Effectiveness of Osteopathic Manipulative Treatment for Carpal Tunnel Syndrome: A Pilot Project

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Context: Osteopathic manipulative treatment (OMT) has been recognized as a management option for carpal tunnel syndrome (CTS), although limited research exists to substantiate its effectiveness.

Objective: To evaluate the effectiveness of OMT in the management of CTS.

Methods: This single-blinded quasi-controlled trial was conducted at an academic institution. Participants with CTS underwent weekly OMT sessions for 6 consecutive weeks. The main outcome measures were the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ), a sensory symptom diagram (SSD), patient estimate of overall change, electrophysiologic testing of the median nerve (trans–carpal tunnel motor and sensory nerve conduction velocity and amplitude ratio), and carpal tunnel ultrasound imaging of the cross-sectional area of the median nerve and transverse carpal ligament length and bowing. All outcome measures were administered to participants before the first OMT session. Immediately after the first session, electrophysiologic testing of the median nerve and ultrasound imaging of the carpal tunnel were repeated. After 6 weeks of OMT, all outcome measures were readministered.

Results: Results of the BCTQ revealed statistically significant improvements in symptoms and function after 6 weeks of OMT (F=11.0; P=.004), and the improvements tended to be more pronounced on the treated side. The drop in SSD scores after 6 weeks of treatment was statistically significant (F=4.19; P=.0002). Patient estimate of overall improvement of symptoms was statistically significant for the treated side. No statistically significant changes in electrophysiologic function of the median nerve, cross-sectional area of the median nerve, or transverse carpal ligament bowing were observed. After treatment, the increase in transverse carpal ligament length was statistically significant, but no side-to-side difference was detected.

Conclusion: Osteopathic manipulative treatment resulted in patient-perceived improvement in symptoms and function associated with CTS. However, median nerve function and morphology at the carpal tunnel did not change, possibly indicating a different mechanism by which OMT acted, such as central nervous system processes.

Carpal tunnel syndrome (CTS) is the most common peripheral entrapment neuropathy. Surgical decompression of the carpal tunnel is an evidence-based and commonly performed treatment for patients with severe cases of CTS and provides long-term symptom relief.[1] Evidence-based nonsurgical treatments shown to provide short-term relief for mild to moderate CTS include the use of ergonomic keyboards, therapeutic ultrasonography, wrist splinting, oral corticosteroids, and intra–carpal tunnel corticosteroid injection.[2,3] Osteopathic manipulative treatment (OMT) for CTS has been reported but is less commonly used,[4] possibly owing to the paucity of research validating these techniques.

To our knowledge, no controlled trial evaluating the effectiveness of OMT for CTS has been published. The existing literature is predominately the substantial work of 1 clinical researcher and is composed primarily of case reports and case series.[5-11] The research by Sucher[5-8] and Sucher et al[9] suggest that OMT results in favorable changes in CTS symptoms, palpatory diagnostic findings, median nerve conduction, magnetic resonance imaging measures of carpal tunnel size, and cadaveric measures of transverse carpal ligament length. Sucher[10,11] pioneered the use of neuromuscular ultrasonography to evaluate the pathomechanics of median nerve compression at the carpal tunnel during prehensile hand activity. Several reliable and valid quantitative instruments that measure the presence and severity of CTS have become available. These instruments include a standardized questionnaire to quantify CTS symptoms and associated hand dysfunction, electrophysiologic techniques reflecting median nerve myelination and axonal function in the carpal tunnel, and measures of median nerve and transverse carpal ligament morphology using ultrasound imaging. The purpose of the present pilot study was to evaluate the effectiveness of OMT for CTS using a robust study design and currently available validated quantitative outcome measures.

Methods

The Institutional Review Board of the A.T. Still University–School of Osteopathic Medicine in Arizona (ATSU-SOMA) in Mesa approved the study.

Participants

Recruitment of study participants targeted all students and staff of ATSU-SOMA via an e-mail outlining typical symptoms of CTS, a brief description of the study, and an invitation to be evaluated if they thought they might have CTS and, if so, to participate in the study. In addition, patients in the Physical Medicine and Rehabilitation practice of D.C.H. with suspected or confirmed CTS were contacted by telephone and asked whether they were interested in participating in the study. If patients did not answer the phone, a message was left for interested patients to call the office. Respondents who expressed an interest in participating were then contacted by telephone to review the study requirements and inclusion and exclusion criteria. Before enrollment, all potential participants underwent clinical and electrophysiologic testing performed by the same physician (R.S.B.) to ensure that they met the following criteria:

