A PROSPECTIVE QUESTIONNAIRE STUDY OF PATIENTS WITH SUSPECTED CARPAL TUNNEL SYNDROME REFERRED TO A UNIVERSITY HOSPITAL ELECTRODIAGNOSTIC LABORATORY: A COMPARISON OF SELF-REPORTED SYMPTOMS AND NCS FINDINGS

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A prospective questionnaire study of patients with suspected carpal tunnel syndrome referred to a university hospital electrodiagnostic laboratory: a comparison of self-reported symptoms and NCS findings

by

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Abstract:

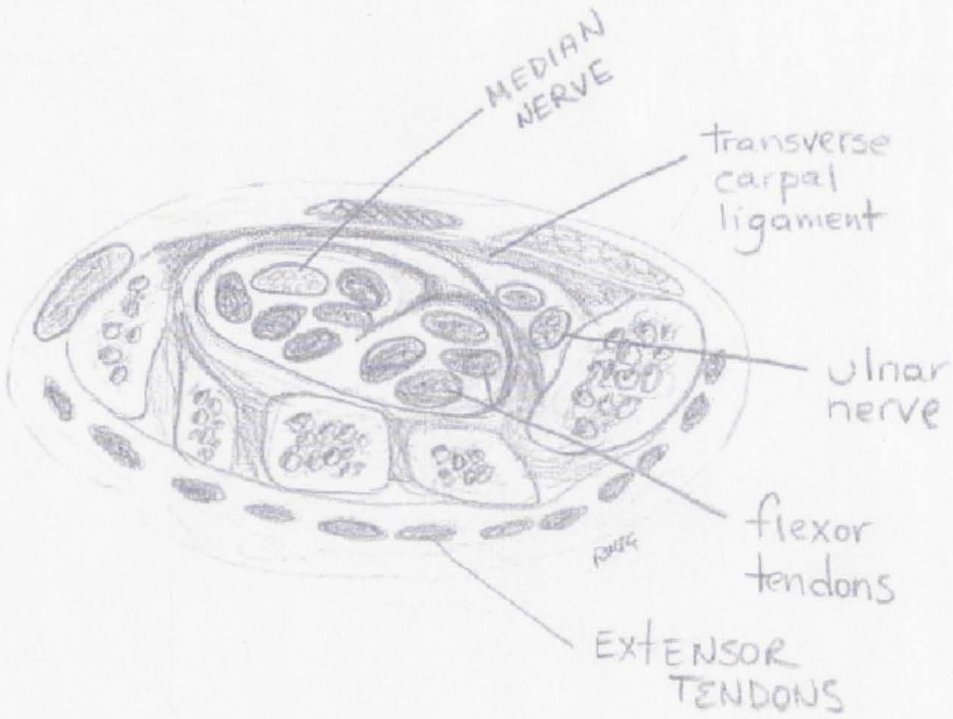
The primary objective of this prospective questionnaire study was to determine whether self-reported symptoms were predictive of nerve conduction study (NCS) results. The population consisted of 211 unselected patients with clinically suspected carpal tunnel syndrome (CTS) who were physician referred for confirmatory NCS. These patients were administered a pre-NCS questionnaire. Patients reported 350 symptomatic hands, and 72 asymptomatic hands. A comparison of symptom lateralization and bilateral NCS results was performed. Standardized electrophysiologic criteria were applied. In symptomatic hands, 49.2% of NCS studies reported median mononeuropathy, while, 50.8% were negative. In asymptomatic hands, 37.5% of NCS studies showed median mononeuropathy, the remaining 62.5% were negative. Overall accuracy of NCS compared to symptoms was 51.4%, with a sensitivity of 86.4%, specificity of 20.1%, positive predictive value of 49.1% and negative predictive value of 62.5%. These comparisons do not support a strong relationship between clinical symptoms and NCS results in this patient group.

Abbreviations:

CTS	carpal tunnel syndrome
NCS	nerve conduction study
CTR	carpal tunnel release
BMI	body mass index (kg/m^2)
msec	millisecond
mo	month
yr	year
kg	kilogram
m	metre
EMG	electromyogram
RUH	Royal University Hospital
SDH	Saskatoon District Health
NSAIDs	non-steroidal anti-inflammatory drugs
ASA	acetylsalicylic acid
cm	centimetre
WCB	workman's compensation board
SD	standard deviation
CI	confidence intervals
mmHg	millimeters of mercury (units for measurement of tissue pressure)
RA	rheumatoid arthritis
DM	diabetes mellitus
ROC	receiver operator characteristic

Figure 1.1.1

The Anatomy of the Carpal Tunnel



boundaries. Ten structures have passage through the carpal tunnel: eight flexor tendons to the four fingers, the flexor pollicis longus tendon and the median nerve [9].

The basic pathophysiologic abnormality in carpal tunnel compressive neuropathy is understood to be one of increased pressure in the carpal tunnel. The tissue pressure studied by wick catheter techniques within a compartment of a limb is 7-8 mmHg under normal circumstances. In carpal tunnel syndrome the pressure is often 30 mmHg, which

is close to the level at which nerve dysfunction occurs [10, 11]. Flexion or extension of the wrist may result in pressure increases to 90 mmHg or more in carpal tunnel syndrome. These pressures can have a two–fold effect on the nerve. The magnitude of the pressure increase can result in ischemia. Supporting this premise is the finding that systemic blood pressure influences the tissue pressure threshold at which nerve dysfunction occurs. In a study of normotensive and hypertensive subjects, tissue pressure thresholds at which median nerve sensory responses were completely blocked varied from 40-50 mmHg for the normotensive to 60-70mmHg for the hypertensive. The tissue pressure threshold was consistently 30mmHg below diastolic blood pressure [12]. Chronic increased pressures and mechanical stress can also result in focal demyelination and deformation of the myelin lamellae [1].

The pathogenesis of carpal tunnel syndrome seems to be multifactorial. Nonspecific flexor tenosynovitis has been theorized to be responsible for increased pressure in many cases of CTS [13]. However, in some patients underlying medical or physiological conditions are felt to be contributory or predispose to neural susceptibility. The most common of these include obesity, diabetes, hypothyroidism, and inflammatory wrist arthritis [13, 14, 15, 16]. A positive family history of carpal tunnel syndrome has been reported as frequent in patients with CTS [17], as has cigarette smoking [18].

Treatment for this condition has traditionally included volar splinting in the neutral position, avoidance of movements requiring wrist flexion/extension, +/- NSAIDs. Volar wrist splinting in the neutral position has been shown to be of benefit in improving symptoms and electrophysiologic parameters in CTS [19, 20]. Some studies have suggested benefit from vitamin B6 supplementation, others have not [21, 22, 23, 24].

Studies of carpal tunnel corticosteroid injection have shown some benefit both symptomatically and electrophysiologically [13, 25]. Relapse rates are high [25, 26, 27, 28]. It has been suggested that patients with mild symptoms and findings of less than one year's duration, normal sensibility, normal thenar strength and mass, and one to two millisecond prolongations of either distal median motor or sensory latencies had the most satisfactory responses to injections and splinting [29]. Age more than 50 years, duration of disease for more than 10 months and constant paresthesias are all indicators that conservative management will not succeed [30].

Surgical carpal tunnel release has been the definitive therapeutic intervention and is highly successful [31]. In the Montreal study, the surgical incidence of CTS was 0.9/1000 adults/year [32]. Many patients post carpal tunnel release will have delayed return to full use of the hand [33]. Efforts have been made to identify patients who are good surgical candidates by examination of pre-operative characteristics [34].

Diagnosis of carpal tunnel syndrome is based on history, physical examination, and often electrodiagnostic testing. On history, patients often report numbness, tingling, and pain in the hand which is generally more severe at night or after use of the hand. The pain may radiate proximally into the forearm. The paresthesias and numbness are generally in the median nerve distribution, involving the first three and a half digits with sparing of the lateral aspect of the fourth digit and the entire fifth digit. Many patients however, have difficulty in describing distribution of their symptoms and will report entire hand involvement. In more severe nerve compression, sensory loss will be reported over some or all the digits affected. Physical examination findings may be normal in early stages, and involve wasting of the thenar eminence and motor weakness

in later stages. Sensory examination may be abnormal. Physical examination maneuvers have been reported by many investigators to be of limited sensitivity and specificity in diagnosis of carpal tunnel syndrome [35, 36, 37, 38]. Phalen's test (appearance or worsening of paresthesias with maximal passive wrist flexion for one minute) and Tinel's sign (paresthesias in the median nerve distribution elicited by gentle tapping over the carpal tunnel) are frequently utilized in assessment. Phalen's test has been shown to have a sensitivity of 75% and a specificity of 47%. Tinel's sign has been associated with a sensitivity of 60% and a specificity of 67% [36]. The overall relationship of specific physical examination maneuvers with symptoms and sensory electrophysiological test results is weak.

