Journal of Manipulative and Physiological Therapeutics
Volume 21 • Number 5 • June, 1998
0161-4754/98/2105-0317 $4.00/0 © 1998 JMPT

ORIGINAL ARTICLES

Comparative Efficacy of Conservative Medical and Chiropractic Treatments for Carpal Tunnel Syndrome: A Randomized Clinical Trail

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ABSTRACT

Objective: To compare the efficacy of conservative medical care with chiropractic care in the treatment of carpal tunnel syndrome.

Design: Two-group, randomized, single-blind trial with 9 wk of treatment and a 1-month follow-up interview.

Setting: Wolfe-Harris Center for Clinical Studies at Northwestern College of Chiropractic in Bloomington, Minnesota.

Patients: Ninety-one of 96 eligible subjects who reported symptoms that were confirmed by clinical exam and nerve conduction studies.

Interventions: Interventions included ibuprofen (800 mg 3 times a day for 1 wk, 800 mg twice a day for 1 wk and 800 mg as needed to a maximum daily dose of 2400 mg for 7 wk) and nocturnal wrist supports for medical treatment. Chiropractic treatment included manipulation of the soft tissues and bony joints of the upper extremities and spine (three treatments/week for 2 wk, two treatments/week for 3 wk and one treatment/week for 4 wk), ultrasound over the carpal tunnel and nocturnal wrist supports.

Main Outcome Measures: Outcome measures were pre- and postassessments of self-reported physical and mental distress, nerve conduction studies and vibrometry.

Results: There was significant improvement in perceived comfort and function, nerve conduction and finger sensation overall, but no significant differences between groups in the efficacy of either treatment.

Conclusions: Carpal tunnel syndrome associated with median nerve demyelination but not axonal degeneration may be treated with commonly used components of conservative medical or chiropractic care. (J Manipulative Physiol Ther 1998; 21:317–26).

Key Indexing Terms: Carpal Tunnel Syndrome; Chiropractic; Electrodiagnosis; Randomized Controlled Trial

INTRODUCTION

Carpal tunnel syndrome (CTS) with pain and sensory and motor deficits is treated with a variety of conservative (nonsurgical) and nonconservative (surgical) interventions. These include manual procedures, prescription of nonsteroidal anti-inflammatory drugs (NSAIDs), wrist supports, injection of steroids into the carpal tunnel and several forms of surgery (1–21). Recent practice parameters developed by the American Academy of Neurology indicate a conservative, nonsurgical approach as the preferred primary treatment (22). In addition to medical providers of conservative care, chiropractic physicians treat CTS, and in some locations they are the most commonly sought conservative primary care for CTS (23). Conservative treatment for CTS, including the manual therapy of chiropractic, if effective, can relieve patients of serious discomfort and dysfunction and offer longer term, nonsurgical management of CTS.

Increased availability of and access to screening and primary treatment for CTS will be an important factor in reducing the number of cases left untreated. Moreover, if chiropractic can be shown to be efficacious primary care, patients unable to tolerate NSAIDs would have alternate conservative treatment available.

The research question in this study was this: How do outcomes of chiropractic treatment of CTS compare with outcomes of conservative medical treatment? This question is the first in a series developed to examine the efficacy of several modes of conservative care for CTS. This first project does not contain a "delayed-treatment control group" because its purpose is limited to comparing an established and preferred primary treatment mode (conservative medical) (12, 22) with

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Paper submitted October 14, 1997; in revised form December 11, 1997.
Presented at the Annual International Conference on Spinal Manipulation, Bournemouth, UK, October 1996. This research was funded through Grant 92–10-03 from the National Chiropractic Mutual Insurance Company and administered by the Foundation for Chiropractic Education and Research. The research team thanks these organizations for their consistent support of efficacy and effectiveness research relevant to chiropractic.

one that is not yet supported by randomized clinical trials in the peer-reviewed literature (chiropractic treatment). Additionally, treatment protocols in the project reflect the current practice of primary care in the United States that usually involves several components. In one study, more than three fourths of a sample of primary care physicians treating patients for CTS reported using multiple modalities (12). This research design does not permit assessment of the separate effects of each treatment component.

The null hypothesis was that there would be no difference in the outcome of either treatment based on subject self-reports of distress or neurophysiological measures of dysfunction after a 1-month follow-up period. The alternate hypothesis was that one treatment would prove superior to the other.

