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MASSAGE THERAPY RESEARCH

Carpal tunnel syndrome symptoms are lessened following massage therapy

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Abstract *Objective*. To determine the effectiveness of massage therapy for relieving the symptoms of carpal tunnel syndrome (CTS).

Methods. Sixteen adults with CTS symptoms were randomized to a 4-week massage therapy or control group. Participants in the massage therapy group were taught a self-massage routine that was done daily at home. They were also massaged once a week by a therapist. The participants' diagnosis was based on a nerve conduction velocity test, the Phalen test, and the Tinel sign test performed by a physician. The participants were also given the state trait anxiety inventory (STAI), the profile of mood states (POMS), a visual analog scale for pain and a test of grip strength.

Results. Participants in the massage therapy group improved on median peak latency and grip strength. They also experienced lower levels of perceived pain, anxiety, and depressed mood.

Conclusion. The results suggest that symptoms of CTS can be relieved by a daily regimen of massage therapy.

Carpal tunnel syndrome symptoms are lessened following massage therapy

As many as one million adults in the United States suffer from carpal tunnel syndrome (CTS), annually (Tanaka et al., 1994) particularly those who do repetitive manual labor involving the wrist (Akelman and Weiss, 1995; Atterbury et al., 1996; Kulick, 1996; Smith et al., 2000; Stevens, 1996; Szabo, 1998). Carpal tunnel syndrome has significantly increased since the advent of the computer (Belmonte, 1996; Blanc et al., 1996; Leigh and Miller, 1998; Martin, 2000) and continues to contribute to unpleasant symptoms, loss of worker productivity and worker's compensation costs (Ditmars, 1993; Kasdan et al., 1994; Louis et al., 1996).

Carpal tunnel syndrome is defined as pain and paresthesias (tingling, burning, and numbness) in the hand in the area of the median nerve by bounded fibers of the carpal ligament (Akelman and Weiss, 1995; Kulick, 1996). The carpal bones located in the wrist region form a transverse arch in the proximal palm. This narrow archway or tunnel, formed by the above rigid structures is traversed by nine flexor tendons (Akelman and Weiss, 1995), the median nerve and surrounding tenosynovium and vasculature. The median nerve passing through the carpal tunnel divides into sensory branches to the thumb, index, middle, and radial half of the ring fingers (Kulick, 1996; Ditmars, 1993).

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Encroachment into the small volume of the carpal tunnel will cause compression of the perineural and intraneural vasculature, first causing venous congestion and later arterial obstruction. The resulting local metabolic dysfunction of the median nerve causes a nerve conduction delay, with early symptoms of tingling, numbness, and pain in its sensory distribution (Akelman and Weiss, 1995). If compression persists, degeneration and intraneural fibrosis result, eventually leading to complete irreversible blockade.

Radiographs and electrodiagnostic tests such as nerve conduction velocity are helpful, but the diagnosis typically is based on clinical symptoms and signs (Von Schroeder, 1996) including Tinel and Phalen signs, both of which are noted to be sensitive assessments (D'Arcy and McGee, 2000; Szabo et al., 1999). In the early stages of CTS, symptoms such as numbness and tingling may be present, while nerve conduction latencies may still be normal (Chang et al., 2000; Rankin, 1995; Szabo, 1998).

Medical interventions include splints to hold the wrist in a neutral position to avoid pressure build up within the carpal tunnel (Kulick, 1996) non-steroidal anti-inflammatory agents, and steroid injections reduce symptoms temporarily, (Akelman and Weiss, 1995) or for a longer term (Dammers et al., 1999). The Carpal Tunnel release procedure which is among the top ten operating room procedures, accounting for $1 billion in direct medical costs, has been generally successful in approximately 75% of cases (Blanc et al., 1996). However, complications have accompanied this procedure including failure to completely divide the transverse carpal ligament, injury to the median nerve, scarring, loss of motion, and infection (Rankin, 1995; Duclos and Sokolow, 1998; Giunta et al., 1998) and a recurrence rate in about 9–19% of cases (Botte et al., 1996; Lindau and Karlsson, 1999). Endoscopic surgery may offer several advantages over the standard open technique including less scar tenderness, earlier return to work and activities of daily living and earlier return of pinch and grip strength (Botte et al., 1996; Innis, 1996).