The history and clinical examination of carpal tunnel syndrome may be mimicked by proximal median nerve compression by muscles in the forearm such as the pronator teres, lacertus fibrosus, and arch of flexor digitorum superficialis. Additionally, cervical radiculopathy or diffuse peripheral neuropathy may confuse the clinical picture. Electrodiagnostic testing (NCS) is employed to confirm neuropathology and to distinguish compression at the carpal tunnel from other forms of neuropathy. Normal ranges are based on latency distributions from multiple large group electrophysiologic studies; an absolute sensory latency of more than 3.7 msec, a difference of 0.4 msec or more between values obtained for the median nerve and those obtained for the radial or ulnar nerve, a motor conduction latency of more than 4.2 msec, are all considered abnormal (with control for the patient's age and limb temperature) [39]. Nerve conduction studies are considered the "gold standard" for laboratory diagnosis of carpal tunnel syndrome. The validity of this assumption has been called into question by

several investigators [40, 41, 42]. In 1997, Concannon et al described a retrospective study of patients with CTS symptoms who had undergone carpal tunnel release (CTR) surgery. 13% of patients had negative NCS for CTS, but did not otherwise differ from positive NCS CTS patients in symptoms, surgical outcomes or complications. They reported a 13% false negative rate of NCS in this population [40]. Homan et al published a cross-sectional study of 824 workers showing poor overlap between reported symptoms, physical examination findings and the electrodiagnostic study results. There was poor concordance of symptoms and electrophysiological evidence of median mononeuropathy. In that population, the majority of persons with electrophysiological evidence of median mononeuropathy did not have symptoms of CTS and, conversely, the majority of those with symptoms of CTS did not have a median mononeuropathy [41]. Atroshi et al reported a CTS prevalence survey study from Sweden. In this study, 14.4% of responders reported median nerve distribution sensory symptoms. Of these symptomatic responders who underwent NCS, 45.8% had confirmatory electrophysiologic studies. 18.4% of an asymptomatic control population also met electrophysiological criteria for median neuropathy. These observations call into question the specificity of electrophysiologic diagnostic criteria for median mononeuropathy [5]. This is an issue with practical implications as in today's medico-legally conscious environment many surgeons require electrophysiologic confirmation of CTS prior to considering surgical therapeutic intervention. Additionally, NCS results carry weight in Workman's compensation cases or third party insurance claims. The accuracy of this diagnostic tool has bearing on the potential level of care a patient may be offered, as well as on the level of compensation which may be available.

In this study we plan to further evaluate the diagnostic interplay between patient's symptoms and nerve conduction studies in carpal tunnel syndrome. The utility of any given diagnostic test is dependant in part on the population being tested and the pre-test probability of the disorder in question. The workplace screening study reported by Homan et al was initially a screening study of an asymptomatic population with a low pre-test probability [41]. The population survey study reported by Atroshi et al, screened a symptomatic population, however, this population was identified from responders to a population survey [5]. In neither case was it likely that the study population would be representative of patients presenting to their physician with complaints potentially attributable to carpal tunnel syndrome. It is difficult to apply the findings from these previous studies to the physician's office practice population. In this study the population examined is made up of patients seen by their family physicians primarily. These patients have all presented to their physicians with complaints suspicious of carpal tunnel syndrome and have been referred for confirmatory nerve conduction studies to the electrodiagnostic laboratory at Royal University Hospital. By examining this population with a high pre-test probability of carpal tunnel syndrome; comparison of symptomatic measures and symptom lateralization to nerve conduction study results can be made. This study will permit further evaluation of the nerve conduction examination as a diagnostic tool in the population for which it is primarily employed.

1.2 Research Questions:

Primary:

In a population with a high pre-test probability of carpal tunnel syndrome, are symptoms predictive of nerve conduction study results?

This will be examined by comparison of lateralization of patient symptoms and nerve conduction study results. Comparison will also be made between symptom characteristics of the population with positive nerve conduction study results and those with negative results. These characteristics will include: duration of symptoms, a symptom severity score, a functional severity score which reflects symptom impact on patient function, and the use of treatment modalities as a limited proxy for symptom severity.

Secondary:

1. What proportion of patients clinically suspected of CTS and referred for electrodiagnostic studies by their physicians had confirmatory NCS results?
2. How common are previously reported risk factors for carpal tunnel syndrome in our population?
3. What is the prevalence of use of conservative treatment modalities in a population clinically suspected of CTS?

(Appendix B) were reviewed and signed by those who agreed to participate. The questionnaire was completed by the patient in the waiting area just prior to their scheduled nerve conduction study.

2.31 Inclusion criteria:

1. The patient must have been referred for nerve conduction studies with median nerve distribution symptoms as per requisition form.

2. The patient must be capable of understanding and agreeing to the questionnaire application.

3. The patient must be 18 years of age or older.

2.4 Study duration:

Patients were recruited from the nerve conduction laboratory at Royal University Hospital from January 2003 through November 2003 inclusive.

2.5 Questionnaire design:

This survey (Appendix C) consisted of four domains:

1. Patient personal/demographic information, including age, gender, hand dominance, symptomatic hand(s), duration of symptoms, weight and height (Body Mass Index (BMI) was calculated using kg/m^2 formula), and whether there was either lost work time or workman's compensation claims related to CTS symptoms.

2. A validated CTS scoring instrument, the Levine questionnaire with symptomatic and functional scores [43]. This tool was developed by Levine et al and initially reported in The Journal of Bone and Joint Surgery in 1993. The authors reported

evaluation of reproducibility, internal consistency, validity, and responsiveness to clinical change of scales for the measurement of severity of symptoms and functional status. In a sample of 38 CTS patients the scales were highly reproducible with Pearson correlation coefficient r = 0.91 and 0.93 for severity of symptoms and functional status, respectively. Internal consistency in a sample of 67 patients provided Cronbach alpha values of 0.89 and 0.91 for severity of symptoms and functional status respectively. Responsiveness to clinical change was evaluated by follow up of 38 patients post-CTR (median of 14 months post-op). The mean symptom-severity and functional-status scores improved compared to pre-op values. Validity of the questionnaire was problematic as there is no universally accepted standard for measurement of the severity of symptoms or hand functional status. Both the symptomatic and functional scales had positive but weak correlations with two sensory physical examination techniques; two-point discrimination and Semmes-Weinsten monofilament testing (Spearman coefficient, r = 0.12 – 0.42). Since publication, this outcome measure has been evaluated by other investigators and used in several clinical trials.[44, 45, 46, 47] The original authors employed a mean score for each of the symptomatic and functional scales. In this study the raw scores were used to permit more effective use of parametric analysis. Higher scores are associated with more severe symptoms and more severe functional impairment.

3. Self-reported potential risk factor assessment, including presence of associated medical co- morbidities (diabetes mellitus, thyroid disease, pregnancy, rheumatoid arthritis, ganglion, fibromyalgia, hypertension), or use of associated medications (prophylactic ASA, antihypertensives, 'cardiac drugs', cholesterol lowering medication, antidepressants, thyroid medications, hormonal therapy, oral contraceptives), smoking

status, positive family history, and usual/most recent employment. Employment history data was subsequently coded as: unskilled labour, housewife, farmer, professions (primarily nursing and teaching professions), clerical workers, mechanical/machinery worker, or no information provided.

4. Therapeutic intervention evaluation including: prescription/recommendation, purchase, use of, adjustment of and benefit from volar wrist splints; prescription/recommendation, purchase, use of, and benefit from non-steroidal anti-inflammatory drugs (NSAIDs), administration of and benefit from intra-carpal tunnel corticosteroid injection, use of vitamin B6 or multivitamins, and discussion of surgical referral or actual surgical consultation. Benefit questions were structured as a 4 point scale (yes, a great deal, yes, somewhat, uncertain, or not at all).

