similar follow-up questionnaire. The age of the patients ranged from 22 to 74 years (average, 45 years; SD, 10 years). It is not possible to estimate the proportion of potentially eligible patients who were referred, because we do not have an accurate count of the number of eligible patients seen during the study period. However, Keller et al[11] demonstrated that this community-based strategy yielded a sample of surgically treated patients that was representative of all CTS patients operated on in Maine with respect to age, sex, and other social and demographic variables.

The surgical outcome measures were defined as symptom severity, upper extremity functional limitations, and satisfaction with surgery. These factors were assessed by questionnaire at 6 months with reliable, valid scales.[13,14] The questionnaires contained seven symptom items, eight function items, and eight satisfaction items. Each item was rated from 1 (no symptom, no difficulty, complete satisfaction) to 5 (very severe symptom, so much difficulty subject could not perform the activity, or very dissatisfied). For purposes of analysis, the scales were transformed to range from 0 (best) to 4 (worse). Cronbach's alpha reliability coefficients in this cohort were 0.8 and 0.9 for the symptom severity and functional limitations scales, respectively. General physical health status was assessed with the Physical Component Scale (PCS-12) of the short form health survey.[15] The PCS ranges between 0 (poor) and 100 (excellent physical health). The questionnaire also asked participants about musculoskeletal pain or discomfort in other parts of the body, including hands, wrists, forearms, elbows, shoulders, neck, and back. We summed the number of discrete self-reported sites of upper extremity, neck, and back pain to assess musculoskeletal comorbidity. The questionnaire included portions of the Karasek-Theorell Job Content Questionnaire, which generates scales of mental workload (psychological job demands), decision latitude, and social support from coworkers and supervisors.[16] The questionnaires also assessed sociodemographic variables, including age, sex, income, education, and workers' compensation status.

Electrophysiologic data were collected preoperatively for all study participants by examining reports from the 24 different nerve-conduction testing sites that evaluated patients in the cohort. Reports from the clinics ranged from detailed data worksheets to qualitative reports that simply confirmed the CTS diagnoses. For the detailed reports, preoperative DML data were reported for 129 of the patients who completed a baseline questionnaire and 109 of the patients who completed the 6-month questionnaire. The reported DML values ranged from 3.0 to 10.3 msec (average, 5.4 msec; SD, 1.5 msec). Within these detailed reports, DML was consistently defined as the time from the stimulus to the onset of the nerve signal. For the detailed reports, DSL data existed for 114 of the patients who completed the baseline questionnaire and 97 of the patients who completed the 6-month questionnaire. DSL was defined as the time from the stimulus to the onset of the nerve signal. When a distal sensory wave was detected, the reported DSLs ranged from 1.6 to

6.5 msec (average, 3.8 msec; SD, 1.0 msec). Twenty-three patients reported an absent sensory signal.

When both DML and DSL data existed ($n = 95$), the results were assigned a category severity level based on Pauda et al[17] and Stevens et al.[18] Table 1 presents the definitions for the severity levels and the number of cases that were assigned to each level.

The bivariate associations between the preoperative nerve conduction variables and the 6-month surgical outcomes were assessed by Spearman correlation coefficients. Similarly, the nerve conduction variables and 6-month surgical outcome measures were also compared with other baseline variables. For dichotomous variables, *t* tests were performed for the outcome variables and the nerve conduction variables. Linear regression analyses further examined the association between DML and each of the outcome measures while adjusting for other variables also associated with the outcome measures at *P* values of 0.05 or less. All analyses were performed in SAS™ (SAS Computing Software, Cary, NC).