METHODS

Recruitment and Inclusion/Exclusion Criteria of Subjects

Subjects were recruited using notices in local newspapers and on local radio. Respondents were screened through telephone and personal interviews, self-reported health history and health status questionnaires and clinical interviews. Inclusion criteria for the personal interview were the following: men and women aged 21–45 yr with self-reported symptoms of CTS, especially numbness and tingling in the affected hand(s), and results of a clinical exam indicating symptoms involving the median nerve distribution. Excluded were people with a currently prescribed treatment for CTS, a pending workers' compensation claim based on CTS, pregnancy in women, a relevant systemic condition (diabetes or thyroid disorder), a prior wrist surgery, a current prescriptive anti-inflammatory medication or vitamin B_6 supplementation, a prescriptive wrist brace worn on a regular basis or electrodiagnostic abnormalities inconsistent with CTS or indicating axonal degeneration.

The inclusion/exclusion clinical exam included pinch and full-hand grip strength assessments; a Semmes-Weinstein monofilament test; Phalen's and Tinel's tests; and orthopedic and neurological testing for CTS and possible spinal involvement. Testing focused on both the upper extremities and the cervical and thoracic spine (24–28). Results of the clinical exams for inclusion Semmes-Weinstein, Phalen's and Tinel's test data are not included here because they are separate from the evaluative data focusing on efficacy of treatment.

Baseline neurophysiological assessment for inclusion relied on nerve conduction studies (NCS) in the affected hand(s) and were performed on either a Cadwell Sierra or Dynamic Engineering Nomad. Baseline and end-of-treatment NCS were also used as evaluative, baseline-to-follow-up measures. Nerve conduction inclusion criteria were (a) a median sensory nerve peak latency in the fourth digit >3.5 msec or a fourth-digit median-to-ulnar nerve-peak latency difference of ≥ 0.5 msec, and (b) a median sensory palm-wrist peak latency of > 2.3 msec or a median-to-ulnar palm-wrist segment latency difference of ≥ 0.5 msec. The project used measures of fourth-digit latencies because they are more sensitive in the detection of CTS and permit comparison of median-ulnar differences (29–31). Antidromic digital sensory studies were performed with the active recording electrode at the metacarpophalangeal joint and the active stimulating electrode at 13-cm proximal over the respective median or ulnar nerve. Palm-wrist segment studies were performed orthodromically with an 8-cm distance between the active stimulating and recording electrodes. For median motor studies, patients were tested with the stimulating electrode placed 6 cm from the recording electrode over the median nerve (first site) and along the medial border of the biceps just proximal to the tendinous junction (second site). All recordings were made with patient skin temperature at or above 31°C (32).

Treatment Protocols

Those in the medical group received ibuprofen 800 mg 3 times a day for 1 wk, 800 mg twice a day for 1 wk, and 800 mg as needed for 7 wk to a maximum cumulative daily dose of 2400 mg (1, 12). Medication was monitored during personal interviews and through telephone contact. Medical treatment included cock-up (15° from horizontal) nocturnal wrist supports (elastic closure with a metal splint) (13). Subjects in the chiropractic group received high-velocity, low-amplitude manual thrust procedures creating a cavitation response and increased joint motion in the bony joints of the upper extremities including the wrist, elbow and shoulder as well as in the vertebrae of the cervical and upper thoracic regions. Soft tissue tonicity was also addressed with myofascial massage and loading procedures (5). Three chiropractic treatments were given per week in the first 2 wk, two treatments per week for the next 3 wk, and one treatment per week in the final 4 wk. The term "treatment" used here indicates subject visit; actual therapeutic intervention during each treatment or visit was given as appropriate at the discretion of the chiropractic physician. Chiropractic subjects also received ultrasound treatment (Chattanooga Group Intelect Model 230P, Chattanooga, TN) and, like the medical group, nocturnal wrist supports. Ultrasound was applied over the carpal tunnel for half of the chiropractic treatment visits at a setting of 1 MHz and 1.0–1.5 W/cm^2 at 50% duty cycle for 5 min (11).

Evaluation of Change

Primary evaluative measures were used to assess changes over time (33). From baseline to the end of treatment, primary outcome evaluative measures of change included self-reports of physical and mental distress and neurophysiological assessments of nerve conduction velocity. Self-report instruments of physical and mental distress focused on hand discomfort and function were developed for the project [Carpal Tunnel Outcome Assessment-physical distress (CTOA-P); Carpal Tunnel Outcome Assessment-for mental distress (CTOA-M)]. These instruments were developed and used before standardized, self-report assessments of outcome of CTS treatment became available (34–36). The CTOA-P and the CTOA-M are presented and discussed in Figures 1 and 2. Examples of typical instructions include the following: "Because of your hand(s), how often in the past 4 wk have you had difficulty performing the following activities?" CTOA-P items include "opening jars, bottles," and CTOA-M items include "I become embar-

1. CTOA-P: CTS OUTCOME ASSESSMENT- PHYSICAL DISTRESS SCALE

Because of your hand(s), how often in the past 4 weeks have you had difficulty performing the following activities?