- symptoms compatible with CTS involving at least 1 upper limb, including hand numbness, tingling, pain, weakness, or nocturnal symptom exacerbation
- electrophysiologic evidence of median nerve dysfunction typical in CTS (median sensory nerve conduction velocity <43 m/s or distal motor latency >4.3 milliseconds in the carpal tunnel) involving at least 1 symptomatic upper limb[12]
- no clinical or electrophysiologic evidence of peripheral neuropathy, cervical radiculopathy, brachial plexopathy, proximal median neuropathy, ulnar or radial neuropathy, a history of carpal tunnel release surgery, or intracarpal tunnel corticosteroid injection in the previous 6 months

Potential participants meeting these criteria were given a detailed printed and verbal explanation of the nature and purpose of the investigation and participation requirements. Persons who agreed to participate signed the informed consent and were enrolled in the study. Descriptive information about each participant was recorded, including age, handedness, height, weight, duration of CTS symptoms, and current management of CTS, if applicable. Participants who were managing their CTS with measures such as using wrist splints or taking nonsteroidal anti-inflammatory drugs were instructed to continue doing so for the duration of the study (*Figure 1*).

Outcome Measures

The Boston Carpal Tunnel Questionnaire (BCTQ), sensory symptom diagram (SSD), patient estimate of

overall change, electrophysiologic testing, and ultrasound imaging were used to assess both upper limbs before the first OMT session and within 1 week after the sixth OMT session. Immediately after the first OMT session, electrophysiologic testing and ultrasound imaging were readministered. The physician performing the electrophysiologic testing and ultrasound imaging (R.S.B.) was blinded to the questionnaire results and the side that was assigned to receive OMT.

Boston Carpal Tunnel Questionnaire

A self-assessment questionnaire, the BCTQ assesses the severity of symptoms and the functional limitations of the hand. Each hand is assessed separately, and the scores range from 1 to 5, with 5 indicating the most severe symptoms or functional limitations.[13] Psychometric evaluation has indicated that the BCTQ is a valid, reliable, responsive, and acceptable outcome tool for clinical and research purposes.[14]

Sensory Symptom Diagram

For the purposes of the present study, we modified the commonly used Pain Drawing, which has been shown to have favorable psychometric properties.[15-17] In addition to pain, participants were instructed to mark areas on a drawing of the human body where they experienced numbness or tingling. Participants were asked to portray their average symptoms for the 7 days before the first treatment and for the 7 days before the sixth treatment. For scoring, the graphic representation of the entire body was divided into 50 areas, and 1 point was given for each symptom in each area. No attempt was made to separate the treated from the untreated side. Quantitatively, the total number of points in the drawings before and after treatment were used. Qualitatively, composite drawings before and after treatment were created for the study cohort as a whole.

Patient Estimate of Overall Change

Each participant was asked, within 1 week of the sixth treatment, to provide an estimate of the percentage of
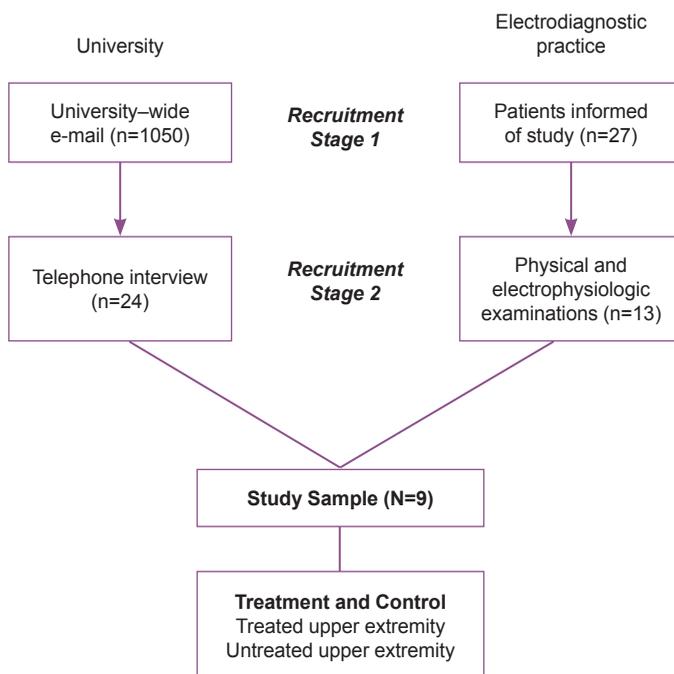

Figure 1.
Study flow diagram for the evaluation of osteopathic manipulative treatment techniques for the management of carpal tunnel syndrome.

change (improvement or worsening) of pain and function for each of their upper extremities.