Results

Longer preoperative distal latencies of the median nerve at the wrist were associated with better 6-month surgical outcomes (Table 2). The Spearman correlation coefficients indicate that longer distal motor and sensory latencies were associated with less postoperative levels of symptom severity and functional limitations and greater satisfaction with surgery. Figure 1 illustrates the association between better outcome measures and longer DMLs. Figure 2 illustrates that, on average, patients

TABLE 1
Nerve Conduction Test Severity Categories*

No.	CTS Severity	DSL (msec)	DML (msec)	No. of Cases†
0	Normal	< 2.2	< 4.4	2
1	Mild	≥ 2.2	< 4.4	14
2	Moderate	≥ 2.2	≥ 4.4	56
3	Severe	Absent	≥ 4.4	23
4	Extreme	Absent	Absent	0

* CTS, carpal tunnel syndrome; DSL, distal sensory latency; DML, distal motor latency.
† Number of patients who completed the 6-month questionnaire and had both DSL and DML data.

TABLE 2
Spearman Correlation Coefficients (SCC) and *P* Values of the Outcome Measures With Preoperative Variables[a]

Variable	Symptom Severity at 6 Months[b] SCC	*P*	Functional Limitations at 6 Months[b] SCC	*P*	Surgery Satisfaction[b] SCC	*P*	Interpretation
DML	−0.33	0.001	−0.23	0.01	−0.34	0.00	Worse DML, better outcome
DSL	−0.13	0.19	−0.03	0.76	−0.17	0.10	Worse DSL, better outcome
Classification	−0.14	0.15	−0.05	0.65	−0.23	0.02	Worse Class, better outcome
Symptom severity at 6 months[b]	–		–		–		
Functional limitations at 6 months[b]	0.88	0.00	–		–		Outcomes are highly correlated with one another
Surgery satisfaction at 6 months[b]	0.82	0.00	0.76	0.00	–		
Physical Health (PCS-12)[c]	−0.41	0.00	−0.52	0.00	−0.40	0.00	Healthier patients, better outcome
Income[d]	−0.34	0.00	−0.33	0.00	−0.34	0.00	Higher income, better outcome
Working at baseline[e]	−0.14	0.10*	−0.21	0.01**	−0.11	0.20	Working at baseline, better outcome
Social support at work	−0.16	0.06	−0.24	0.004	−0.13	0.13	More support at work, better outcome
Education[e]	−0.22	0.01**	−0.25	0.004**	−0.21	0.01**	Attended college, better outcome
Female[e]	0.02	0.86	0.08	0.34	−0.05	0.58	No correlation
Age	−0.01	0.87	0.03	0.74	−0.03	0.76	No correlation
Symptoms severity at baseline[b]	0.13	0.14	0.13	0.13	0.12	0.19	No correlation
Other MSDs	0.17	0.05	0.23	0.01	0.20	0.02	Other MSDs, worse outcome
Control of job	0.20	0.02	0.23	0.01	0.26	0.003	Less control, worse outcome
Attorney[e]	0.22	0.01*	0.19	0.03*	0.18	0.04*	Having an attorney, worse outcome
WC[e]	0.22	0.01**	0.21	0.01**	0.32	0.00**	On WC, worse outcome
Functional limitations at baseline[b]	0.25	0.004	0.36	0.00	0.29	0.001	Worse baseline limitations, worse outcome

[a] DML, distal motor latency; DSL, distal sensory latency; PCS, Physical Component Scale; MSDs, musculoskeletal disorders; WC, worker's compensation.
[b] Values ranged from 0 to 4, with 0 being no reports or completely satisfied and 4 being worse or very dissatisfied.
[c] Values ranged from 0 to 100, with higher scores indicating better general health.
[d] Categorical value (6-levels) depicting increasing income ranges of $10,000 increments.
[e] Binary, dichotomous variables, with 1 being an affirmation of the condition. Results also confirmed with *t* tests: *P* values denoted as * $P < 0.05$, ** $P < 0.01$.