Items	Response Set:
1. Dressing yourself	0 = "Not at all"
2. Driving personal transportation	1 = "A little bit"
3. Holding objects	2 = "About 1/2 time"
4. Lifting objects	3 = "Most of the time"
5. Washing dishes	4 = "All the time"
6. Using a telephone	
7. Opening doors or windows	
8. Personal hygiene: showering, washing hair, brushing teeth, combing hair, wiping your backside, etc.	
9. Feeding yourself, using utensils	
10. Opening jars, bottles	

Because of your hand(s), how much difficulty have you had with the following tasks in the past 4 weeks?

Items	Response Set
11. Writing	0= "None"
12. Tying bows, knots, or shoelaces	1= "Mild"
13. Finding removing objects from pockets	2= "Moderate"
14. Performing household chores	3= "Severe"
15. Operating appliances or tools that vibrate	4= "Extreme"
16. Wearing or removing rings from your fingers	

Higher unweighted summary score = Greater Physical Distress
Minimum score: 0 Maximum score: 64 Internal Consistency/ Reliability: ALPHA=.90

Fig. 1 *Self-reported carpal tunnel syndrome questionnaires.*

rassed in social gatherings." The response sets are variations of "not at all," "a little bit," "about half the time," "most of the time" and "all the time." The CTOA-P and CTOA-M scales demonstrated reliability in the study (Cronbach's alphas, indicating internal consistency, were 0.90 and 0.86, respectively) (Figures 1 and 2). The scales differentiated quite well between symptomatic (volunteer research participants) and asymptomatic (volunteers with no self-reported upper extremity tingling or numbness). In separate logistic regression modeling of data including the symptomatic (n = 91) and asymptomatic (n = 93) participants, the CTOA-P and CTOA-M successfully differentiated ($p < .0001$) between the two groups (37). Neurophysiological assessment, from baseline to the end of treatment, involved NCS of digit 2 of the affected hand(s) (32).

From baseline to 1-month follow-up, objective assessment involved vibrometric thresholds of finger sensation on affected hand(s) and was the primary outcome assessment. The vibrometer is used to analyze the vibrotactile sensibility of the hand and especially the fingers. Vibrotactile sensibility can verify early sensory impairment. The protocol for vibrometric assessment is detailed elsewhere (38–41). Third digits were tested, yielding evaluations of median innervated sites. The vibration shaker producing vibrations from 8 to 500 Hz (8, 16, 31.5, 63, 125, 250 and 500 Hz) is contained in a support frame providing a rest for fingers not tested and a plastic tip of the shaker for the finger assessed. Frequencies perceived by the subject were automatically recorded by the vibrometer. The Total Jetzer Index, used as the vibrometric score for the third digit in each affected hand, is a sum of the measures in decibels (db) taken at each of the seven frequencies. The vibrometer used was a Bruel and Kjaer Vibrometry System 9627 (Naerum, Denmark). The reliability and validity of the vibrogram are being debated (42–45).

Secondary self-reported outcome assessments included a five-item hand-finger functioning subscale, HAND, developed for the research by the investigators, and a general health status questionnaire, SF–36. (46) (See Figures 1 and 2). The HAND instructions include questions such as "during the past month. . . . . could you tie a knot or bow?" The response set is "all days," "most days," "some days," "few days" and "no days." The reliability of the HAND scale is indicated by Cronbach's alpha (79). Secondary neurophysiological assessments involved NCS of the median motor and sensory nerves for digits 3 and 4 and palm-wrist segment of the affected hand(s) (32).

Statistical Power

Statistical power and the sample size were based on pilot vibrometric measurements collected by the research team from asymptomatic volunteers indicating a standard deviation of 6.14 db (47). The minimal mean difference between groups that was considered significant was 4.0 db. The power calculation, based on an acceptable type I error of 5% and type II error of 20%, yielded a suggested 36 subjects in each of the two groups (48). Allowing for an expected 20% attrition indicated a goal of 45 subjects per group.

2. CTOA-M: CTS OUTCOME ASSESSMENT - MENTAL DISTRESS SCALE

Regarding your hands, please choose the answer that best describes how true or false each of the following statement is for the past four weeks:

	Items	Response Set:
*	1. I can enjoy my hobbies as much as before.	0= "Definitely true"
	2. I work more slowly than before.	1= "Mostly true"
	3. I have difficulties with intimate encounters.	2= "Not sure"
	4. I become embarrassed in social gatherings.	3= "Mostly false"
	5. I become frustrated or angry with myself more easily than before.	4= "Definitely false"
	6. I frequently take breaks from hard activities.	
*	7. I feel rested in the morning.	
	8. I feel more clumsy than before.	
	9. I feel that people notice or stare at my hand more often.	
	10. I feel less useful than before.	
	11. I feel less able to express my creativity.	
	12. I drink alcohol more than before.	
	13. I use more over-the-counter pain relievers.	
	14. I wonder if I'm more seriously ill than my doctor or others suspect.	
	15. I am less optimistic about the future.	
	16. I am concerned about my future ability to perform my daily tasks or work.	
	17. I have more aches and pains in my hands or arms than before.	
	18. I cut down on the amount of time spent on work or other related activities.	