Alternative therapies have also been tested but not using objective measures such as median nerve latency. Exercise and yoga (Seradge et al., 2000) programs have resulted in as much as a 45% reduction in CTS symptoms. Range of motion exercises have also been noted to be more effective than splinting (Feuerstein et al., 1999). Low-level laser acupuncture and transcutaneous electrical nerve stimulation have also reduced carpal tunnel syndrome pain (Braco and Naeser, 1999).

The paucity of alternative therapy research is particularly surprising since a therapy like self-massage would seem to be a technique people would naturally use (rubbing with pressure) to reduce pain. Massage therapy has reduced pain in other syndromes such as fibromyalgia (Sunshine et al., 1996) and low back pain (Hernandez-Reif et al., 2001). Certain pain syndromes (sympathetically mediated pain) are thought to be maintained and exacerbated by local sympathetic activation (Naliboff and Tachiki, 1991) and massage therapy typically decreases sympathetic activity or increases vagal activity as well as increases serotonin levels, known to reduce pain (Ironson et al., 1996). The current study examined massage therapy effects on pain, median nerve conduction, and accompanying anxiety and depression related to CTS. Based on other research we have conducted, we expected that massage therapy would reduce pain and accompanying anxiety and depression (Sunshine et al., 1996; Field, 1998).

Materials and methods

Participants

Sixteen adults (93% female) were recruited at a local university via advertising for people already diagnosed as having CTS whose work involved extensive time at the computer. The number of participants was determined by a power analysis based on a previous study (Sunshine et al., 1996). The participants had unilateral symptoms. They ranged in age from 20 to 65 ($M = 47$), were middle socioeconomic status ($M = 2.44$ on the Hollingshead Index) and distributed 72% Caucasian, 18% Hispanic, and 10% African-American. The number of years since diagnosis averaged 6.7%, and 23% had experienced surgery. The diagnosis of CTS (median nerve compression at the wrist) was made again based upon the subject's symptom complaints and physical findings (positive Phalen test and Tinels sign). Nerve conductions tests do not always correlate to signs and symptoms. Patients with severe symptoms may have normal electrodiagnostic values while those with milder symptoms may have glaringly abnormal results. The severity is based upon the extent of nerve injury. Despite this, electrodiagnosis remains a useful modality to assist in the diagnosis and treatment of this condition. They were then randomly assigned to standard treatment control and massage therapy groups. The groups did not differ on the above variables.

Procedures

The massage therapy group participants received a massage on the affected arm by a therapist once a week for a 4-week period and were also taught self-massage that was to be done daily at home prior to bedtime. The participants were called on a weekly basis to check on their ability to schedule daily sessions. The 15 min massage consisted of moderate pressure stroking concentrated on the fingertip to elbow area. The massage begins with stroking the wrist up to the elbow and back down on both sides of the forearm. Next, a wringing motion (much like milking a cow) is applied to the same area. This is followed by stroking, using the thumb and forefinger, in a circular or back and forth motion covering the entire forearm and hand. Finally, the skin is rolled using the thumb and forefinger across the hand and up both sides of the forearm.

The massage group participants were asked to complete a *Massage and Pain Log* for the month. The participants were asked to use the log to report the time they started and finished the self-massage as well as their level of pain at that time using a scale from 0 to 10 with 0 being no pain and 10 being the most intense pain.

The standard treatment control group received the same assessments as the massage group but did not receive massage therapy during the study. They were taught the self-massage routine after the end of the study.