Electrophysiologic Testing

All electrophysiologic tests were performed by the same physician (R.S.B.) using the same electrodiagnostic machine. Before testing, skin surface temperature was measured using an infrared thermometer. If the skin surface temperature was less than 31°C, the hands were warmed with a heating pad until the temperature was greater than 31°C. Real-time skin surface temperature was measured throughout testing by a plate thermistor taped to the base of the index finger. Because it has been reported that nerve conduction velocity correlates positively with hand temperature, it was important to record hand temperature to ensure that any conduction velocity changes subsequent to OMT were not simply the result of the hand surface temperature change.[18]

Conduction studies of the motor fibers of the median nerve were performed with a recording electrode on the thenar eminence. Stimulation was applied at the palm over the recurrent thenar branch of the median nerve and over the median nerve proximal to the wrist (8 cm proximal to the active recording electrode). Care was taken to ensure that the median palmar stimulation resulted in abduction of the thumb. As with all of the nerve conduction testing, the stimulus intensity was gradually increased until a maximum waveform size was achieved. The stimulus intensity was then increased by 10% to confirm that supramaximal stimulus had been applied. The trans–carpal tunnel motor conduction velocity and the wrist-to-palm compound motor action potential ratio were calculated. Distal motor latency was also recorded. Trans–carpal tunnel conduction studies of the sensory fibers of the median nerve were performed antidromically with the active recording ring electrode around the proximal interphalangeal joint of the third digit and the reference electrode 4 cm distally. A point in the palm 7 cm proximal to the active recording electrode was then stimulated, followed by a point at the wrist 7 cm proximal to the site of palm stimulation overlying the median nerve, between the flexor carpi radialis and palmaris longus tendons. The trans–carpal tunnel sensory conduction velocity and the wrist-to-palm sensory nerve action potential amplitude ratio were calculated. The latencies were measured from the onset of the waveform, and the amplitude was calculated from baseline to peak. The trans–carpal tunnel motor and sensory conduction velocities were considered a measure of median nerve myelination, whereas the proximal to distal amplitude ratios were considered a measure of axonal function and conduction block.

Ultrasound Imaging

A cross-sectional area of the median nerve was measured at each wrist in the transverse plane at the level of the volar distal wrist crease (representing the carpal tunnel inlet). A direct tracing method was used to outline the inner border of the thin hyperechoic rim of the perineural sheath (*Figure 2*). Transverse carpal ligament length and bulge were measured at the carpal tunnel outlet—the level of the trapezium and hook of the hamate. The length was measured as the distance between the volar-most tips of the trapezium and hamate. The bowing measurement was the perpendicular distance from a line connecting the volar-most tips of the trapezium and hamate to the volar-most point of the transverse carpal ligament (*Figure 3*). A 13-6 MHz 38 mm broadband linear array transducer interfaced with a SonoSite M-Turbo ultrasound machine was used for all studies.

Measurement of the cross-sectional area of the median nerve has been shown to provide reliable and valid diagnostic data for suspected CTS.[19] In CTS, an abnormal enlargement of the median nerve develops at the carpal tunnel inlet. This enlargement is thought to reflect congestion of the epineural and endoneural veins and nerve edema just proximal to the site of median nerve compression under the transverse carpal ligament.[20] Osteopathic manipulative treatment designed to reduce intracarpal tunnel pressure and improve perineural blood
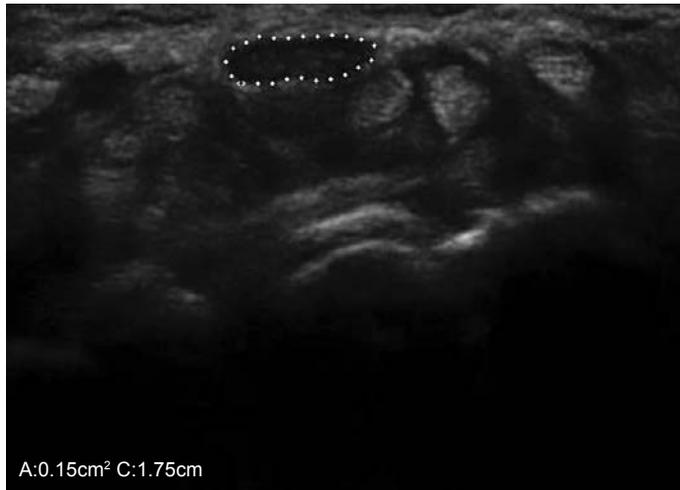
Figure 2.
Transverse ultrasonographic image of the carpal tunnel inlet in a patient with carpal tunnel syndrome. The median nerve is outlined.
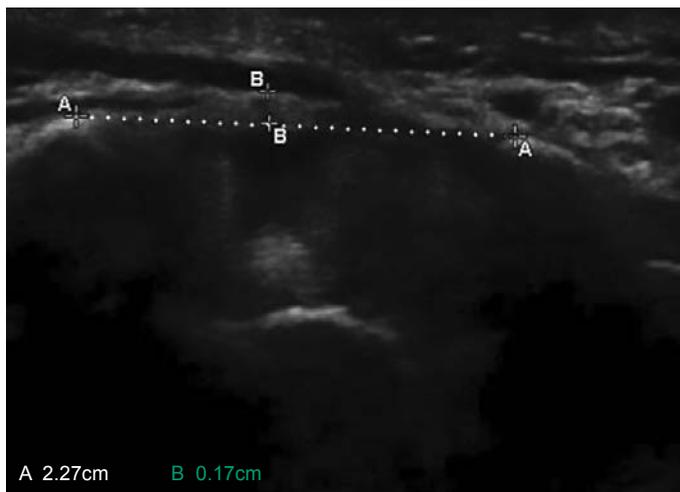
A:0.15cm² C:1.75cm