* = Coding reversed prior to scoring.

Higher unweightred summary score = greater mental distress
Minimum score = 0 Maximum score = 72 Internal consistency: ALPHA = .86

3. HAND: HAND- FINGER FUNCTIONING SCALE

These questions refer to HAND AND FINGER FUNCTION. DURING THE PAST MONTH ...

Items	Response Set:
1. Could you easily write with a pen or pencil?	1= "All Days"
2. Could you easily button a shirt or blouse?	2= "Most Days"
3. Could you easily turn a key in a lock?	3= "Some Days"
4. Could you easily tie a knot or bow?	4= "Few Days"
5. Could you easily open a new jar of food?	5= "No Days"

Higher unweighted summary score = Greater hand and finger dysfunction
Minimum score = 5 Maximum score = 25 Internal consistency: ALPHA = .79

Fig. 2 *Self-reported carpal tunnel syndrome questionnaires (continued).*

Statistical Analysis

Statistical analysis first involved assessments of bias in group assignment and group dropout rates using cross-tabulation and group t tests (SPSS for Windows, version 6.1; SPSS Inc., Chicago, IL). At no point were missing data replaced with imputed information. Outcome analyses from baseline to end of treatment and from baseline to follow-up were performed using a repeated-measures multivariate analysis of variance procedure with a control of participant in the initial models for both self-reported and neurophysiological measures (STATISTICA for Windows; StatSoft Inc, Tulsa, OK). Criteria for statistical significance, the probabilities associated with Type I error, were adjusted to conservative levels to reflect the number of planned primary comparisons (six comparisons) of the measures: NCS (two comparisons: both hands, digit 2), vibrometer (two comparisons: both hands), the CTOA-P (one comparison) and the CTOA-M (one comparison) to decrease the chance of randomly significant results. Accordingly, the single-test level ($p = .05$) was divided by 6 to generate the new criterion for statistical significance, $p < .00833$ (48). Confidence intervals (99%) were calculated for each of the primary outcomes: overall mean differences before and after and mean differences between group changes.

Analyses included all subjects who completed end-of-treatment and one-month follow-up self-reports and assessments. The research included subjects who may have received less than the full 9 wk of medical or chiropractic treatment but were present when data at the end of treatment or follow-up were collected. There were no a priori rules for stopping the trial before all subjects were treated, interviewed and assessed.

Assignment to Treatment

This was a randomized clinical trial, and subjects were randomly assigned to either conservative medical or chiropractic treatment for 9 wk to control for biased assignment. Level of activity that might have caused or aggravated CTS, either before or during treatment, was also controlled through random assignment.

Assignment was based on a computer-generated random sequence of letters "A" and "B" that were placed in a series of opaque envelopes in the order they printed, sealed and opened in sequence only as subjects were qualified at their clinical interviews and assigned treatment. At this point, each subject had reviewed and signed an informed consent to treatment form approved by the Human Subjects Committee of Northwestern College of Chiropractic. Neither investigators nor sub-

jects were aware of group assignments before the envelopes were opened. The research consultant who generated the random sequence was not otherwise involved in the interviewing, random assignment process or treatment. Masking treatment group to subjects and treating physicians was not possible, but it was possible to mask subject assignment to nerve conduction and vibrometric assessment physicians or technicians and the data analyst. Subject group identifiers were merged with the dataset only after data entry had been completed. Baseline, end-of-treatment and 1-month follow-up self-reported data concerning health history, general health, hand discomfort and hand functional status were collected.

RESULTS

Subject Flow, Follow-Up, Dropout

A total of 1624 volunteers responded to notices in local newspapers and radio. From these, 652 prospective participants were qualified for personal interviews and clinical assessment, and 361 took part in the interviews and exams. Of the 265 people found to be not qualified for the project, 11 (3% of 361 interviewees) were disqualified because of reduced motor amplitude (NCS) and/or thenar atrophy (physical exam). Finally, 96 people qualified for participation, and 91 accepted random assignment to treatment. Five people who were qualified for participation refused random assignment because their schedules made them unavailable to the research (two subjects), or despite their orientation and their agreement to be assigned randomly, they still wished to select their treatment mode (three subjects). Random assignment yielded 46 participants in conservative medical contact at end-of-treatment and follow-up interviews, including the number of subjects who dropped out, is given in Figure 3.