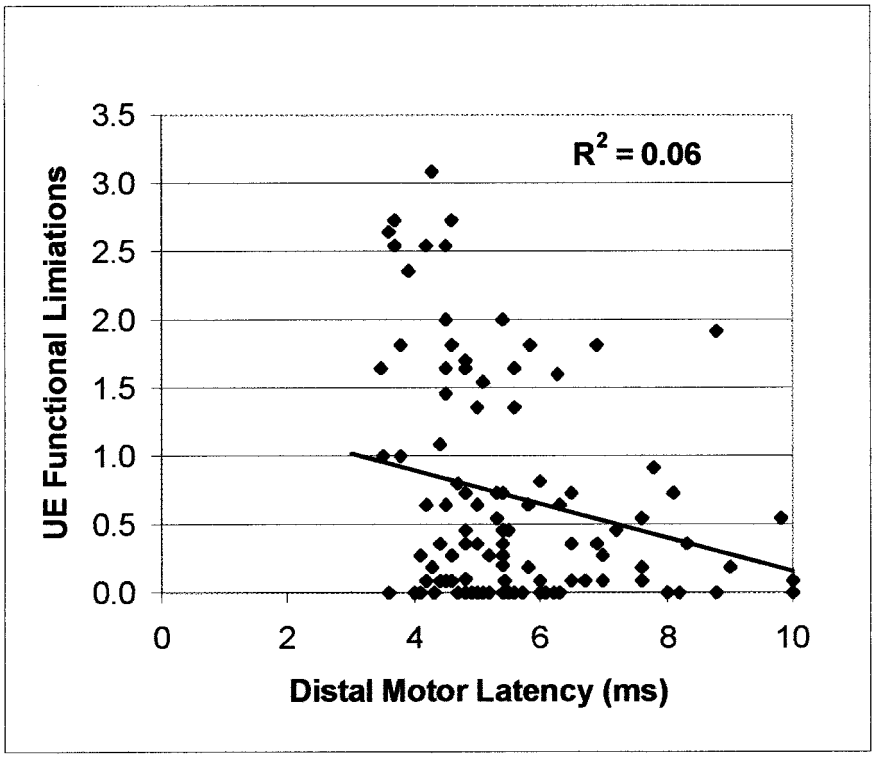

Fig. 1. Self-reported functional limitation of the upper extremity (UE) at 6 months versus the distal motor latency (DML). Functional limitation level was the average of eight questions with 0 to 4 responses, 0 corresponding to no limitations. As the DML becomes more prolonged, the level of postoperative functional limitations decreases.

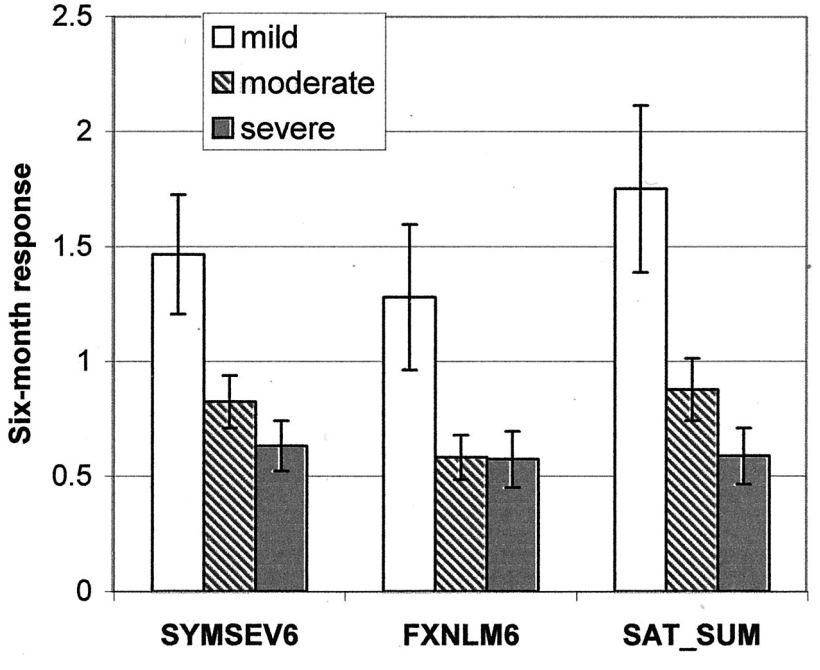

Fig. 2. Mean values with error bars representing 1 standard error of the three outcome measures (symptom severity [SYMSEV6], upper extremity functional limitations [FXNLM6], and satisfaction of surgery [SAT_SUM]) over the reported levels of nerve impairment, as defined by Table 1. As the preoperative impairment classification—a combined measure of both the distal motor latency and the distal sensory latency—worsens, the outcome measures improve.