Figure 3.
Transverse ultrasonographic image of the carpal tunnel outlet in a patient with carpal tunnel syndrome. The dotted line from A (left) to A (right) is the volar tip of the trapezium and hamate bone, which estimates the length of the transverse carpal ligament. The area between the Bs is the volar edge of the transverse carpal ligament from the dotted line, reflecting bowing.

A 2.27cm   B 0.17cm

or lymphatic flow could conceivably reduce the swelling of the median nerve at the carpal tunnel inlet. Transverse carpal tunnel ligament lengthening is one of the goals of OMT for CTS and, therefore, its measurement using ultrasound imaging is appropriate. However, its reliability and validity as a diagnostic or treatment outcome measure in CTS has not been studied. Exaggerated transverse carpal ligament bowing supposedly reflects increased intracarpal tunnel pressure; therefore, it may also be a measurement of interest for diagnosing CTS.[21]

Intervention

Within 1 week after the initial assessment, OMT was performed on a once-weekly basis for 6 weeks for somatic dysfunction identified in each spinal region as well as 1 upper limb in all participants. In cases of unilateral CTS, the affected limb was treated. If a participant had bilateral symptomatic CTS, the limb to be treated was chosen by the participant. The untreated upper limb functioned as a quasi-control because it had similarities to the treated limb yet was less symptomatic.

An osteopathic physician (D.M.H.) and her student (T.B.) performed the OMT. The osteopathic medical student's treatments were under the direct tactile guidance of and were double-checked by the physician. At each visit, participants underwent a standing postural evaluation to assess the levelness of 4 landmarks (iliac crest, inferior medial border of the scapula, acromioclavicular joint, and mastoid process) as well as compensatory lateral and anteroposterior curves. Participants were then placed in a supine position for palpatory examination of each spinal region, ribs, and the selected extremity to detect somatic dysfunction. Additionally, the anterior Chapman point at the third rib on the affected side was assessed, owing to its known relationship with paresthesias of the upper extremity.[22] Vertebral segmental somatic dysfunction was treated first using balanced ligamentous tension followed by treatment of the Chapman point using light rotatory motion. The extremity dysfunction was treated with balanced membra-

nous tension of the interosseous membrane; low-velocity, high-amplitude springing of the carpal bones with direct release; and extension and release of the transverse carpal ligament using the opponens pollicis roll maneuver.[6] Treatment was considered effective when tissue texture changes occurred, including warming and softening of the tissues, restored range of motion, and decreased tenderness.

Statistical Analysis

A 2-way analysis of variance (ANOVA; treatment group × time) with repeated measures on the time factor was performed for each of the outcome measures of BCTQ, SSD, and ultrasound imaging. A 2-way analysis of covariance (ANCOVA) was used to analyze the electrophysiologic data (treatment group × time with repeated measures on the time factor, and skin surface temperature as the covariant). The patient estimate of overall change was analyzed using a 1-way ANOVA.

Results

Nine participants completed all aspects of the study treatment and testing. Six participants were female, and 3 were male. The mean (SD) age was 48.6 (17.8) years (range, 27-78 years). The mean (SD) height was 67.6 (3.7) inches (range, 62-72 inches), and the mean (SD) weight was 189.3 (39.5) lb (range, 130-250 lb). The mean (SD) duration of symptoms was 8.6 (9.1) years (range, 1-28 years). Five participants were not receiving concurrent treatment for CTS. Three participants were using nighttime wrist splints, and 1 was taking oral nonsteroidal anti-inflammatory drugs. Seven participants were right-handed. Five symptomatic participants had symptomatic bilateral hand symptoms compatible with CTS with confirmatory median nerve electrophysiologic abnormalities, and 3 participants had unilateral hand symptoms indicative of CTS. In these participants, electrophysiologic abnormalities were seen bilaterally but were worse on the symptomatic side. One participant had unilateral hand

symptoms indicative of CTS, with electrophysiologic abnormalities on the symptomatic side.