Physicians' assessments

The collaborating physicians (A.G. or W.S.) assessed the participants at the beginning and end of the study on the following: (A) *Carpal Tunnel Symptoms* including loss of strength, tingling, numbness, burning or pain to the affected area. (B) The *Tinel sign*, elicited by lightly tapping the carpal ligament over the median nerve along the wrist. For a positive sign, the person feels a pain or tingling sensation along the thumb or first two fingers. (C) The *Phalen Test* requiring the participants to flex their wrists firmly with both palms touching at a 90° angle for 60 s. The same process is done inversely with the back of the hands touching. The test is positive if numbness or tingling sensations are experienced along the path of the median nerve across the wrist and hand. (D) *Nerve Conduction Test*. Nerve conduction velocity of the median nerve was measured electrophysiologically using a Cadwell Model 5200 A manufactured by Cadwell Laboratories of Kennewick Washington. This device can perform electromyography as well as nerve conduction testing. Nerve conductions using surface electrodes to avoid the needle examination are also associated with electromyography. The Cadwell 5200A consists of an oscilloscope, time base, and amplifier, pre-amplifier and surface electrodes. Prior to testing, the skin was ''cleaned'' with a mild abrasive and wiped with alcohol swabs to reduce electrical resistance. Motor and sensory nerve conductions were performed by attaching surface electrodes (covered with a conduction gel) and taped to the upper extremities. Stimulation of the median nerve was done orthodromically, that is, via the normal anatomical propagation of the nerve impulse. The stimulation is proximal to distal for the motor response and distal to proximal for the sensory studies. Testing of the Median Motor and sensory nerves were performed as described by Kimura (1983). Stimulation for the median sensory nerves were accomplished using ring electrodes placed on the index finger with the recording electrode placed at a fixed distance of 12–14 cm on the flexor surface of the wrist. A ground electrode was placed on the dorsum of the hand being evaluated. Peak sensory latencies were obtained. Latencies greater than 3.6 ms were considered to be prolonged (abnormal) and suggest nerve compression at the carpal tunnel when commensurate with appropriate signs and symptoms. Motor conductions were performed with the stimulating electrodes placed at the flexor surface of the wrist (region over the median nerve) with the active recording electrode over the belly of the Abductor Policis Brevis muscle and the indifferent electrode just distal to the first metacarpophalengeal joint. A ground electrode was placed on the dorsum of the hand being evaluated. The compound action potential was recorded after stimulation at the wrist 7–10 cm from the active electrode and at the anti-cubital fossa 15–20 cm from the distal stimulating electrode. The latencies obtained were subtracted and divided into the distance between the proximal and distal latencies to provide a velocity. A velocity below 48.0 m s^{-1} was considered to be slow (abnormal) and suggests neuropraxia (mildest form of nerve block associated with reversible injury). To reduce the potential of temperature variability (nerve impulses conduct faster in higher temperatures and slower in colder ones), patients were allowed to acclimate to room temperature for 10–15 min before testing. Ambient temperature was maintained between 24°C and 26°C. As our testing was non-invasive, a liquid crystal thermometer was used to check surface skin temperatures, which averaged above 34°C. Possible sources of error in

our testing as related to electrodiagnosis were limited by using a single examiner, monitoring for environmental temperature variations, allowing subjects to equilibrate to room temperature and using fixed distance for electrode placement and recording. Maximizing the stimulus used to avoid temporal dispersion (the difference between slower and faster conducting nerve fibers). Amplitudes of distal motor and peak sensory latencies were obtained but were not used for diagnosis. Large differences in amplitude can suggest nerve injury due to neuropraxia as well as axonal drop out. Normal variation in amplitude exists from subject to subject, making more subtle changes in this parameter of limited usefulness. (*E*) Median Peak Latency, as the latency with which the electrical impulse is transmitted at the median nerve, was considered the primary outcome measure.

Pre–post session assessments (immediate treatment effects)

The participants completed the following assessments before and after the treatment sessions on the first and last days of the 1-month study. *Perceived Grip Strength Scale* is a 10 point scale, ranging from weakest (score of 0) to strongest (score of 10) grip, where the participants determine their perceived grip strength after clenching both fists for 5 s. *VITAS* (1993) is a pre–post session pain assessment using a Visual Analogue Scale (VAS) ranging from 0 (No Pain) to 10 (Worst Possible Pain), anchored with 5 faces. Acceptable scores for criterion-related validity have been established by correlating the VITAS with sleep disturbance ($r = 0.63$, $P < 0.01$) since body pain has been associated with difficulty sleeping (Hertz et al., 1992). The state anxiety inventory (STAI) (Spielberger et al., 1970) consists of 20 items on how the participant feels at that moment in terms of severity from (1) ''not at all'' to (4) ''very much so''. Typical items include ''I feel nervous'' and ''I feel calm''. The STAI has adequate concurrent validity and internal consistency ($r = 0.83$) (Spielberger, 1972). *The Profile of Mood States* (POMS) (McNair, 1971) is a 5-point Likert rating scale on how well an adjective describes the participant's feelings including helpless or gloomy feelings, depression and anxiety. The scale has adequate internal consistency ($r = 0.95$) (Pugatch, 1969).