with more severe electrophysiologic impairment, as defined by the nerve impairment classification in Table 1, have better surgical outcomes. Figure 3 illustrates that patients with more severe electrophysiologic impairment had greater improvement from the preoperative to the 6-month postoperative evaluation in the self-reported levels of symptoms and functional limitations. Table 2 indicates that, along with more prolonged DML, other preoperative variables associated with better surgical outcomes included better general physical health (PCS-12), higher income, working at the time of surgery, having good social support at work, control over one's job, and having attended college. Factors associated with worse surgical outcomes were the presence of other musculoskeletal disorders, hiring an attorney, receiving workers' compensation, and worse functional limitations of the upper extremity at baseline just before surgery.

The distal motor and sensory latencies were not significantly correlated with the preoperative symptom severity and upper extremity functional limitations (Table 3). The distal motor latencies were strongly negatively correlated with the presence of other musculoskeletal disorders (Table 3). That is, subjects with shorter (better) distal motor latencies had a higher prevalence of other musculoskeletal disorders. Furthermore, patients in good general physical health preoperatively in general had longer distal motor latencies. Parameters associated with both prolonged distal motor latencies and unfavorable 6-month outcome measures included poor general health (PCS-12), receiving workers' compensation, and burden of other musculoskeletal disorders.

Multiple linear regressions were performed to assess the independent associations between preoperative distal motor latency and 6-month symptom severity and functional limitation, adjusting for other factors that could influence these outcomes.

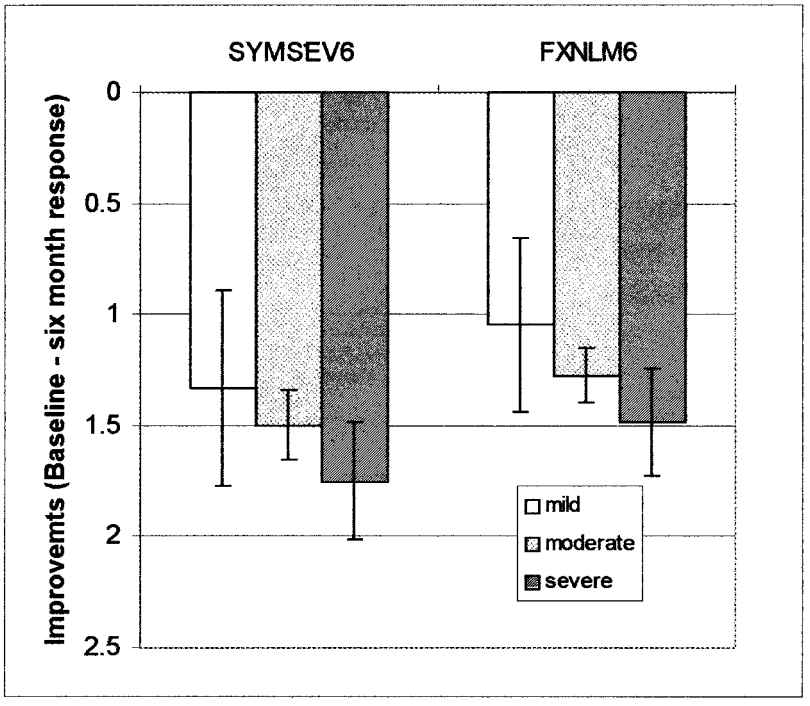

Fig. 3. Mean improvements (the 6-month response is subtracted from the preoperative baseline response) with error bars representing 1 standard error of the two outcome measures (symptom severity [SYMSEV6] and upper extremity functional limitations [FXNLM6]) over the reported levels of nerve impairment as defined by Table 1. Again, as the preoperative impairment classification worsens, the outcome measures improve.