2.51 Questionnaire trial/ Pilot data collection:

In order to evaluate ease of understanding of the question structures and language, the questionnaire was initially administered as a trial to six volunteers with and without hand symptoms. Subsequently, 25 consecutive patients were surveyed as a pilot study to determine an estimate of unilateral versus bilateral proportions in this patient population. These estimated proportions were employed in the sample size calculation for this study.

2.6 Sample Size:

The sample size for this study was based on the primary research question; whether, in the population referred for NCS with suspected CTS, symptoms would be

predictive of NCS results. This would be primarily evaluated by comparison of lateralization of symptoms and NCS results.

We anticipate two populations; those with unilateral symptoms and those with bilateral symptoms. We therefore expect to compare NCS results in symptomatic hands and asymptomatic hands. Based upon the pilot data an estimate that 30% of patients will have unilateral symptoms was made. This means 15% of hands being tested by NCS will be asymptomatic. This provides an allocation ratio of 5.5:1 ($r = 5.5$). The NCS results will be either positive or negative for carpal tunnel syndrome. This gives a binary outcome. Based on previous studies, the proportion of symptomatic hands expected to have positive NCS is 0.5 (50%). The proportion of asymptomatic hands expected to have positive NCS is 0.2 (20%). $P_A = 0.5$, $P_B = 0.2$ [5].

For this comparison of NCS study results between symptomatic and asymptomatic hands, the following equation was employed to calculate the number of patients required in each group [48]:

Where m = patient number/group.

$$m = \frac{[Z_{1-\alpha/2}\sqrt{\{2p(1-p)\}} + Z_{1-\beta}\sqrt{\{P_A(1-P_A) + P_B(1-P_B)\}}]^2}{\delta^2}$$

Where: $\delta = P_A - P_B$ and $p = (P_A + P_B)/2$. $Z_{1-\alpha/2} = 2.58$, and $Z_{1-\beta} = 1.28$ for a two-sided $\alpha = 0.01$, and a $\beta = 0.1$

$$m = \frac{[2.58\sqrt{\{2(0.7/2)(1-0.7/2)\}} + 1.28\sqrt{\{0.5(1-0.5) + 0.2(1-0.2)\}}]^2}{(0.5-0.2)^2}$$

$m = 72.857$ or 73 hands/group. As, there is an unequal allocation ratio (r), a further calculation is required: Given m, which was calculated assuming equal sized groups, m'

will be the sample size in the first group and rm' will be the sample size in the second group.

$$m' = \frac{r+1}{2r} \times m$$

m' = 43.07 or 44 hands (asymptomatic), and rm' = 236.885 or 237 hands (symptomatic)

In terms of people, this will equal 44 people with unilateral CTS, and 97 people with bilateral CTS, for a total of 141 in both groups. A further 50% (71 patients) was added to the total sample size desired to account for individuals who did not provide appropriate signed consent (for questionnaire study itself or access to electrophysiology test results) or failed to complete the questionnaire. In summary, the sample size proposed for this study was 212 patients.

2.7 Electrophysiologic Data Collection:

Consent for access to medical records was a component of the study consent form. For those who completed the questionnaire and provided this consent, raw results and the neurologist's interpretation of electrophysiology studies were accessed for each study participant.

Bilateral studies are standard in our NCS laboratory regardless of whether patients report unilateral or bilateral symptoms.

2.71 Electrophysiological definition of CTS

A positive nerve conduction study for CTS was defined as demonstrating one or more of the following characteristics [39, 49]:

Median motor latency > 4.2 msec, Median sensory latency > 3.7 msec, orthodromic Median palmar sensory latency (8cm) > 2.2 msec, antedromic wrist to palm (7cm) Median sensory distal latency (wrist to digit 3 – palm to digit 3) > 2 msec. A difference of 0.4 msec or more between values obtained for the median nerve and those obtained for the radial or ulnar nerve.

2.8 Statistical Analysis

The data analysis for this study was based on the primary research question; whether, in the population referred for NCS with suspected CTS, symptoms would be predictive of NCS results. This was evaluated by comparison of lateralization of symptoms and NCS results in two group comparisons. However, as this study was in part an exploratory hypothesis generating study with substantial descriptive data, multiple testing was performed. Corrections for multiple testing were made using the Bonferroni method as described below.

Data was entered into a computer spreadsheet. Continuous or numerical data, were entered directly, categorical data was given a numerical code i.e. for gender, male was coded as 1, female was coded as 2. The numerical code was entered into the spreadsheet for categorical or frequency data. SPSS version 12.0 statistical software was utilized for data analysis.

Continuous data was available for the following variables: age, symptom duration, on a ratio scale, Levine symptomatic and functional scores, height, weight, and BMI (directly calculated from height and weight) on an interval scale. Continuous data when normally distributed permit use of parametric analytic techniques. Characteristics of the data were assessed; including measures of central tendency, dispersion, skewedness and kurtosis. Comparisons were primarily between two groups. This allowed use of t-tests for two group comparisons. Independent 2-tailed t-tests were used for comparisons of continuous ratio/interval data between groups Two-tailed tests were used rather than one-tailed in order to assess differences between the two groups in either a positive or negative direction. When appropriate, 95% confidence intervals were reported. In order to correct for multiple testing and avoid an increased risk of type I error, the alpha value required before rejection of the null hypothesis was divided by k (the number of comparisons made).

Frequency data (categorical, binomial, or count data) was generated for gender, symptom lateralization, co-morbidities – present or absent, conservative treatment utilization –yes or no, and occupational status. The chi-square distribution, which was used in this study is the most commonly utilized statistical method for analysis of frequency data. However, the chi-square test is not an appropriate method of analysis if minimum expected frequency requirements are not met or if one of the expected frequencies is less than five. Accordingly, Fisher's exact test was used when one or more cell entries were less than five. Multiple testing correction of α/k were also performed.

For occupational categorical data, odds ratios were calculated for risk of a positive NCS in each occupational group. This technique was employed as the

population consisted of those with a positive NCS and those without a positive NCS, the distribution of the potential risk factor of occupation was retrospectively addressed The 95% confidence intervals for the odd's ratios was calculated using Woolf's formula [50].

Regression analysis was employed to determine independence of variables associated with increased probability of a positive NCS. Binary-logistic regression was utilized with the dichotomous outcome of a positive or negative NCS for CTS. Variables were included by 'stepwise-enter' method. Variables were selected based on demonstrated association with outcome in bivariate analysis. The Hosmer-Lemeshow goodness of fit test was employed [51].

2.9 Ethical/Administrative Approvals:

Approval for this study was obtained from the University of Saskatchewan Research Ethics Board (EC#: B2002-755), and the Saskatoon District Health Research Services Unit.

family's medical history. Pregnancy within the previous 6 months of the nerve conduction study was reported in 1.4% (3) patients.

Current or most recent employment information was provided by 207/211 study participants. The breakdown on occupational category in the study population revealed: 20.4% (43), were unskilled labour, 6.6% (14) were housewives, 4.3% (9) were farmers, 32.7% (69) were in the professions of nursing and teaching, 21.8% (46) were clerical workers, 11.8% (25) were mechanical/machinery workers, and for 2.4%(5) no information was provided [Figure 3.1.1].

Conservative treatment modalities were used in 55% (116) of the study population pre-test. Wrist splints had been recommended in 33.2% (70) of patients, and NSAIDs tried by 38.9% (82) of patients. Corticosteroid injection to the carpal tunnel was administered in 1.9% (4) of patients. Discussions with their doctor regarding surgical referral were recalled by 31.8% (67) of the study population. 9.5% (20) had already seen a surgeon for their current symptoms. Previous unilateral carpal tunnel release (CTR) had been undergone in 7.6% (16) {right CTR in 5.7% (12), left CTR in 1.9% (4)} and bilateral CTR in 1.4% (3) of study patients.