The effects of OMT on CTS symptoms and function are summarized in *Table 1*. The BCTQ findings demonstrated that CTS-related symptoms were worse on the treated side before treatment ($F=8.3$; $P=.01$) and statistically significantly improved after treatment ($F=11.0$; $P=.004$). Disability related to CTS was also worse on the treated side before treatment ($F=5.8$; $P=.03$) and was statistically significantly improved after treatment ($F=6.8$; $P=.02$). Statistically significant lowering of SSD scores was observed after treatment ($F=4.19$; $P=.0002$). The composite change from before to after treatment in the SSD scores for all participants is represented in *Figure 4*. The perceived overall improvement of symptoms was statistically significantly greater for the treated upper limb ($F=4.8$; $P=.046$). Notably, greater symptom improvement and patient estimate of overall change and improved function after treatment were seen in the treated upper limb, but these findings did not reach statistical significance ($F=4.3$, $P=.054$; $F=4.1$, $P=.06$; and $F=4.2$, $P=.06$, respectively). All participants were consistently noted to have persistent presence of Chapman point tenderness at the third rib and somatic dysfunction in all spinal regions and extremities. No consistent pattern or predictable palpatory findings were seen in each of the spinal regions or extremities between participants. With OMT, the physician and student subjectively noted an associated reduction in severity of palpatory findings as the participants' symptoms improved. All participants had minimal palpatory findings in all spinal regions as well as the wrist and forearm after the fourth treatment, but tenderness at the Chapman point persisted. By the sixth week of treatment, almost all participants had no pain associated with palpation at any location other than a slight tenderness at the third rib on the affected side.

The effects of OMT on the electrophysiologic function of the median nerve are summarized in *Table 2*. Initially, an ANOVA was used to explore the data, revealing a pattern of faster trans–carpal tunnel sensory

Table 1.
Effect of Osteopathic Manipulative Treatment on Carpal Tunnel Syndrome–Related Symptoms and Function[a]

Outcome	Before Treatment		After Final Treatment		P Value
	Treated	Untreated	Treated	Untreated	
BCTQ					
Symptoms	2.42 (0.47)	1.52 (0.60)	1.73 (0.57)	1.36 (0.51)	<.05
Function	2.39 (0.69)	1.45 (0.46)	1.60 (0.75)	1.35 (0.62)	<.05
Sensory Symptom Diagram	9.1 (4.3)		4.0 (3.5)		<.05
Overall Improvement, %					
Symptoms	NA	NA	56.3 (27.6)	24.4 (30.5)	<.05
Disability	NA	NA	55.0 (38.9)	18.8 (31.8)	>.05

[a] Data are given as mean (SD) unless otherwise indicated.

Abbreviations: BCTQ, Boston Carpal Tunnel Syndrome Questionnaire; NA, not applicable.

conduction velocity with successive testing for both median nerves with no side-to-side difference. The mean (SD) sensory conduction velocity before treatment was 34.4 (10.2) m/s; and after the first treatment, 34.2 (10.0) m/s; and after the sixth treatment, 35.6 (10.5) m/s (F=3.51; P=.04). Hand surface temperature was notably higher with successive testing sessions (mean [SD] temperature before treatment, 30.6°C [0.97°C]; after the first treatment, 30.7°C [1.3°C]; and after the sixth treatment, 32.2°C [1.3°C]; F=9.0, P=.0008). The trans–carpal tunnel sensory conduction changes became statistically insignificant when temperature was used as a covariate in the ANCOVA, suggesting that the faster trans–carpal tunnel sensory conduction velocities recorded after the sixth treatment were temperature related. Accordingly, the ANCOVA was used for all of the electrophysiologic data analysis. No statistically significant main or interaction effect changes were found for any of the motor or sensory conduction velocities or amplitude ratios.

Table 3 summarizes the effect of OMT on median nerve and transverse carpal ligament morphology. No statistically significant changes were seen in the cross-sectional area of the median nerve and transverse carpal ligament bowing. Transverse carpal ligament length did increase notably with OMT (F=14.3; P<.001), but this change was comparable on both the treated and untreated sides.

Discussion

The effectiveness of OMT for patients with CTS was demonstrated in the current pilot study of 9 participants. However, objective measures of median nerve electrophysiologic function and morphology at the carpal tunnel did not change. It is notable that, despite the small sample size, statistically significant subjective improvements in symptoms and function were achieved, suggesting that the magnitude of the treatment effect was substantial. Electrophysiologic dysfunction of the median nerve across the carpal tunnel and swelling of the median nerve at the carpal inlet are objective measures reflecting median nerve compression at the carpal tunnel. The lack of improvement in these measures suggests that either the measurements were compromised or the benefits of OMT were achieved by mechanisms other than carpal tunnel decompression.