TABLE 3
Spearman Correlation Coefficients (SCC) and *P* Values Between Other Preoperative Variables and Nerve Conduction Variables[a]

	DML		DSL		Classification	
Variable	SCC	*P*	SCC	*P*	SCC	*P*
Female[b]	0.04	0.64	0.08	0.38	−0.04	0.68
Functional limitations at baseline	0.08	0.39	0.19	0.05	0.01	0.95
Symptoms severity at baseline	0.09	0.34	0.16	0.09	0.08	0.38
Other MSDs	−0.19	0.03	−0.08	0.37	−0.07	0.44
Workers' compensation	−0.19	0.02*	−0.16	0.06*	−0.21	0.01*
Physical health (PCS12)	0.21	0.02	0.07	0.42	0.19	0.03
Age	0.23	0.01	0.25	0.01	0.20	0.03

[a] DML, distal motor latency; DSL, distal sensory latency; MSD, musculoskeletal disorders; PCS-12, Physical Component Scale.

[b] Binary, dichotomous variables, with 1 being an affirmation of the condition. Results also confirmed with *t* tests: *P* values denoted as * $P < 0.05$.

Table 4 presents the beta coefficients for the distal motor latency from these regression analyses. First, we regressed the 6-month postoperative symptom severity and functional limitations against DML. Then we regressed these 6-month outcomes against DML and the other covariates, including the preoperative values of functional limitations of the upper extremity, education level, working at baseline, income, general physical health (PCS-12), and the presence of other musculoskeletal disorders. These variables were included in the model because they had strong correlations with the outcome and DML as shown on Tables 2 and 3. In these models, the significant predictors of worse symptom severity were lower DML ($\beta = -0.11$, $P = 0.04$), lower income ($\beta = -0.19$/$10,000 income intervals, $P = 0.01$), and worse general physical health ($\beta = -0.28$/10 points of PCS-12, $P = 0.003$). The significant predictors of worse functional limitations were worse general physical health ($\beta = -0.33$/10 points of PCS-12, $P = 0.0001$) and ever receiving workers' compensation benefits ($\beta = 0.41$, $P = 0.01$). DML had a borderline association ($\beta = -0.07$, $P = 0.12$) with postoperative functional limitations. To determine whether the association between DML and outcome was explained by PCS-12, we removed the PCS-12 and indeed found that the association was stronger (Table 4). This finding suggests that PCS-12 mediates some of the effect of DML on outcomes. In summary, the associations between longer DML and less severe symptoms and functional limitations documented at 6 months in univariate analysis persisted in multivariable models but were somewhat weaker when adjusted for other covariates. PCS-12 seems to explain some of the effect of DML on the outcomes.

Figures 4 and 5 show the separate effects of DML and PCS-12 on the outcomes of surgery. The figures show that PCS-12 has a stronger effect than DML. In predicting functional limitations, a DML greater than 6 msec seems to be associated with better function only in patients who have poor general physical health (PCS-12 less than the median). However, the formal test for an interaction had a *P* value of 0.12, indicating that the interaction failed to reach statistical significance. In contrast, a DML greater than 6 msec seems to be associated with less severe postoperative symptoms, irrespective of the level of preoperative PCS-12. The formal test for an interaction between PCS-12 and DML had a *P* value of 0.62, indicating there was no evidence of an interaction whatsoever.

TABLE 4
Summary of Models for Associations Between 6-Month Outcomes and Preoperative DML: Regression Beta Coefficients (β) and *P* Values for DML[a]

	6-Month Symptom Severity		6-Month Functional Limitations	
Model	**β**	***P***	**β**	***P***
Univariate regression	−0.17	0.001	−0.12	0.01
Fully adjusted multivariate regression[b]	−0.11	0.04	−0.06	0.13
Fully adjusted multivariate regression[b] without PCS-12	−0.12	0.02	−0.08	0.07

[a] For definition of abbreviations, see Table 3.
[b] Other parameters included in the regression were general physical health, college, income, workers' compensation, other musculoskeletal disorders, working at baseline, control of job, hired an attorney, social support at work, and baseline functional limitations.