Table 3.1.1: Personal characteristics of population in total

Characteristic	Mean (SD)	Range
Age for total population	46.72 (12.22) years	67 (21-88) years
Age for females (73.9%)	47.37 (12.40) years	67 (21-88) years
Age for males (26.1%)	44.85 (11.58) years	60 (23-83) years
Height for total population	165.42 (8.26) cm	43.20 (147.32 -190.5) cm
Weight for total population	80.22 (20.73) kg	140.90 (43.18 -184.09) kg
BMI for total population	29.25 (6.47) kg/m^2	36.69 (16.89 -53.55) kg/m^2

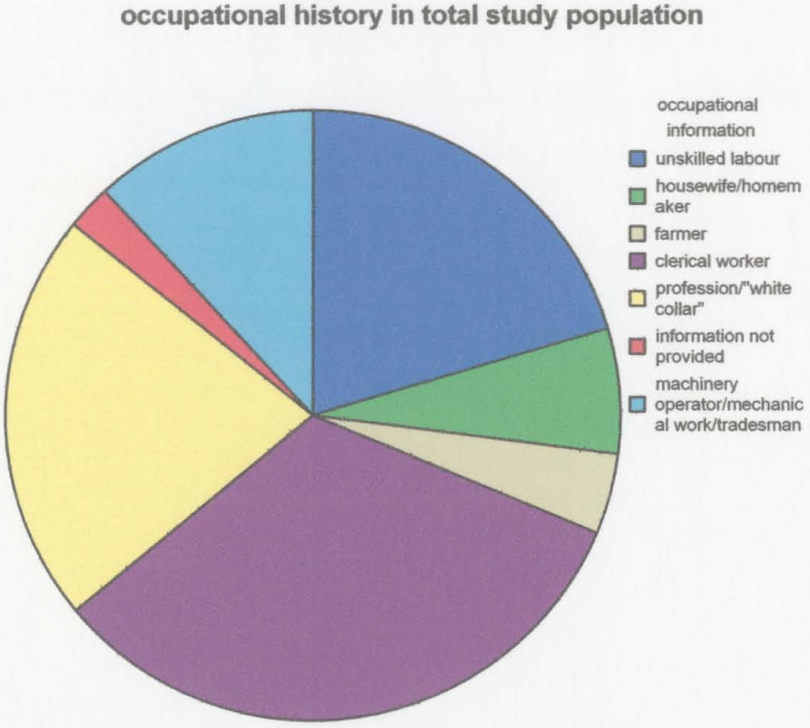


Figure 3.1.1

3.2 Levine Scoring Instrument Application Analysis for Study Population

The Levine scoring instrument is a validated self-administered tool for measurement of symptoms and function in carpal tunnel syndrome. The Levine symptomatic and functional questionnaires were incorporated into the survey. Scores were tabulated from each survey. The mean Levine symptomatic score for the total population was 28.75. The minimum and maximum scores possible were 11 and 55. The mean symptomatic score for the male population was 28.14 (SD 7.07), and for the female population was 28.96 (SD 7.47) [Figure 3.2.1]. Comparisons of the symptomatic score

means using 2-tailed independent t-tests showed no significant differences between genders. The mean functional score for the male population was 13.46 (SD 4.37), and for the female population was 15.61 (SD 5.34) [Figure 3.2.2]. Independent 2-tailed t-testing comparison of the means showed a significant difference between genders with p =.009. The mean Levine functional score for the total population was 15.05. The minimum and maximum possible scores were 8 and 40 respectively.

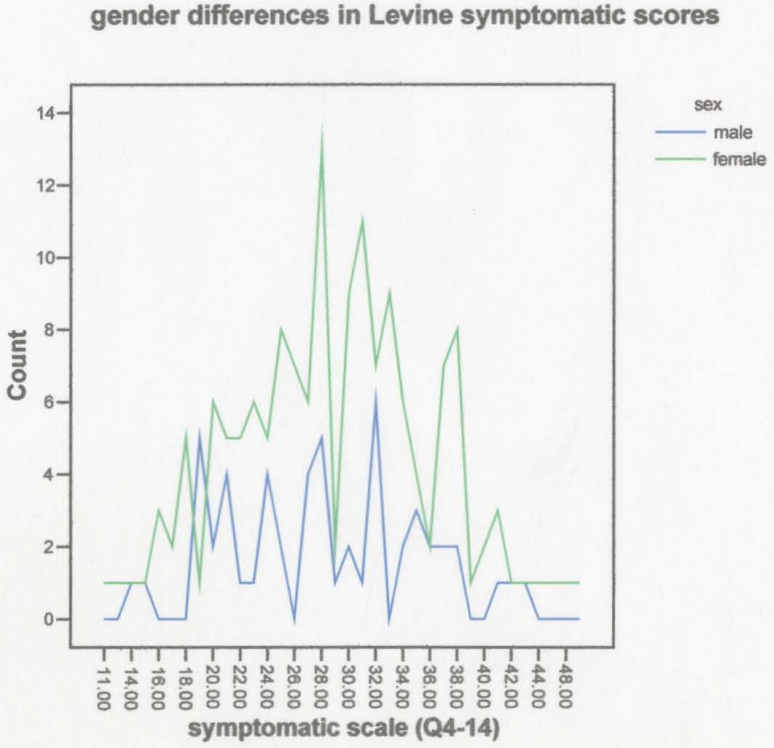


Figure 3.2.1

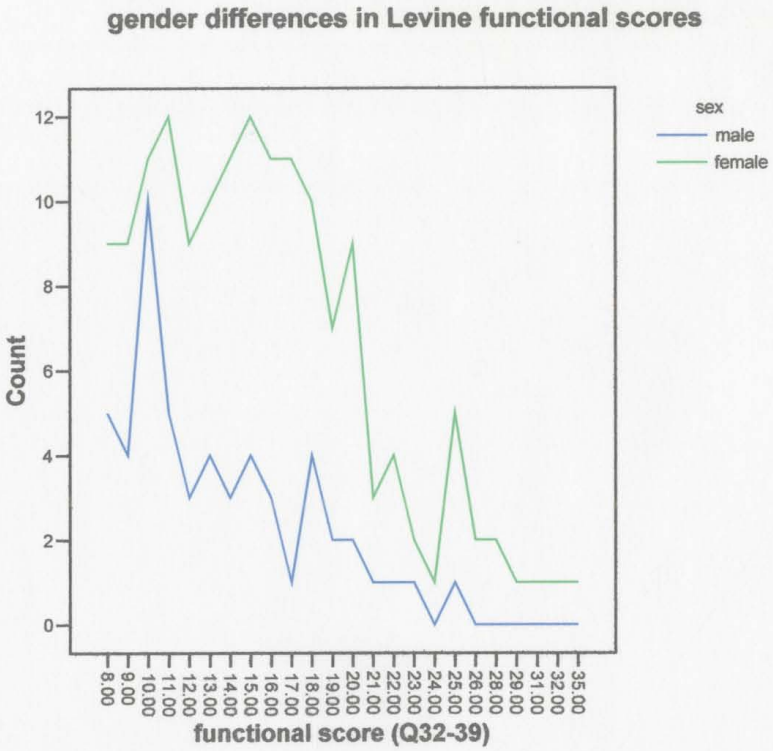


Figure 3.2.2

3.3 Nerve Conduction Study Results:

Nerve Conduction Study results [Figure 3.3.1], utilizing the previously mentioned electrodiagnostic criteria for CTS were as follows:

For 57.3% (121) of patients, the NCS were confirmatory of CTS

For 39.3% (83) of patients, the NCS were normal studies

For 3.4% (7) of patients, the NCS demonstrated non-CTS abnormalities

Differences in age between groups were observed. The NCS positive group had a mean age of 49.08 years (SD 12.92), the NCS negative group had a mean age of 43.54 years (SD 10.45) p = .001 (95% CI -8.81, -2.26) by independent 2-tailed t-test.

Age, BMI and its associated variable, weight showed significant differences between groups in independent 2-tailed t-tests. Symptomatic score comparison was not significant after correction for multiple comparisons, and substantial overlap in range between the two groups is obvious [Figure 3.4.1]. No differences were seen between groups in terms of functional scores, or frequency of use of conservative treatment modalities. Symptom duration between NCS positive and NCS negative groups did not differ. Examination of the gender groups revealed longer symptom duration in women but not men, with positive NCS for CTS. These women had a mean symptom duration in the NCS positive group of 36.5 months and in the NCS negative group of 21.2 months (p = 0.025). When corrected for multiple comparisons, the p value was not significant.

Comparison of personal characteristics revealed no significant differences in gender between the two groups. The NCS positive group was comprised of 27.3% (33) men, and the NCS negative group 24.4% (22) men, p = .643.