Analysis

The analysis to detect possible group bias, either in assignment or in dropout rate, indicated no significant differences between groups. At baseline, both medical and chiropractic groups were not significantly different regarding gender, age, education, marital status, previous visits to a chiropractic physician, chronically split by baseline median, severity split by baseline median and the degree to which right hands, left hands or both hands were affected. In addition, groups were not significantly different regarding the number of dropouts at the end of treatment or at follow-up. Finally, means of self-reported measures for subjects and neurophysiological measures for both right and left hands indicated groups were similar at baseline (Table 1).

Some subjects experienced adverse effects of treatment. In their clinical interviews, 10 (22%) of the 46 medical subjects receiving ibuprofen reported some intolerance to ibuprofen within the first 2 wk of treatment, and five of these experienced marked intolerance (acute gastrointestinal intolerance, headache and/or nausea) and were unable to continue taking the medication. Two of the five dropped from the project, and the remaining three were retained without a requirement that they continue to take medication. The other five medical subjects with adverse reactions continued taking ibuprofen with a liquid antacid. One chiropractic subject complained of a temporary "sore neck," linked to manipulation, at the end-of-treatment interview. This subject completed the project. Adverse effects for both chiropractic and medical treatment were recorded in daily clinical notes and summarized at the end of treatment for each subject.

The final analyses assessed the significance of changes experienced by each treatment group, controlling for gender. Self-reported physical and mental distress decreased significantly for all subjects, medical and chiropractic, from baseline to end-of-treatment. None of the treatment group or gender differences was statistically significant, although subjects having medical treatment did tend to experience more pronounced decreases in mental distress from baseline to end-of-treatment than did subjects undergoing chiropractic treatment. Additional self-reports were used in secondary analyses; the HAND scale indicated overall improvement, but the SF-36 global scale, role-physical and bodily pain subscales did not (Table 2).

Results for neurophysiological measures were similar to the self-reports. Group differences in change in NCS and vibrometry were tested for the 84 affected right hands and 65 affected left hands separately, rather than for the total 149 affected hands to avoid bias favoring outcomes of individuals with bilateral CTS. These sets of analyses indicated an overall treatment effect, either from baseline to end-of-treatment (nerve conduction) or from baseline to follow-up (vibrometer), without accompanying gender and treatment group effects. Subjects in both groups experienced substantive increases in vibrometer scores indicating clinically meaningful improvement in finger sensation. For example, for affected right hands, the medical group averaged an improvement of 1.37 db, and the chiropractic group averaged an improvement of 3.05 db. The group difference of 1.68 db in these changes, however, is not statistically significant.

Of the secondary comparisons, the HAND survey corroborated the results of the primary self-reports, and at the original $p < .05$ level, five of the six secondary nerve conduction assessments of wrist, digit 3 and palm supported the primary findings (Tables 2 and 3).

DISCUSSION

Interpretation

Subjects in both treatment groups improved significantly; they felt better, their nerve conduction velocities increased and their finger sensation improved. Overall improvement for both treatment groups indicated by self-reported physical and mental distress, NCS and the vibrometer can be considered clinically meaningful. That these results are based on both subjective and objective measures strengthens this interpretation.

Nevertheless, because there were no a priori equivalence criteria established, the present research neither "proves" the equivalence of conservative medical with chiropractic treatment for CTS nor do the results indicate that either treatment is more efficacious than "watchful waiting." Such conclusions may be possible after more definitive research is conducted.