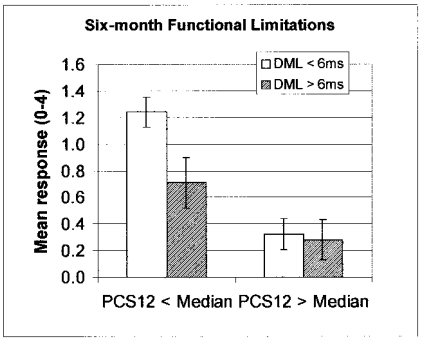

Fig. 4. Mean values with error bars representing 1 standard error of the self-reported functional limitation of the upper extremity at 6 months, divided into four populations as indicated. The participants are divided into those with and without extremely prolonged distal motor latency (DML > 6 ms) and then those with a general health index (PCS-12) above or below the median. Outcome measures improve with both prolonged DML and better general health; however, the effects of DML are more evident with those patients with low PCS-12 scores.

Discussion

In this prospective observational cohort study of workers undergoing carpal tunnel release, more severe preoperative nerve conduction abnormalities were associated with better surgical outcomes. Longer distal motor and sensory latencies were correlated with less severe symptoms and fewer functional limitations of the upper extremity and with higher levels of overall satisfaction with the surgery measured 6 months postoperatively. These findings largely persisted after adjustment for covariates. The association between DML and outcomes was not especially strong, and, as shown in Fig. 1, the outcomes were particularly heterogeneous for patients with mild nerve impairment (DML values less than 6 msec).

These findings may seem paradoxical. One might suspect that a longer DML, indicating more severe damage to the nerve, would be associated with less success from surgical decompression because of residual nerve damage. However, as shown in Table 1, most patients in the cohort had mild-to-moderate nerve conduction impairments. This may have occurred because participants were workers who used their hands in their work and likely sought treatment before the impairments became advanced enough to create permanent axonal damage.

At less severe levels of nerve conduction impairment, one might assume the nerve would more readily heal. However, in these cases with minimal nerve conduction impairment, symptoms may arise largely from conditions other than entrapment of the median nerve at the wrist. For these cases, carpal tunnel release would be of less benefit.

The data here support the supposition that the outcome of carpal tunnel surgery is affected by many factors. Table 2 indicates that several other baseline parameters were highly correlated with the outcome measures, as demonstrated previously.[19] For example, both higher income and better general physical health preoperatively were correlated with better outcomes. Factors correlating with worse outcomes included the existence of other musculoskeletal disorders and worse baseline functional status. The DML was also correlated with some of these factors (Table 3), raising the issue of confounding effects. The effect of DML on these outcomes persisted in multivariate analyses that adjusted for relevant covariates. However, the regression coefficients were smaller and less significant in regressions that adjusted for covariates, indicating some confounding (Table 4).

The most prominent prognostic factor was a patient's preoperative general physical health score (PCS-12). As shown in Fig. 4, general physical health and DML both influenced the functional limitation outcome; however, DML had little effect for those with better general health scores. The effect of DML on 6-month postoperative functional limitation was striking in patients with lower PCS-12 values. The formal test for an interaction failed to reach statistical significance, however ($P = 0.12$). There was no suggestion of an interaction between PCS-12 and DML in predicting 6-month postoperative symptom severity scores (Fig. 5). At both high and low levels of PCS-12, a more prolonged DML was associated with better outcome. In general, postoperative symptom severity was more strongly associated with DML than postoperative functional limitations (Table 2). This finding may reflect that symptom severity included patients' reports of symptoms, numbness, and pain, all of which are direct results of CTS. Alternatively, upper extremity functional limitation can

be affected by other musculoskeletal and medical conditions.