Assessment of potential risk factors and co-morbidities showed significant increase in hypertension, associated use of antihypertensives (in all but one hypertensive patient) and prophylactic ASA in the NCS positive population. As these characteristics all increase with age, it was not clear that they could be viewed as independently associated with increased likelihood of a positive NCS for CTS. Evaluation by logistic regression did not confirm these variables to be independent of age. No differences

between groups were seen in other co-morbidities or potential risk factors. Table 3.4.1.1 compares differences between the NCS positive and negative groups.

Table 3.4.1.1: Comparison of CTS NCS positive and negative groups

Variable	NCS + (S.D.) n = 121	NCS – (S.D.) N = 90	Sig (2-tailed)	95% CI Lower	95% CI Upper
Mean age (years)	49.08 (12.92)	43.54 (10.45)	.001	-8.81	-2.26
Gender (% male)	27.3% (n = 33)	24.4% (n = 22)	.643		
Mean duration symptoms (months)	33.07 (49.53)	24.21 (25.63)	.095	-19.26	1.55
Height (cm)	165.02 (8.35)	165.95 (8.16)	.422	-1.34	3.19
Weight (kg)	83.93 (22.90)	75.31 (16.33)	.003	-14.22	-3.02
BMI	30.61 (6.82)	27.45 (5.50)	<.001	-4.89	-1.43
Levine symptomatic score	29.82 (7.46)	27.34 (7.01)	.016	-4.50	-0.47
Levine functional score	15.40 (5.52)	14.58 (4.87)	.267	-2.27	0.63
Work missed n = 29	55.2% (n = 16)	44.8% (n = 13)	.855		
Workman's Compensation cases n = 13	38.5% (n = 5)	61.5% (n = 8)	.215		

Results expressed as mean values (standard deviation) unless otherwise specified

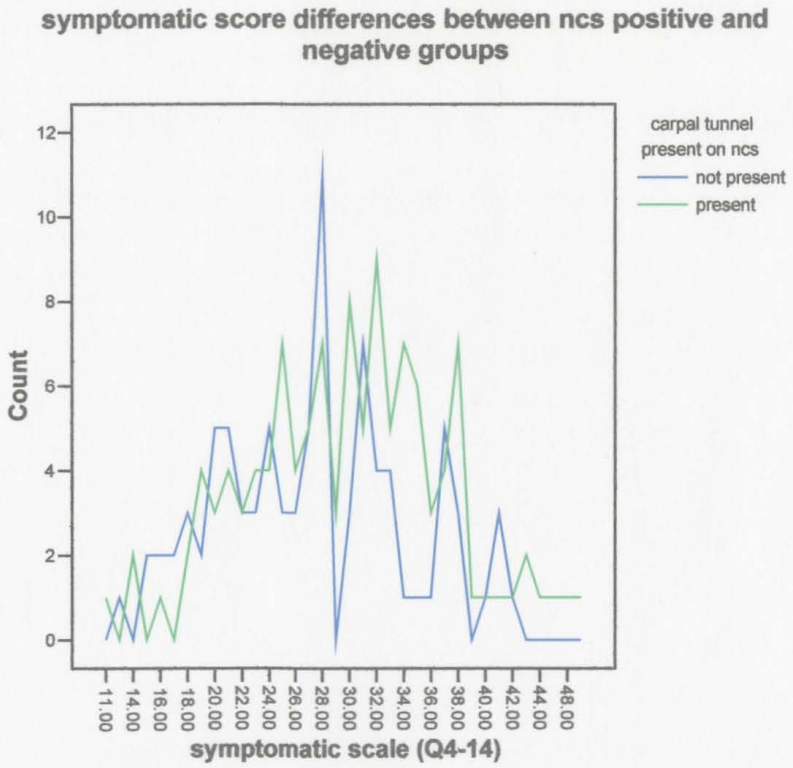


Figure 3.4.1

From the clinical characteristic data gathered, logistic regression was employed to confirm independence of variables associated with a positive NCS for CTS.

Using NCS positive or negative as previously defined as the binomial dependant variable, use of the independent variables, age, symptomatic score, and BMI in a logistic regression provides the best model. These variables were chosen based on demonstrated association with outcome in bivariate analysis. These three variables provide a model with a chi squared of 32.2 with 3 degrees of freedom and $p < .001$. The Homer and

3.4.2 Comparison of occupational category

Information on most recent occupation was provided by 206 of the 211 study participants. Table 3.4.2.1 compares differences between occupational groups. Housewives, farmers, and unskilled labourers have higher odds of a positive test for CTS than clerical workers, nurses or teachers in this population.

Table 3.4.2.1: Comparison of occupational category

Occupation	Total number	Mean age(yrs)	Mean BMI	%NCS +	Odds Ratios	95% CI
Unskilled labour	43/211 (20.4%)	44.0	28.90	30/43 (70%)	1.95	.95, 4.00
Housewife	14/211 (6.6%)	52.2	26.74	12/14(86%)	4.84	1.06, 22.20
Farmer	9/211 (4.3%)	43.3	35.33	7/9 (78%)	2.70	0.49, 15.0
Clerical worker	69/211 (32.7%)	46.3	29.06	30/69 (43%)	0.43	0.24, 0.77
Professions	46/211 (21.8%)	48.4	29.32	24/46(52%)	0.76	0.39, 1.47
Machinery operators	25/211 (11.8%)	41.8	29.32	14/25 (56%)	0.94	0.23, 1.25
No info. Provided	5/211 (2.4%)	74.8	29.47	4/5 (80%)	3.04	.33, 27.67

3.5 Comparison of Lateralization of Presenting Symptoms and NCS Results

This portion of the analysis compares the symptom lateralization self-reported by patients and the NCS results, addressing directly the primary research question posed.

Seventy-two (34.1%) patients reported unilateral symptoms, in contrast to 139 (65.9%) reporting bilateral symptoms. This proportion of patients with unilateral involvement was quite consistent with the pilot data employed in sample size estimation. Patients with unilateral symptoms did not differ from those with bilateral symptoms in demographics, co-morbidities, symptomatic scores, functional scores, or frequency of conservative treatment recommendation. Symptom duration did differ between groups. Patients with unilateral symptoms had a mean symptom duration of 18.5 months, while those with bilateral symptoms had a mean symptom duration reported of 34.9 months ($p = 0.001$).

A comparison between: presenting symptom lateralization and NCS results, was possible, as bilateral NCS is standard laboratory protocol whether a patient has unilateral or bilateral symptoms. These results are outlined in Table 3.5.1. A comparison of NCS findings by hand dominance is also made. There was substantial discordance between lateralization of CTS symptoms (left, right or bilateral hand symptoms) and NCS results. Whether CTS symptoms were unilateral or bilateral, 31-44% of NCS were negative. The group reporting bilateral symptoms had the highest degree of agreement with the NCS with 38.9% concordance. Unilateral NCS abnormalities were seen in 18% of the bilateral symptom group. Isolated right sided symptoms were more often in agreement with NCS results than isolated left sided; 25.6% versus 13.8%. Discordant findings, either bilateral median neuropathies or isolated opposite side median neuropathies, were seen on NCS in 25.6% of patients reporting isolated right sided symptoms, and in 55.2% of those reporting isolated left sided symptoms. Interestingly, although patients with isolated left

median mononeuropathy were seen in the right hand dominant population, they were not seen in the left hand dominant population.

A comparison of NCS results in symptomatic and asymptomatic hands was possible. Examination by individual wrists is outlined in Table 3.5.2, where presence or absence of clinical symptoms suspected to be CTS are compared to NCS results (as previously defined). From this perspective, employing the NCS as the 'gold standard', the following comparative characteristics were calculated for diagnosis by symptoms: sensitivity of 86.4% (172/199), specificity of 20.1% (45/223), positive predictive value of 49.1% (172/350), negative predictive value of 62.5% (45/72), accuracy of 51.4% (217/422), and prevalence of disease (pre-test probability in this population) of 47.1% (199/422). The positive likelihood ratio was 1.13, indicating a patient reporting symptoms was 1.13 times more likely to have a positive NCS study than those without symptoms in this population. The negative likelihood ratio was 0.70. These comparisons do not support a strong relationship between clinical symptoms and NCS results in this patient group.