Results

A two-way mixed multivariate analysis of variance (MANOVA) with group as a between subjects variable and first day/last day as the repeated measures variable was conducted on the group of first day/last day measures including the Carpal Tunnel symptoms and the physicians assessment measures (Table 1). A second repeated measures MANOVA was conducted on the group of pre–post session measures on the first and last day including the self-reported pain, grip strength and anxiety/depression mood state measures (Table 2). These were followed by two-way mixed analyses of variance (ANOVAs) on each of the measures and post hoc Bonferroni *t*-tests in the case of significant repeated measures by group (massage therapy vs. control) interaction effects.

Table 1 Means for physician's assessments (control group in parentheses).

Measure	First day	Last day
Carpal tunnel symptoms	3.00 (3.00)	2.22[a] (3.00)
Tinel's sign	3.11 (3.33)	3.11 (3.33)
Phalen test	2.67 (2.33)	3.00 (2.50)
Nerve conduction velocity	46.79 (46.49)	53.57 (49.24)
Median peak latency	3.59 (3.50)	3.40[a] (3.48)

[a] $P < 0.05$.

Table 2 Means for pre–post session measures (control group in parentheses).

Pre–post measures	First day		Last day	
	Pre	Post	Pre	Post
Pain (VITAS)	4.11 (6.17)	2.22[3] (6.16)	2.59[1] (4.83)	0.96[4] (5.33)
Grip strength	6.61 (5.58)	8.80[2] (5.00)	7.80[1] (6.25)	8.98[2] (6.08)
Anxiety (STAI)	35.11 (31.00)	25.62[3] (26.17)	31.89[1] (32.50)	25.69[3] (31.33)
Depression (POMS)	5.44 (4.17)	1.89[2] (2.50)	3.95[1] (3.50)	2.22[2] (3.50)

Superscripts in columns 2 and 4 indicate pre–post differences and in column 3 indicate first day–last day differences. [1] $P < 0.05$, [2] $P < 0.01$, [3] $P < 0.005$, [4] $P < 0.001$.

As can be seen in Table 1, group by time interaction effects and post hoc Bonferroni *t*-test on those suggested that the massage therapy group showed fewer carpal tunnel symptoms and a shorter median peak latency by the end of the treatment period (significance levels are indicated by superscripts in the tables). Although improvement was also noted for the massage therapy group on the Phalen test and nerve conduction velocity measures, these changes were not statistically significant (Table 1).

Functional activity also improved as noted in reduced pain and increased grip strength in the massage therapy group, both immediately after the first and last massage therapy sessions and by the end of the study (see Table 2). Finally, the massage therapy group reported lower anxiety and depressed mood levels both immediately after the first and last sessions and by the end of the study (Table 2).

Discussion

Massage therapy significantly decreased carpal tunnel symptoms, median peak latency and pain, while increasing grip strength. Although massage therapy has decreased pain in several pain syndromes including arthritis, fibromyalgia, lower back pain and migraines (Melzack, 1965) this is the first report of pain reduction in carpal tunnel syndrome following massage therapy. Several underlying mechanisms have been hypothesized for pain reduction following massage therapy including the gate theory (Tennent and Goddard, 1997) which suggests that larger, more myelinated fibers such as pressure fibers transmit the pressure message more rapidly to the brain than the smaller less myelinated pain fibers, thus "closing the gate" to the pain message. Other potential mechanisms are the release of pain-relieving neurotransmitters such as serotonin and oxytocin. Serotonin has been noted to increase following massage therapy in several pain syndromes (Pugatch et al., 1969) and oxytocin has been noted to increase following massage and acupuncture in the rat model (Tennent and Goddard, 1997). The reduction in carpal tunnel symptoms and in median peak latency probably also derive from the stimulation of pressure receptors.

The increase in grip strength could be related to massage increasing muscle strength or simply grip strength increasing as pain is decreased. Finally, decreases in self-reported anxiety and depression invariably occur following massage therapy associated decreases in pain (Field, 1998) so these effects were not surprising.

Future research is needed for replication of these effects with a better control group (e.g. a group that receives some form of physical contact) and for exploring underlying mechanisms. Other electrophysiological tests of more chronic symptoms, for example sleep disturbances and neurotransmitter/neurohormone assays, may help inform the process of pain reduction following massage therapy.

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