Previous studies have reported mixed conclusions regarding the relationship between the preoperative latencies and carpal tunnel release outcomes (Table 5). Studies that did not show effects may not have had a large range of latencies or outcomes to detect associations between latencies and the outcomes. If we limit our analysis to those who have distal motor latencies below 6 msec, then there seems to be little affect of DML on the outcome measures (Fig. 1). In addition, this study used validated continuous outcome measure.[14] Other studies have used categorical outcome measures, which may have decreased their sensitivity to detecting differences. Furthermore, this study was unique in its attempt to identify other factors that confound or mediate the associations between nerve conduction and surgical outcomes. We found, for example, that patients with worse general preoperative health have less severe nerve dysfunction and worse outcomes.

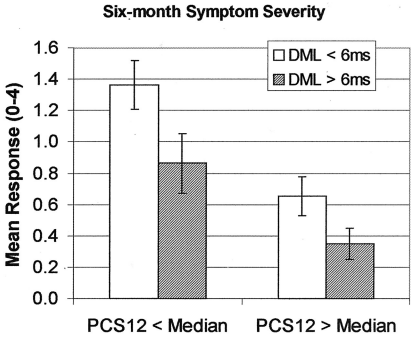

Fig. 5. Mean values with error bars representing 1 standard error of the self-reported function symptom severity at 6 months divided into four populations as indicated. The participants are divided into those with and without extremely prolonged distal motor latency (DML > 6 ms) and then those with a general health index (PCS-12) above or below the median. Outcome measures improve with both prolonged DML and better general health. The effect of DML is evident in patients with lower and higher PCS-12 scores.

Strengths of this study include the use of validated outcomes, prospective design, and community-based recruitment of working patients enrolled by several physicians across the state of Maine, minimizing selection bias associated with single clinic cohorts. Along with these strengths, the study also had some limitations. Standard nerve conduction data were collected at many different electrophysiology clinics, each with specific protocols. This potential source of misclassification would bias the results toward the null. Furthermore, the size of the cohort was relatively small, with only 109 patients with specific DML data included in both the baseline and 6-month questionnaires.

In conclusion, the results suggest that patients diagnosed with CTS who have moderately prolonged distal motor latencies benefit the most from carpal tunnel release. The outcomes become less pronounced or predictable when a patient's DML is only mildly prolonged. Other factors associated with successful surgical outcomes include better general health and the lack of other musculoskeletal disorders. These results should help clinicians and patients develop appropriate outcome expectations of carpal tunnel release.

Acknowledgments

The authors appreciate the many patients and their physicians who participated in this study. The authors also thank the staff at the Maine Health Information Center for expert data collection and data management, including Nancy Mooney and Valerie Soucie. This study was funded by a Clinical Science Grant from the Arthritis Foundation and grants from the National Institutes of Health (P01 AR36308, K24 AR02123) and a grant from

TABLE 5
Previously Reported Studies Investigating Preoperative Nerve Conduction Tests[a]

Ref.	*n*	Population	Design	Neurological Data	Outcome Measures	Conclusions
2	112	General; 2 surgeons	Retrospective	Categorical (2 levels)	Categorical (3 levels)	NCT not a factor
3	128	General	Prospective: preop, 3 and 6 months	Continuous and categorical	Categorical (2 self-reported levels)	Worse DL, better outcome
4	45	General	Retrospective: 0.2–8 years	Categorical	Categorical (4 levels)	NCT not a factor
5	60	General; 1 surgeon	Retrospective: 6–33 months	Categorical (3 levels)	Categorical (3 levels)	NCT not a factor
6	124		Retrospective: >6 months	Continuous	Categorical (3 levels)	Worse DL, better outcome
7	93	Workers; 6 surgeons	Retrospective: 6–100 months	Continuous and categorical (2 levels)	Categorical (2 levels)	Worse DL, better outcome
8	73	General	Retrospective: <2 years	Categorical (2 levels)	Categorical (3 levels)	NCT not a factor
This study	109	Workers; 15 surgeons	Prospective: preop and 6 months	Continuous	Continuous (self-reported)	Worse DL, better outcomes

[a] NCT, nerve conduction test; DL, distal latency.

the National Institute for Occupational Safety and Health (5R01-OH-03523).