Table 3.5.1: Comparison of symptom lateralization and NCS results

		NCS result				
		Bilateral Negative	Bilateral Positive	Isolated right positive	Isolated left Positive	Other non-CTS abnormality
Lateralization of symptoms	Bilateral	39.6% (55/139)	38.9% (54/139)	10.8% (15/139)	7.2% (10/139)	3.6% (5/139)
	Isolated right side	44% (19/43)	25.6% (11/43)	25.6% (11/43)	0	4.6% (2/43)
	Isolated left side	31% (9/29)	44.8% (13/29)	10.4% (3/29)	13.8% (4/29)	0
Hand dominance	Right	39.3% (75/191)	36.1% (69/191)	13.6% (26/191)	7.3% (14/191)	3.7% (7/191)
	Left	40% (8/20)	45% (9/20)	15% (3/20)	0	0

Table 3.5.2: Comparison of number of symptomatic wrists with NCS results

		NCS Results for CTS		
		Positive	Negative	Total
Symptomatic Wrist	Yes	172	178	350
	No	27	45	72
	Total	199	223	422

3.6 Conservative treatment measures:

Conservative treatment measures had been offered to approximately half of these patients with clinically suspected carpal tunnel syndrome (Table 3.6.1). Only 33.2% (70/211) of the study population had been prescribed wrist splints. 69/70 purchased the wrist splints, and 13% (9/69) had undergone adjustment of the splint for optimal treatment. Reported compliance with splint usage varied with 38/69 (55%) usually/always wearing splints at night, compared to 20 (29%) who reported occasional night time use, and 11 (15.9%) who stated they never wore their splints at night. Daytime usage of more than 6 hours was reported by 21 (30.4%) patients. Eighteen (26.1%) patients reported usage for 2-6 hours/day. The remaining 29 (43.5%) patients reported one hour or less of wrist splint use each day. The majority of patients did not usually wear their splints to their workplace, with 28 (40.6%) reporting never doing so. A further 28 (40.6%) of patients with wrist splints occasionally wore them to work. Nine (13%) patients usually/always wore their splints to work, and the remaining four of the

sixty-nine patients reported no workplace outside the home. Improvement in symptoms perceived to be related to wrist splint use was reported in 54/69 (78.3%) patients. However, 25 of these 54 successfully treated patients had negative NCS.

NSAIDs were prescribed/recommended in 52/211 (24.6%) patients, but 82/211 (38.9%) had purchased/tried NSAIDs. As several NSAIDs are non-prescription medications, this discrepancy was expected. The mean reported duration of use of NSAIDs was 17.8 months (SD 30.9) with a range of 203 (1-203 months). Improvement perceived to be related to NSAID use was reported in 61/82 (74.4%). However, 28 of these 61 successfully treated patients had negative NCS. These patient numbers reporting improvement were arrived at by collating the number of patients who responded with; yes, a great deal or yes, somewhat; to the questions on benefit for splint use or NSAID use. Thirty-five patients were prescribed/used both splints and NSAIDs. In this subgroup, 85.7% (30/35) reported improvement. Interestingly, there were no significant differences between the NCS positive and negative groups in reported improvements with splints or NSAIDs. Patients prescribed these therapeutic interventions did not differ in age, BMI, gender, duration of symptoms, symptomatic or functional scores from the remainder of the population. Patients responding to NSAIDs and/or splinting did not differ from non-responders in terms of Levine symptomatic, functional scores, age, gender, BMI, or duration of symptoms. In all 55% (116) patients had used wrist splints and/or NSAIDs.

No significant difference in vitamin usage was noted between the diagnostic groups.

Table 3.6.1: Conservative treatment utilization

Treatment	Total population (n = 211)	CTS + group (n = 121)	CTS – group (n = 90)	Significance (2-tailed) (p value)
NSAIDs: prescribed	52 (24.6%)	26 (21.5%)	26 (28.9%)	.200
NSAIDs: use reported	82 (38.9%)	45 (37.2%)	37 (41.1%)	.520
Wrist splints: prescribed	70 (33.2%)	38 (31.4%)	32 (35.6%)	.583
Wrist splints: obtained	69 (32.7%)	37 (30.5%)	32 (35.6%)	.471
NSAIDs &/or splint use	116 (55%)	63 (52.1%)	53 (58.9%)	.325
Vitamin B6	18 (8.5%)	12 (9.9%)	6 (6.7%)	.410
Intra-carpal corticosteroid injection	4 (1.9%)	1 (0.8%)	3 (3.3%)	.313

3.7 Questionnaire Defects:

Upon reviewing the completed questionnaires it became apparent despite initial testing of the instrument that one question was flawed and data from it was not interpretable. This error in question design occurred for Question 46 where the question was not structured clearly enough to distinguish the postmenopausal woman on no hormonal supplements from the premenopausal woman on no hormonal therapies. This could have been prevented by a wider population demographic for the questionnaire trial and an earlier evaluation of the completed questionnaires.

symptomatic improvement with use. No increase in frequency of NCS positive individuals was seen in either the patients prescribed or responding to splinting/NSAIDs.

5.2 Conservative Treatment Utilization:

This study also assessed the prevalence of pre-test therapeutic interventions. These 'conservative' therapeutic options included use of wrist splints, NSAIDs, intra-canal corticosteroid injection and vitamin B6 use. Wrist splinting has been shown by several studies to be efficacious in relieving symptoms of carpal tunnel syndrome [19, 20]. The intra-carpal pressure in CTS as determined through Wick catheter measurements is tremendously elevated with flexion and extension, the lowest pressure transduced in CTS patients has been in the neutral position [52]. Not surprisingly, the wrist splint positioned in a neutral angle provides superior symptom relief compared to other splinting angles [53]. Significant improvement in both sensory and motor distal latencies has been observed in full time use of wrist splints compared to night use only patients [19]. Corticosteroid injection has also been shown to be efficacious in relief of symptoms of CTS [25, 26, 29, 54].

Considering both NSAIDs and wrist splints, 55% of the study population received either or both of these treatments. The ratio of NCS positive/ negative was approximately equal between the treated and untreated groups for both NSAIDs and wrist splints. No differences in Levine symptomatic, functional scores, age, gender, BMI, or duration of symptoms were observed between the treated and untreated groups or between the responders and non-responders. The response to treatment measure utilized in this study was quite subjective, depending on patient recall of response. Limited conclusions from this retrospective approach can be drawn regarding efficacy of these therapeutic interventions in this study. Intra-articular steroid injection was used in only 4 cases.

It would seem in this patient population that non-invasive conservative treatment modalities, despite previous reports of efficacy, are recommended or utilized in only half of the patients referred for NCS with symptoms of CTS.

5.3 Diagnostic Utility of Self-Reported Symptoms in CTS:

The issue of diagnostic clarity creates difficulty in epidemiologic research in CTS. A combination of consistent symptoms, physical exam signs and electrophysiological findings would be compelling in diagnosing CTS. However, physical exam signs have been evaluated by many investigators and found to be wanting in sensitivity and specificity in relation to symptoms and NCS results. A self-administered hand diagram in the diagnosis of carpal tunnel syndrome has been shown to have a sensitivity of 80% and specificity of 90% [55]. This is superior to most physical examination maneuvers. The nerve conduction study is often held to be the "gold standard" in providing some measure of objectivity in assessing patients with median nerve distribution symptoms or signs. As previously mentioned, the validity of this assumption has been called into question by several investigators [40, 41, 42]. In this patient population, with clinically diagnosed or suspected CTS, 39.3% had completely normal or negative electrophysiologic studies. It should be pointed out that the majority of the referring physicians were family practitioners and not musculoskeletal specialists or neurologists. The argument could be made that family practitioners may be less skilled at clinical evaluation of potential carpal tunnel syndrome than specialists leading to a higher number of negative studies from a lower pre-test probability. On the other hand, as has been mentioned, the physical examination for carpal tunnel syndrome has imperfect sensitivity

and specificity even in a clinical trial setting. Accordingly, our finding of 39.3% negative studies may be a reflection of poor specificity of the clinical screening process, and/or limited sensitivity of the NCS. The questioning of sensitivity and specificity of clinical diagnostic maneuvers, reported symptoms, and nerve conduction studies leave the clinician without a reliable standard on which to base a diagnosis of carpal tunnel syndrome, or rule that diagnosis out. Likewise, arriving at a case definition of CTS for future research which would be widely accepted may be problematic.

In this study, the primary objective was to compare the diagnostic utility of self-reported symptoms to NCS results. A methodological criticism could include the absence of a patient completed hand diagram in the data collection. However, a physician-completed hand diagram is included in the NCS requisition form for each patient (Appendix A), and specific symptom lateralization is a component of the questionnaire.