One potential compromise to the validity of the objective measurements used in this study was their timing. The last nerve conduction and ultrasound measurements were made within days after the sixth OMT session. It may have been too early for improvements in electrophysiologic function, such as remyelination or axonal regeneration, and reduction in nerve swelling to have occurred. The literature suggests that objective electrophysiologic and morphologic improvements are measurable within weeks after treatments that decompress the carpal tunnel.[23-25] After intracarpal tunnel corticosteroid injection, Cartwright et al[23] documented improvements in median nerve conduction through the carpal tunnel as early as 1 week after injection, with further improvement at 30 days that either plateaued or continued to improve at 180 days. They found a similar pattern of reduction in a cross-sectional area of the median nerve at the carpal tunnel inlet.[23] At 2 weeks after endoscopic carpal tunnel release, Rotman et al[24] found consistent improvements in median nerve motor conduction across the carpal tunnel that progressed and then plateaued by 3 months. Ginanneschi et al[25] measured median nerve function electrophysiologically before and after open surgical carpal tunnel decompression. They found statistically significant and progressive improvements in conduction velocity at 1 and 6 months postoperatively. In the current study, early and subtle electrophysiologic and morphologic improvements in the median nerve may have begun, but the small sample size may have been insufficient to show the changes statistically.

Studies evaluating the effectiveness of noninvasive treatments for mild to moderate CTS have also showed statistical significance for subjective symptom improvement but statistical insignificance for objective improvements.[26-28] These studies reported trends toward median nerve conduction improvement; however, the changes may have been explained by the lack of real-time temperature monitoring and control. In the present study, the initial analysis of the sensory conduction across the
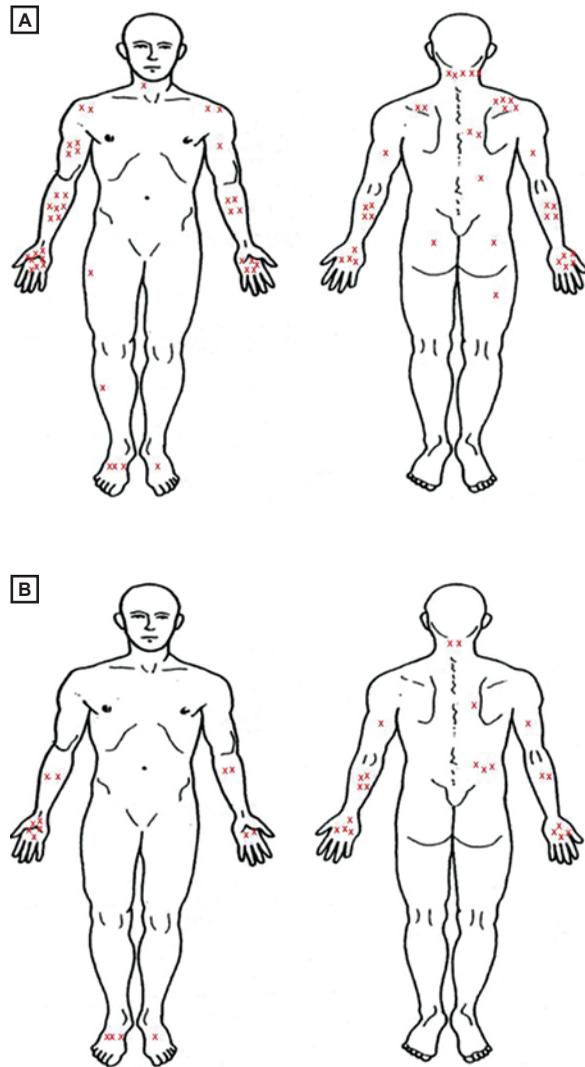

Figure 4.
Sensory symptom diagram of patients with carpal tunnel syndrome before treatment (A) and after treatment (B).

carpal tunnel after OMT suggested a subtle yet statistically significant increase in conduction velocity that could have easily been attributed to the OMT if real-time hand surface temperature had not been monitored. When the correlation between the hand surface temperature and conduction velocities was factored in as a covariate, it became clear that the increase in hand surface tempera-

Table 2.
Effect of Osteopathic Manipulative Treatment on Median Nerve Electrophysiologic Function[a]

Outcome	Before Treatment		After First Treatment		After Final Treatment		P Value
	Treated	Untreated	Treated	Untreated	Treated	Untreated	
Sensory Conduction Velocity, m/s	32.5 (9.1)	36.3 (11.3)	32.2 (9.4)	36.1 (10.8)	34.0 (9.4)	37.1 (11.9)	>.05
Sensory Amplitude Ratio	0.75 (0.23)	0.70 (0.12)	0.66 (0.26)	0.69 (0.12)	0.66 (0.17)	0.72 (0.13)	>.05
Distal Motor Latency, m/s	4.8 (1.0)	4.4 (1.1)	4.6 (0.9)	4.4 (1.1)	4.7 (0.9)	4.4 (0.9)	>.05
Motor Conduction Velocity, m/s	28.7 (6.3)	30.5 (8.7)	30.5 (10.0)	31.4 (9.4)	29.4 (8.5)	30.8 (7.7)	>.05
Motor Amplitude Ratio	0.75 (0.12)	0.77 (0.21)	0.76 (0.15)	0.74 (0.19)	0.79 (0.11)	0.84 (0.22)	>.05

[a] Data are given as mean (SD) unless otherwise indicated.