References

1. Courtney TK, Webster BS. Disabling occupational morbidity in the united states: an alternative way of seeing the Bureau of Labor Statistics' data. *J Occup Environ Med*. 1999;41:60–69.
2. Al-Qattan MM, Bowen V, Manktelow RT. Factors associated with poor outcome following primary carpal tunnel release in non-diabetic patients. *J Hand Surg [Br]*. 1994;19:622–625.
3. Atroshi I, Johnsson R, Ornstein E. Patient satisfaction and return to work after endoscopic carpal tunnel surgery. *J Hand Surg [Am]*. 1998;23:58–65.
4. Nau HE, Lange B, Lange S. Prediction of outcome of decompression for carpal tunnel syndrome. *J Hand Surg [Br]*. 1988; 13:391–394.
5. Yu GZ, Firrell JC, Tsai TM. Preoperative factors and treatment outcome following carpal tunnel release. *J Hand Surg [Br]*. 1992;17:646–650.
6. Harris CM, Tanner E, Goldstein MN, Pettee DS. The surgical treatment of the carpal-tunnel syndrome correlated with preoperative nerve-conduction studies. *J Bone Joint Surg Am*. 1979;61:93–98.
7. Higgs PE, Edwards DF, Martin DS, Weeks PM. Relation of preoperative nerve-conduction values to outcome in workers with surgically treated carpal tunnel syndrome. *J Hand Surg [Am]*. 1997;22:216–221.
8. Kulick MI, Gordillo G, Javidi T, Kilgore ES, Newmeyer WL. Long-term analysis of patients having surgical treatment for carpal tunnel syndrome. *J Hand Surg [Am]*. 1986;11:59–66.
9. Amick BC III, Habeck RV, Hunt A, et al. Measuring the impact of organizational behaviors on work disability prevention and management. *J Occup Rehabil*. 2000; 10:21–38.
10. Katz JN, Lew RA, Bessette L, et al. Prevalence, and predictors of long-term work disability due to carpal tunnel syndrome. *Am J Ind Med*. 1998;33:543–550.
11. Keller RB, Largay AM, Soule DN, Katz JN. Maine Carpal Tunnel Study: small area variations. *J Hand Surg [Am]*. 1998; 23:692–696.
12. Katz JN, Keller RB, Simmons BP, et al. Maine Carpal Tunnel Study: outcomes of operative and nonoperative therapy for carpal tunnel syndrome in a community-based cohort. *J Hand Surg [Am]*. 1998; 23:697–710.
13. Levine DW, Simmons BP, Koris MJ, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg [Am]*. 1993; 75:1585–1592.
14. Katz JN, Punnett L, Simmons BP, Fossel AH, Monney N, Keller RB. Workers' compensation recipients with carpal tunnel syndrome: the validity of self-reported health measures. *Am J Public Health*. 1996;86:52–56.
15. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992;30:473–483.
16. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick BC III. The Job Content Questionnaire (JCQ): an instrument for international comparative assessments of psychosocial job characteristics. *J Occup Health Psychol*. 1998; 3:322–355.
17. Pauda L, Lomonaco M, Gregori B, Valente EM, Pauda R, Tonali P. Neurophysiological classification and sensitivity in 500 carpal tunnel syndrome hands. *Acta Neurol Scand*. 1997;96:211–217.
18. Stevens JD, Witt JC, Smith BE, Weaver AL. The frequency of carpal tunnel syndrome in computer users at a medical facility. *Neurology*. 2001;56:1568–1570.
19. Katz JN, Losina E, Amich BC, Fossel AH, Bessette L, Keller RB. Predictors of outcomes of carpal tunnel release. *Arthritis Rheum*. 2001;44:1184–1193.