Symptom characteristics between the NCS positive and negative groups revealed no difference in frequency of conservative treatment use, lost work time, workman's compensation claims, or Levine functional score. Intuitively, one would expect a higher symptomatic score to be associated with a positive NCS result. There was indeed such a difference observed in the Levine symptomatic score between groups, but when corrected for multiple comparisons lost significance. This is not surprising when the extent of overlap in symptom score ranges between groups is observed.

A wide range of symptom duration was seen in the population, from 1 up to 300 months was reported. The duration of hand symptoms was not predictive for a positive NCS. The mean duration was 29.3 months, suggesting many people tolerate their

symptoms for a prolonged period, prior to seeking medical advice. This implies a large number of unreported or unrecognized CTS may exist in the general population. This tolerance of symptoms was also reflected in the relatively small numbers of people in this study population who reported missing work or filing WCB claims due to their hand symptoms. Patients with unilateral symptoms reported shorter symptom duration than those with bilateral symptoms.

The superior sensitivity and specificity of the hand diagram in diagnosis of CTS, suggests that self-reported symptom lateralization would be predictive of NCS results. This was not the case. Assuming accuracy of reporting on the part of the patients in terms of lateralization of their symptoms, marked discordance was evident in the comparison with NCS results. In terms of symptomatic hands; there was confirmation in the form of a positive NCS in 49.2% of symptomatic hands. A negative NCS was seen in 50.8% of symptomatic hands. In terms of asymptomatic hands; concordance with a negative NCS was seen in 62.5% of asymptomatic hands. Asymptomatic hands were found to have positive NCS for CTS in 37.5% of cases. The overall accuracy of symptom lateralization for NCS results was 51.4%.

It has been suggested that patients with asymptomatic median mononeuropathy may have subclinical CTS. In this study, the observation that those with unilateral symptoms had shorter symptom duration than those with bilateral symptoms would fit with that possibility. However, if this is the case, it is reasonable to expect an abnormal NCS in these individuals to be predictive of future symptom development. Although limited observations have been made, this has not been confirmed in other studies. This question was partially addressed by Nathan et al in a longitudinal study of 289 workers in

four industries, who compared NCS results with symptoms and found that 82% of subjects with abnormal NCS results had persistence of NCS slowing over time, but symptoms fluctuated substantially, with only 13% having persistent symptoms over the eleven year follow-up period [56]. Another case control study of over 700 workers in five sites found 77 asymptomatic workers with NCS evidence of median mononeuropathy and compared them with a control group of normal NCS subjects who were age and sex matched. A follow-up questionnaire 6 months later found no difference in percentage of subjects reporting CTS-like symptoms between the two groups [57].

These observations, as well as the findings of this study create confusion as to the role of NCS in diagnosis of CTS. It is likely that diagnostic utility varies with the pre-test probability of a population, and very likely varies in subpopulations depending on susceptibility of neural elements to insult.

In clinical practice, substantial weight may be placed on NCS results; influencing referral for surgical intervention as well as prescription of non-surgical interventions. Further evaluation of sensitivity and specificity of standardized nerve conduction studies would be clinically relevant. Ideally, the NCS could be studied in comparison with another "gold standard" diagnostic measurement. Potentially, intra-carpal pressure measurements may be an appropriate comparison for nerve conduction studies. Wick catheter measurements in previous studies have demonstrated substantial differences between the intra-carpal pressure in a normal and a wrist with CTS [11]. However, problems may arise with utilization of absolute intra-carpal pressures as a standard for diagnosis in CTS. Variation in median nerve susceptibility to pressure injury due to pre-existing vascular, metabolic disease likely exists between populations. Diabetes mellitus

is a recognized example of a disease state that may put individuals at increased risk of compressive median neuropathy [58]. Familial predisposition to compressive neuropathy also exists [17, 59]. It is probable, that lower intra-carpal pressures are required to create clinical CTS in a susceptible individual than in a non-susceptible individual. Age related changes in neural susceptibility to compression are also likely. This would potentially create difficulties in defining a pathologic range of intra-carpal pressures for comparison with electrophysiologic test results.

Appendix A: NCS Requisition Form

EMG LABORATORY REQUISITION

PATIENT APPOINTMENT DATE AND TIME _____

CLINICAL NEUROPHYSIOLOGY
ROYAL UNIVERSITY HOSPITAL
SASKATOON, SASKATCHEWAN
PHONE: 306-655-1384
FAX: 306-655-1359

RUH#:

NAME:

ADDRESS:

APPOINTMENT DATE _____ EMG NUMBER _____

SHSP#:

DOB:

PHONE #:

REFERRING PHYSICIAN _____ PHYSICIAN SIGNATURE _____

REQUEST FOR NERVE CONDUCTION STUDIES ONLY:

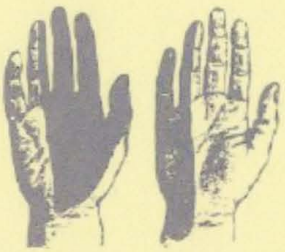
PLEASE TEST FOR: (CHECK BOX)

- ❑ CARPAL TUNNEL SYNDROME
- ❑ ULNAR NEUROPATHY
- ❑ POLYNEUROPATHY
- ❑ OTHER (PLEASE SPECIFY)

_____

IS PATIENT DIABETIC? ❑ YES ❑ NO

IS THIS A WORKERS COMPENSATION BOARD CLAIM ❑ YES ❑ NO



Median ❑ Ulnar ❑

Please check box that corresponds with patient's symptoms.

REQUEST FOR EMG NEEDLE ELECTRODE EXAM:

PLEASE TEST FOR: (CHECK BOX)

- ❑ MYOPATHY
- ❑ OTHER (PLEASE SPECIFY)_____

SYMPTOMS:

Form # 100238 (S) 01/00

Appendix B: Consent form:

Consent Form

You are invited to participate in a study entitled **" A survey of patients with median nerve distribution symptoms presenting for nerve conduction studies"**
Please read this form carefully, and feel free to ask questions you might have.

Researchers: Dr. R.M. Taylor Gjevre, Dr. B. Nair, Dr. J. Sibley, Division of Rheumatology. Dr. C. Boyle, Division of Neurology, Ms. C. Geddes, Neurophysiology Laboratory, Royal University Hospital, University of Saskatchewan. Contact number: 966-8280,

Purpose and Procedure: This study is in the form of a questionnaire. The purpose of the study is to find out what kinds of non-surgical treatments patients with hand/wrist symptoms are using. Also we wish to see if we can predict, based on people's symptoms who will have a positive nerve conduction test. For this purpose, as part of this study, we request permission to review your nerve conduction test results

Potential Risks or Benefits: No risks would be involved. There would be no direct benefits to the participant.

Storage of Data: The questionnaire information will be stored for 5 years in a locked file cabinet in Dr. R. Taylor Gjevre's office. Only the researchers involved will have access.

Confidentiality: When the study is complete the group results will be submitted to medical journals and/or medical conferences. Complete individual confidentiality and anonymity would be guaranteed in presentation or publication of results.

Right to Withdraw: *You may withdraw from the study for any reason, at any time, without penalty of any sort (and without loss of relevant entitlements, without affecting academic or employment status, without losing access to relevant services etc.) If you withdraw from the study at any time, any data that you have contributed will be destroyed.*

Questions: *If you have any questions concerning the study, please feel free to ask at any point; you are also free to contact the researchers at the numbers provided above if you have questions at a later time. This study has been approved on ethical grounds by the University of Saskatchewan Behavioural Sciences Research Ethics Board on Jan.15/03. Any questions regarding your rights as a participant may be addressed to that committee through the Office of Research Services (966-2084).*

We ask you below for permission to review your records for medical research:

I agree to allow information from my medical record to be reviewed for medical research. I understand that this information will remain confidential.

Please put an X in one box. Thank you! ☐ Yes ☐ No

Consent to Participate: *I have read and understood the description provided above; I have been provided with an opportunity to ask questions and my questions have been answered satisfactorily. I consent to participate in the study described above, understanding that I may withdraw this consent at any time. A copy of this consent form has been given to me for my records.*

_____ _____

(Signature of Participant) (Date)

_____

(Signature of Witness)

Appendix C: Study Questionnaire

University of Saskatchewan

Divisions of Rheumatology and Neurology

Research Questionnaire:

You have been sent for a nerve conduction test because you have symptoms in your hands which may be related to a nerve problem. We are doing a study on patients like yourself who are going to have this test. We are interested in the kinds of symptoms you have as well as the kinds of treatments which have been tried so far. If you would consent to participate by completion of this questionnaire we would be **very** grateful. Thank-you!!