Abbreviation: m/s, meters per second.

Table 3.
Effect of Osteopathic Manipulative Treatment on Median Nerve Morphology on Ultrasound Imaging[a]

Measure	Before Treatment		After First Treatment		After Final Treatment		P Value
	Treated	Untreated	Treated	Untreated	Treated	Untreated	
Cross-sectional Area, mm²	13.8 (4.5)	12.4 (3.1)	13.4 (4.8)	12.4 (3.0)	13.0 (3.9)	12.3 (3.5)	>.05
Transverse Carpal Ligament							
Length, cm[b]	2.6 (0.5)	2.6 (0.4)	2.4 (0.19)	2.3 (0.34)	2.9 (0.3)	2.9 (0.2)	>.05[b], <.05[c]
Bowing, cm	0.19 (0.05)	0.20 (0.06)	0.21 (0.08)	0.19 (0.08)	0.26 (0.11)	0.24 (0.09)	>.05

[a] Data are given as mean (SD) unless otherwise indicated.
[b] No significant change for the main effect of side or the interaction effect of side $\times$ time.
[c] There was a significant change for the main effect of time.

ture explained the improvement in conduction velocity after the sixth treatment. This experience highlights the strong relationship between nerve temperature and conduction velocity and the need to measure and factor in body temperature when calculating the effects of nerve-targeted treatments that can potentially change body temperature, including OMT.[18]

Another plausible explanation for the findings of the present study is that the beneficial effect of OMT on CTS was not the result of median nerve decompression at the carpal tunnel but, rather, central nervous system modulation of symptoms, whether hormonal, neuronal, or psychological. The OMT provided in this study was directed not only to the carpal tunnel, but also to dysfunction in-

volving the more proximal upper extremity, related dysfunctional vertebral segments, and the third-rib Chapman point. Treatment of the full length of the kinetic chain may have stimulated endogenous opioid release or changed afferent stimuli to the spinal cord and brain, thus altering the perception of the relative sensory phenomena of CTS. Supporting the central nervous system symptom modulation theory is the observation that both the untreated and treated sides improved with OMT. Other investigators who have evaluated various manual treatments for CTS, including neurodynamic, carpal articular, myofascial mobilization, or joint manipulation, have similarly documented improvement of subjective symptoms and little or no improvement in objective measures.[23-25]

Strengths in the current study include the design (within-participant, quasi-controlled trial), control of potentially confounding variables, and the use of validated outcome measures. As with most of the existing related research, this study was lacking in sample size. Also, several of the participants in this study had concurrent musculoskeletal comorbidities that may have complicated their symptom experience.

Suggestions for future research include an increased sample size and sufficient time between the last treatment and retesting of the electrophysiologic and morphologic properties of the median nerve. These parameters may allow subtle objective changes to be measured if present. Another suggestion is to individually study the different components of OMT techniques to determine which are most effective.

Conclusion

Osteopathic manipulative treatment effectively managed CTS symptoms and disability in 9 participants. However, median nerve function and morphology did not change as measured before and after 6 weeks of OMT. Therefore, the mechanism of OMT in the management of CTS seems to be unclear, although central nervous system processes are suspected.

References

1. Huisstede BM, Randsdorp MS, Coert JH, Glerum S, van Middelkoop M, Koes BW. Carpal tunnel syndrome, part II: effectiveness of surgical treatments—a systematic review. *Arch Phys Med Rehabil*. 2010;91(7):1005-1024. doi:10.1016/j.apmr.2010.03.023.

2. Huisstede BM, Hoogvliet P, Randsdorp MS, Glerum S, van Middelkoop M, Koes BW. Carpal tunnel syndrome, part I: effectiveness of nonsurgical treatments—a systematic review. *Arch Phys Med Rehabil*. 2010;91(7):981-1004. doi:10.1016/j.apmr.2010.03.022.

3. O'Connor D, Marshall SC, Massy-Westropp N. Non-surgical treatment (other than steroid injection) for carpal tunnel syndrome [review]. In: *The Cochrane Collaboration*. DeKalb, IL: John Wiley & Sons; 2012;7:1-58.

4. Siu G, Jaffe JD, Rafique M, Weinik MM. Osteopathic manipulative medicine for carpal tunnel syndrome [review]. *J Am Osteopath Assoc*. 2012;112(3):127-139.

5. Sucher BM. Myofascial release of carpal tunnel syndrome [case report]. *J Am Osteopath Assoc*. 1993;93(1):92-94,100-101.

6. Sucher BM. Palpatory diagnosis and manipulative management of carpal tunnel syndrome [review]. *J Am Osteopath Assoc*. 1994;94(8):647-663.

7. Sucher BM. Palpatory diagnosis and manipulative treatment of carpal tunnel syndrome, part 2: "double crush" and thoracic outlet syndrome. *J Am Osteopath Assoc*. 1995;95(8):471-479.