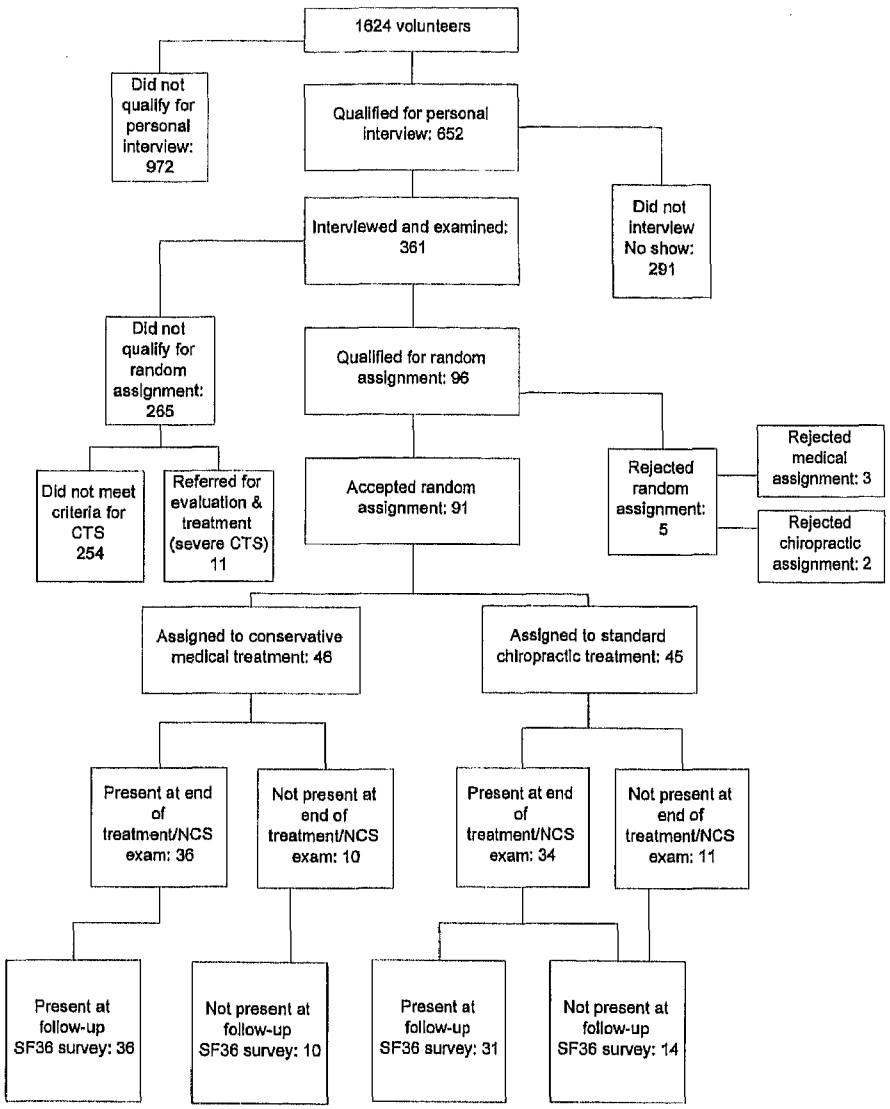

Fig. 3 *Management of volunteers and trial subjects.*

As research accumulates, if evidence continues to indicate that chiropractic treatment is appropriate for CTS, another mode of conservative treatment could be offered to patients with CTS, especially to those who are unable to tolerate ibuprofen.

Limitations of the Research

The research was designed as the first of several projects of increasing complexity examining the usefulness of conservative treatments of CTS. The current project was designed to be a comparison of two treatments for CTS as they are practiced in primary care settings. As such, the project involved two single-effect treatments and no delayed-treatment control group and did include treatments with several aggregated components, the effects of which were not assessed separately.

Secondly, factors that may have increased or decreased symptoms of CTS were uncontrolled. The assumption of the research was that, after participants were randomly assigned and began treatment, equal proportions acted to increase or decrease risk of CTS symptomology. That is, that equal proportions decreased risky, hand-intensive activity or initiated forms of self-treatment such as regular stretching and exercise.

Another limitation of the research is that each treatment group lost > 20% of its subjects by the end of treatment and follow-up. In fact, the medical group lost 22% and the chiropractic treatment group lost 31% of their subjects by the 1-month follow-up. Although the difference between the groups in the proportion of subjects lost was not statistically significant, the greater dropout rate for chiropractic subjects may have been related to the number of qualification, treatment and evaluation visits required of these subjects (22 visits) compared with the number of visits required of the medical subjects (11 visits). Analyses of dropout bias at the two endpoints indicated no significant group differences in gender- or hand-specific severity and chronicity effects (all χ^2 tests were nonsignificant, ranging from $p < .21$ to $p < .96$). It is not clear

Table 1. *Patient characteristics across treatment groups*

Characteristic	Conservative medical (n = 46)[a]	Standard chiropractic (n = 45)[b]	Significance of difference (p value)
Total affected right hands[c]	41	43	<.25
Total affected left hands[c]	35	30	<.32
Gender (% female)	63	56	<.47
Age (mean, SD)	38 (5)	36 (6)	<.25
Education (% college)	39	53	<.18
Ethnicity (% White)	96	98	<.57
Marital status (% married)	72	58	<.16
Previous chiropractic care (%)	54	53	<.92
Subjects lost at EOT[d] (% of baseline total)	10 (22)	11 (24)	<.76
Men lost at EOT (% of all missing subjects at EOT)	5 (50)	7 (64)	<.53
Lost subjects with greater severity[e] CTS in: (% of all missing hands at EOT)			
Affected right hands	5 (56)	6 (67)	<.63
Affected left hands	3 (38)	4 (44)	<.77
Lost subjects with greater chronicity[c] CTS in: (% of all missing hands at EOT)			
Affected right hands	6 (67)	4 (40)	<.25
Affected left hands	4 (50)	3 (30)	<.39
Subjects lost at follow-up (% of baseline total)	9 (20)	14 (31)	<.21
Men lost at follow-up (% of missing subjects at follow-up)	5 (56)	9 (64)	<.68
Lost subjects with higher severity[e] CTS in: (% of all missing hands at follow-up)			
Affected right hands	5 (63)	8 (62)	<.96
Affected left hands	3 (50)	5 (56)	<.83
Lost subjects with higher chronicity[c] CTS in: (% of all missing hands at follow-up)			
Affected right hands	6 (75)	7 (50)	<.25
Affected left hands	4 (50)	3 (30)	<.42

EOT, end of treatment; CTS, carpal tunnel syndrome.