1. About how long have you had these symptoms in your hands?
   _____ months _____ years.

2. Which hand is bothering you?
   a. Left
   b. Right
   c. Both

3. Are you:
   a. Left-handed
   b. Right-handed

These next questions refer to your symptoms for a typical twenty-four hour period during the past two weeks (circle one answer to each question).

4. How severe is the hand or wrist pain that you have at night?
   a. I do not have hand or wrist pain at night.
   b. Mild pain
   c. Moderate pain
   d. Severe pain
   e. Very severe pain

5. How often did hand or wrist pain wake you up during a typical night in the past two weeks?
   a. Never
   b. Once
   c. Two or three times
   d. Four or five times
   e. More than five times

6. Do you typically have pain in your hand or wrist during the daytime?
    a. I never have pain during the day
    b. I have mild pain during the day
    c. I have moderate pain during the day
    d. I have severe pain during the day
    e. I have very severe pain during the day.

7. How often do you have hand or wrist pain during the daytime?
    a. Never
    b. Once or twice a day
    c. Three to five times a day
    d. More than five times a day
    e. The pain is constant

8. How long, on average, does an episode of pain last during the daytime?
    a. I never get pain during the day
    b. Less than 10 minutes
    c. 10-60 minutes
    d. Greater than 60 minutes
    e. The pain is constant throughout the day

9. Do you have numbness (loss of sensation) in your hand?
    a. No
    b. I have mild numbness
    c. I have moderate numbness
    d. I have severe numbness
    e. I have very severe numbness

10. Do you have weakness in your hand or wrist?
    a. No weakness
    b. Mild weakness
    c. Moderate weakness
    d. Severe weakness
    e. Very severe weakness

11. Do you have tingling sensations in your hand?
    a. No tingling
    b. Mild tingling
    c. Moderate tingling
    d. Severe tingling
    e. Very severe tingling

12. How severe is numbness (loss of sensation) or tingling at night?
    a. I have no numbness or tingling at night
    b. Mild
    c. Moderate
    d. Severe
    e. Very severe

13. How often did hand numbness or tingling wake you up during a typical night during the past two weeks?
    a. Never
    b. Once
    c. Two or three times
    d. Four or five times
    e. More than five times

14. Do you have difficulty with the grasping and use of small objects such as keys or pens?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Very severe difficulty

These next questions are about wrist splints for your hand symptoms.

15. Has your doctor recommended or prescribed wrist splints for you?
    a. Yes
    b. No

16. Have you obtained wrist splints to help your hand symptoms?
    a. Yes
    b. No

If the answers to questions 15 and 16 was no; please skip ahead to question 22

17. About how many hours each day do you wear your wrist splints?
    a. I don`t wear wrist splints
    b. One hour or less
    c. 2-6 hours
    d. more than 6 hours each day

18. Do you wear your wrist splints at night while sleeping
    a. Never
    b. Occasionally
    c. Usually
    d. Always

19. Have you had your wrist splints adjusted for a better fit?
    a. Yes
    b. No

20. Do you wear your wrist splints to work outside the home?
    a. Never
    b. Occasionally
    c. Usually
    d. Always
    e. I don't work outside the home at present

21. Do you feel your wrist splints help your symptoms?
    a. Not at all
    b. Yes, somewhat
    c. Yes, a great deal
    d. Uncertain

These next questions are about medications. There is a group of medications called anti-inflammatory medications. This would include the ASA, aspirin group, but not the Tylenol, acetaminophen group. There are many anti-inflammatories on the market at present. Some you need a prescription from your doctor for and others you can just buy without a prescription. The names of some of the more common ones are: ASA, aspirin, Advil, Motrin, ibuprofen, Naproxen, Diclofenac, Voltaren, Celebrex, Vioxx, Mobicox.

22. Have you been prescribed any anti-inflammatory medications for your hand symptoms by your doctor?
    a. Yes
    b. No

23. Have you purchased any anti-inflammatory medications for your hand symptoms?
    a. Yes
    b. No

24. If your answer to question 23 was yes, about how long a period of time have or had you been taking anti-inflammatory medications? _____months or _____years.

25. Did you feel the anti-inflammatory medications helped your hand symptoms?
    a. Yes, somewhat
    b. Yes, a great deal
    c. No
    d. I haven't used anti-inflammatory medications

26. Have you received a "cortisone" or corticosteroid injection into your wrist area to treat your hand symptoms?
    a. Yes
    b. No

If your answer to question 26 was no, please skip to question 29.

27. Did this injection help your symptoms? Circle the best choice.
    a. Not at all
    b. Slight improvement
    c. Moderate improvement
    d. Large improvement
    e. Completely relief of symptoms

28. If the injection helped your symptoms, how long did the improvement last?
    a. Hours
    b. Days
    c. Weeks
    d. Months

29. Has your doctor discussed sending you to a surgeon about your hand symptoms?
    a. Yes
    b. No

30. Have you seen a surgeon for your hand symptoms?
    a. Yes
    b. No

31. Have you had surgery in the past for carpal tunnel syndrome?
    a. Yes on Right side
    b. Yes on Left side
    c. No

These next questions are about the impact your symptoms have had on your ability to do daily activities.

On a typical day during the past two weeks have hand and wrist symptoms caused you to have any difficulty doing the activities listed below? Please circle one answer for each question.

32. Have you had difficulty writing?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

33. Have you had difficulty buttoning clothes?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

34. Have you had difficulty holding a book while reading?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

35. Have you had difficulty gripping a telephone receiver?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

36. Have you had difficulty with opening of jars?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

37. Have you had difficulty with household chores?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

38. Have you had difficulty with carrying of grocery bags?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

39. Have you had difficulty with bathing and dressing?
    a. No difficulty
    b. Mild difficulty
    c. Moderate difficulty
    d. Severe difficulty
    e. Cannot do at all due to hand or wrist symptoms

40. Have you ever had to miss work because of your hand symptoms?
    a. Yes, rarely
    b. Yes, occasionally
    c. Yes, frequently
    d. Never
    e. Not applicable, as not currently employed

41. Have you had to file with workman's compensation board because of your hand symptoms?
    a. Yes
    b. No
    c. Not applicable as not currently employed

42. Are you a smoker?
    a. Yes
    b. An ex-smoker
    c. A never smoker

43. Does anyone in your family (parents, sisters, brothers, your children) have carpal tunnel syndrome?
    a. Yes
    b. No
    c. Don't know

44. Have you been told you have one or more of the following? Circle all which apply to you.
    a. Rheumatoid Arthritis
    b. Fibromyalgia
    c. A ganglion on the wrist
    d. Diabetes
    e. High blood pressure
    f. Thyroid problems
    g. None of the above

45. Are you taking any of the following kinds of medications? Circle all which apply to you.
    a. High blood pressure medicines
    b. Heart medications
    c. Medication to treat high cholesterol
    d. Antidepressants
    e. Aspirin (ASA) for stroke and heart attack prevention
    f. Vitamin B6
    g. Vitamins of any kind
    h. Thyroid medications
    i. None of the above

46. For women; circle all which apply to you. In the last six months have you been:

    a. Pregnant?
    b. Breastfeeding?
    c. On birth control pills?
    d. On fertility treatments?
    e. On other female hormone treatments?
    f. None of the above.

46. What is your height? _____ft/in.

47. What is your weight? _____lbs

48. What is your age? _____years.

49. Are you:
    a. Male
    b. Female

50. Please describe your usual occupation. (if retired, or not presently employed, please describe usual employment previously)

    Title:_____--
    Type of work you
    do:_____
    Kind of company or
    business_____

Thank you for taking the time to help us with this research survey
Please be assured all responses will be kept confidential.

[redacted]

_____ _____

Name Signature

Telephone number:_____ e-mail _____

Personal health number:_____

If further research projects are initiated into hand/wrist problems would you be agreeable to being contacted to participate?

Please put an X in one box. Thank you! ☐ Yes ☐ No.

Today's date: _____

If you have questions or comments about this survey study please contact:

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