8. Sucher BM. Myofascial manipulative release of carpal tunnel syndrome: documentation with magnetic resonance imaging. *J Am Osteopath Assoc*. 1993;93(12):1273-1278.

9. Sucher BM, Hinrichs RN, Welcher RL, Quiroz LD, St Laurent BF, Morrison BJ. Manipulative treatment of carpal tunnel syndrome: biomechanical and osteopathic intervention to increase the length of the transverse carpal ligament, part 2: effect of sex differences and manipulative "priming" [published correction appears in *J Am Osteopath Assoc*. 2005;105(5):238]. *J Am Osteopath Assoc*. 2005;105(3):135-143.

10. Sucher BM. Carpal tunnel syndrome: ultrasonographic imaging and pathologic mechanisms of median nerve compression. *J Am Osteopath Assoc*. 2009;109(12):641-647.

11. Sucher BM. Ultrasound imaging of the carpal tunnel during median nerve compression. *Curr Rev Musculoskelet Med*. 2009;2(3):134-146. doi:10.1007/s12178-009-9056-5.

12. Burnham RS, Steadward RD. Upper extremity peripheral nerve entrapments among wheelchair athletes: prevalence, location, and risk factors. *Arch Phys Med Rehabil.* 1994;75(5):519-524.

13. Levine DW, Simmonds BP, Koris MJ, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg Am.* 1993;75(11):1585-1592.

14. Leite JC, Jerosch-Herold C, Song F. A systematic review of the psychometric properties of the Boston Carpal Tunnel Questionnaire. *BMC Musculoskelet Disord.* 2006;20(7):78.

15. Margolis RB, Tait RC, Krause SJ. A rating system for use with patient pain drawings. *Pain.* 1986;24(1):57-65.

16. Margolis RB, Chibnall JT, Tait RC. Test-retest reliability of the pain drawing instrument. *Pain.* 1988;33(1):49-51.

17. Lacey RJ, Lewis M, Jordan K, Jinks C, Sim J. Interrater reliability of scoring of pain drawings in a self-report health survey. *Spine (Phila Pa 1976).* 2005;30(16):e455-e458.

18. Burnham R, Burnham T. Effect of hand warming on electrodiagnostic testing results and diagnosis in patients with suspected carpal tunnel syndrome. *Arch Phys Med Rehabil.* 2009:90(12):2062-2065. doi:10.1016/j.apmr.2009.07.022.

19. Cartwright MS, Hobson-Webb LD, Boon AJ, et al. Evidence-based guideline: neuromuscular ultrasound for the diagnosis of carpal tunnel syndrome. *Muscle Nerve.* 2012;46(2):287-293. doi:10.1002/mus.23389.

20. Dejaco C, Stradner M, Zauner D, et al. Ultrasound for diagnosis of carpal tunnel syndrome: comparison of different methods to determine median nerve volume and value of power Doppler sonography. *Ann Rheum Dis.* 2013;72(12):1934-1939. doi:10.1136/annrheumdis-2012-202328.

21. Roll SC, Evans KD, Li X, Freimer M, Sommerich CM. Screening for carpal tunnel syndrome using sonography. *J Ultrasound Med.* 2011;30(12):1657-1667.

22. Owens C. *An Endocrine Interpretation of Chapman's Reflexes.* 2nd ed. Chattanooga, TN: Chattanooga Printing & Engraving; 1937.

23. Cartwright MS, White DL, DeMar S, et al. Median nerve changes following steroid injection for carpal tunnel syndrome. *Muscle Nerve.* 2011;44(1):25-29. doi:10.1002/mus.22067.

24. Rotman MB, Enkvetchakul BV, Magerian JT, Gozani SN. Time course and predictors of median nerve conduction after carpal tunnel release. *J Hand Surg Am.* 2004;29(3):367-372.

25. Ginanneschi F, Milani P, Reale F, Rossi A. Short-term electrophysiological conduction change in median nerve fibers after carpal tunnel release. *Clin Neurol Neurosurg.* 2008;110(10):1025-1030. doi:10.1016/j.clineuro.2008.07.006.

26. Tal-Akabi A, Rushton A. An investigation to compare the effectiveness of carpal bone mobilisation and neurodynamic mobilisation as methods of treatment for carpal tunnel syndrome. *Man Ther.* 2000;5(4):214-222.

27. Burke J, Buchberger DJ, Carey-Loghmani MT, Dougherty PE, Greco DS, Dishman JD. A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. *J Manipulative Physiol Ther.* 2007;30(1):50-61.

28. Davis PT, Hulbert JR, Kassak KM, Meyer JJ. Comparative efficacy of conservative medical and chiropractic treatments for carpal tunnel syndrome: a randomized clinical trial. *J Manipulative Physiol Ther.* 1998:21(5):317-326.

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