[a] Nonsteroidal anti-inflammatory drugs and nocturnal wrist supports; 46 subjects at baseline.

[b] Manipulation of soft tissues and bony joints of the upper extremities; 45 subjects at baseline.

[c] Affected hand is unit of analysis for evaluation of hand-specific physical assessments; chronicity split: "chronic" indicates hand-wrist discomfort for 2 or more years before interview.

[d] Individual is unit of analysis for evaluation of self-reported data.

[e] Affected hand is unit of analysis for evaluation of hand-specific physical assessments; severity split at median: "severe" indicates a median nerve conduction time greater than 4.2 ms.

to what extent additional, unmeasured variables may be associated with dropping out.

No examination of the relative cost of medical and chiropractic treatment was made. This analysis, whether cost-effectiveness or cost-comparative, is of increasing importance to health care research. Such analysis will be a component of subsequent research concerning conservative care of CTS.

Finally, at the beginning of the research, inclusion criteria required that a person have positive findings from both nerve conduction and vibrometric testing and an overall clinical judgment that the patient had CTS. After 1 yr and 84 clinical interviews, the research team had only qualified 18 subjects, and the requirement of a positive vibrometric result for inclusion was discontinued. Vibrometric testing, at baseline and follow-up, was continued for research purposes. During the first year, of 84 volunteers tested, seven were disqualified because their vibrometric scores and the findings of their clinical interviews were both negative for CTS. These seven were not tested with the NCS procedures. The remaining 77 volunteers were disqualified based on negative findings of nerve conduction tests and their clinical interviews. After the change in inclusion criteria, the research team recruited and qualified an additional 78 subjects in 1.5 yr to complete the subject pool of 96. If all seven people who disqualified in part because of their "normal" vibrometric results had all tested positive for CTS with nerve conduction testing, the research may have failed to qualify seven volunteers with bona fide CTS. This possibility is remote, however, because the primary

Table 2. *Self-Reports, Pre- and Postintervention (mean (SD))*

	Conservative medical[a]			Chiropractic[b]			Strength of effects	
Baseline to EOT[c]	Baseline	EOT	*n*	Baseline	EOT	*n*	Overall	Treatment
CTOA-P	14.66 (9.89)	5.74 (6.28)	38	12.47 (8.07)	9.25 (8.14)	36	$p = .0000$[d]	$p = .0132$[e]
CTOA-M	33.61 (12.02)	14.94 (11.33)	36	28.94 (11.69)	17.29 (13.24)	34	$p = .0000$[d]	$p = .0085$[e]
Baseline to follow-up	Baseline	Follow-up	*n*	Baseline	Follow-up	*n*	Overall	Treatment
HAND	80.71 (18.48)	89.43 (13.60)	35	80.97 (13.32)	86.13 (13.02)	31	$p = .0000$	$p = .2703$
SF-36D								
Global	72.08 (12.72)	75.99 (12.34)	36	74.79 (10.90)	75.14 (12.38)	31	$p = .1420$	$p = .2174$
Role phys	68.94 (37.52)	80.30 (31.10)	33	75.96 (33.53)	64.42 (40.73)	26	$p = .9842$	$p = .0118$
Body pain	60.80 (21.16)	64.51 (16.12)	36	67.74 (20.36)	69.53 (21.46)	31	$p = .3664$	$p = .7527$

EOT, end of treatment; CTOA-P, Carpal Tunnel Outcome Assessment—Physical distress; CTOA-M, Carpal Tunnel Outcome Assessment—Mental distress.
[a] Ibuprofen and nocturnal wrist supports.
[b] Manipulation of the bony joints and soft tissues of the upper extremities, ultrasound, and nocturnal wrist supports.
[c] Primary outcomes.
[d] Confidence intervals (99%) for overall decrease: CTOA-P: X, −6.69 (−9.43, −3.95) and CTOA-M: X, −15.26 (−18.84, −11.67).
[e] Confidence intervals (99%) for differences in group decrease: CTOA-P: X, −4.59 (−9.93, +.76) and CTOA-M: X, −7.02 (−13.89, −.15).

criteria for all inclusions remained the presence of self-reported symptoms in the distribution of the median nerve and the judgment of the clinical interview.

CONCLUSION

Further research, including participants with self-reported symptoms who did not require positive findings from NCS, will need to include a wider range of subjects to reflect more accurately the primary care patient population. In addition, the age range of subjects can be expanded to include older subjects.

Research will need to define the separate effects of specific interventions: NSAIDs, placebo drugs, splinting, ultrasound and the like. In addition, research designs will need to permit assessments of the effect of "natural history," and to include evaluations of cumulative treatment cost. Finally, follow-up periods of 6 months or longer, rather than 1 month, will enable an assessment of longer term, lasting effects.

Table 3. *Physical Assessments: Pre- and Postintervention (mean (SD))*

	Conservative medical[a]			Chiropractic[b]			Strength of effects	
NCS[c]	*Baseline*	*EOT*	*n*	*Baseline*	*EOT*	*n*	*Overall*	*Treatment*
Median motor, wrist (onset)								
Right	4.64 (1.02)	4.53 (1.22)	35	4.47 (.69)	4.32 (.68)	32	$p = .0085$	$p = .6418$
Left	4.35 (.94)	4.29 (.95)	30	4.10 (.83)	4.14 (.49)	21	$p = .8006$	$p = .3383$
Median sensory, digit 2								
Right[d]	4.18 (.79)	4.06 (.84)	35	4.08 (.61)	3.99 (.64)	32	$p = .0014$[e]	$p = .6109$
Left[d]	4.05 (.58)	3.87 (.58)	30	3.66 (.43)	3.76 (.38)	21	$p = .0000$[e]	$p = .2342$
Median sensory, digit 3								
Right	4.30 (.92)	4.07 (.82)	34	4.20 (.70)	4.12 (.84)	32	$p = .0061$	$p = .1686$
Left	4.14 (.68)	3.96 (.80)	29	3.95 (.59)	3.81 (.55)	20	$p = .0007$	$p = .6193$
Median sensory, palm								
Right	2.86 (.68)	2.73 (.52)	33	2.84 (.46)	2.79 (.50)	31	$p = .0171$	$p = .2919$
Left	2.75 (.46)	2.66 (.48)	29	2.70 (.38)	2.59 (.36)	21	$p = .0018$	$p = .7907$
Vibrometry[f]	Baseline	Follow-up	*n*	Baseline	Follow-up	*n*	Overall	Treatment
Right[d]	27.86 (6.43)	29.23 (5.84)	32	27.14 (5.46)	30.19 (5.88)	29	$p = .0002$[g]	$p = .1424$
Left[d]	28.22 (5.26)	30.57 (5.39)	29	25.94 (6.82)	28.66 (6.64)	20	$p = .0003$[g]	$p = .7802$

[a] Ibuprofen and nocturnal wrist supports.
[b] Manipulation of the bony joints and soft tissues of the upper extremities, ultrasound, and nocturnal wrist supports.
[c] Nerve conduction study (NCS) baseline to end-of-treatment (EOT); onset (wrist) or peak latencies measured in milliseconds.
[d] Primary outcomes.
[e] Confidence intervals (99%) for overall decrease: NCS Digit 2: Affected right hands: X, −.11 (−.19, −.02) and left: X, −.15 (−.24, −.07).
[f] Vibrometry baseline to 1-month beyond EOT follow-up; perception measured in decibels and is given as a Total Jetzer Index.
[g] Confidence intervals (99%) for overall increase: Vibrometer: Affected right hands: X, 3.21 (.07, 6.35) and left: X, 2.50 (.79, 4.20).

ACKNOWLEDGMENTS

We would like to thank the medical consultants and prescribing physicians who assisted them: AV Anderson, D.C., M.D.; Michael Bromer, M.D.; Steven Noran, M.D.; and Steven LeBow, M.D.; and the testing, examining, treating chiropractic physicians who assisted as well: Thomas Bergmann, D.C.; Aase Bronfort, D.C.; Barbara Davis, D.C.; Brad Finer, D.C.; Becky Mjoen, D.C.; Craig Nelson, D.C.; Susan Schoenheider, D.C.; David Simith, D.C.; David Stude, D.C.; Jonathan Williams, D.C.; Zachary Zachman, D.C. Several senior chiropractic students provided invaluable help with evaluation process. Our gratitude goes to Cadwell Labs (Kennewick, WA) and Dynamic Engineering (Middleton, WI) for making testing equipment for nerve conduction studies available to the project. Our gratitude also goes to Chattanooga Group (Chattanooga, TN) for allowing us to use their ultrasound equipment. Finally, we are grateful to Richard Grimm, M.D., Ph.D., of the Berman Center for Clinical and Outcomes Research (Minneapolis, MN), and Kinley Larntz, Ph.D., of the University of Minnesota Department of Applied Statistics, for their reviews of both method and reporting. Excellent advice from all quarters notwithstanding, full responsibility for the conduct and reporting of the research remains with the authors.

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