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QUASI-EXPERIMENTAL TRIAL

Massage therapy as an effective treatment for carpal tunnel syndrome

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Summary Carpal tunnel syndrome is a common peripheral entrapment that causes neuralgia in the median nerve distribution of the hand. The primary aim of this study was to evaluate the efficacy of massage therapy as a treatment for carpal tunnel syndrome. Within this process, the locations of trigger-points that refer neuropathy to the hand were identified. The creation of massage pressure tables provides a means of treatment reproducibility. Twenty-one participants received 30 min of massage, twice a week, for six weeks. Carpal tunnel questionnaires, the Phalen, Tinel, and two-point discrimination tests provided outcome assessment. The results demonstrated significant ($p < 0.001$) change in symptom severity and functional status from two weeks. Based on this study, the combination of massage and trigger-point therapy is a viable treatment option for carpal tunnel syndrome and offers a new treatment approach.

Introduction

Carpal tunnel syndrome (CTS) is caused by the compression of the median nerve at the wrist, with symptoms typically confined to the lateral aspect of the palm, the thumb and the next three fingers (Wilson and Sevier, 2003), but excluding the fifth digit and the medial half of the fourth (Field et al., 2004). It is a costly upper limb disorder that causes neuralgia, such as pain, numbness and tingling in the hand, (Gimeno et al., 2005), which may eventuate in loss of strength and fine motor skills (Moraska et al., 2008). The prevalence of this syndrome in the general population is estimated to range from 3.8% (Atroshi et al., 1999), to 9% in adult women and 0.6% among adult men (De krom et al., 2009). However, certain occupations such as construction, clerical staff, and assembly line workers are increasingly predisposed to the disorder (Lowe, 2008), with the incidence in meat packers reaching 21% (Falkiner and Myers, 2002).

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There is much debate on 'best practice' for CTS, and mild to moderate conditions are frequently prescribed conservative treatments such as local corticosteroid injections, splinting, ultrasound, oral steroids and non-steroidal anti-inflammatory drugs (Wilson and Sevier, 2003; Coppieters and Alshami, 2007). However, a systematic review of the literature indicates limited evidence supporting the long term effectiveness of these treatments (Gerritsen et al., 2002; O'connor et al., 2003). Conversely, surgical decompression of the median nerve is postulated as the definitive solution (Bland, 2007), and the only cure in moderate to severe cases (Aroori and Spence, 2008). Nonetheless, surgical decompression of the median nerve is not without complications. Research has found that as few as 14% of patients may be totally symptom free four years post operatively, with 46% experiencing moderate to severe pain and 47% experiencing moderate to severe numbness (Manktelow et al., 2004). Additionally, scar tenderness remained in 82% of patients three months post operatively (Atroshi et al., 2006).

Diagnosis is typically established with the Phalen test (pushing the back of the hands together for 1 min, which compresses the carpal tunnel), Tinel's sign (lightly tapping the median nerve along its course in the wrist test is positive if tingling is reported) (Bruske et al., 2002), and/or abnormal trans-carpal median nerve conduction (Mondelli et al., 2007), with carpal tunnel questionnaires (Levine et al., 1993; Leite et al., 2006) and two-point discrimination providing reliable assessment outcome (Shooter, 2005). The aetiology of CTS has not been fully elucidated, with opinion divided between a syndrome of idiopathic origin (Ucan et al., 2006; Sezgin et al., 2006), and a syndrome caused by chronic inflammation (Wilson and Sevier, 2003; Gimeno et al., 2005) and metabolic dysfunction (Field et al., 2004). Theoretically, compression of the median nerve can result from the development of hyperplasiastic fibrosis of the tenosynovium, median nerve, and flexor tendons, with excursion into the carpal tunnel by these tendons, further reducing the carpal tunnel dimensions (Wilson and Sevier, 2003).

There are approximately 400,000–500,000 surgical procedures annually for CTS in the United States of America (Mondelli et al., 2007). Each surgical procedure costs approximately $60,000 as compared to $5000 for conservative treatment (Muller et al., 2004), and is second only to lumbar disc replacement in terms of total cost (Shuford and Restrepo, 2005). The high financial encumbrance, combining with the level of post-operative complications associated with this syndrome, is recognised by the American Academy of Neurology with the recommendation to explore more conservative treatment before surgery (Burke et al., 2007). Conversely, the long-term effectiveness of the common conservative modalities is debateable, pointing to the need for a different approach.

A combination of remedial massage techniques may represent that approach, with pilot studies demonstrating significant symptom reduction in patients with CTS (Field et al., 2004; Burke et al., 2007; Moraska et al., 2008). While the term massage encompasses a variety of techniques, remedial massage is defined as soft tissue manipulation to effect structural changes to the body. The body of evidence (Field et al., 2004; Burke et al., 2007; Moraska et al., 2008) that points to hyperplasiastic changes contributing to CTS is compelling, and a treatment protocol addressing those issues offers a possible remedial outcome. Nerve impairments of 5–10% cause disruption to intra-neural blood flow, axonal transport, and nerve conduction (Coppieters and Alshami, 2007). Given that osteopathic manoeuvres to the transverse carpal ligaments of cadaveric females elicited a 9% stretch (Sucher et al., 2005), it was hypothesised that massage could elicit a similar response, rectifying the 5–10% nerve impairment and restore neural conduction.

In determining the appropriate massage protocol, it is necessary to allow for the possibility of proximal trigger-points exacerbating and/or causing the symptoms of CTS in some individuals (Skubick et al., 1993; Dommerholt et al., 2006). This study addressed the multifaceted nature of the disorder by including treatment to all proximal and distal sites of possible entrapment. The aim of this study was to evaluate the efficacy of massage therapy as a treatment for CTS. Related to this aim, trigger-points that refer neuropathic symptoms to the hand were identified, and reproducible tables of massage pressures were created.

Methods

Design

The University Human Research Ethics Committee granted approval to conduct a quasi-experimental trial incorporating a pre/post-test design of paired data analysis. The establishment of the pre-test profile occurred one week prior to the commencement of a six-week treatment protocol. Post-test measurements occurred at weeks two, six, and ten. The ten-week post-test measurement was four weeks after the final treatment, and aimed at assessing the longer term or possible relapse effect of the treatment. To avoid the likelihood of Type II error, a group of 20 participants created an expected 92% chance of rejecting the Ho (population mean difference = 0.8 SD of change = 1, and alpha 0.050, 2 tailed).

Inclusion/exclusion

The inclusion criteria required all participants to return a positive diagnosis of CTS as diagnosed by a registered physician, to be in general good health, and between 30 and 59 years of age. The age group selection for this study considered the fact that individuals of advancing age (more than 59 years of age) may skew the results due to age related neurophysiological deterioration. Specific exclusions were diabetes, pregnancy, thyroid disorders, prior surgery or steroidal injection to the wrist, rheumatoid or osteoarthritis (Burke et al., 2007), lactation, and tumour or deformity of the wrist (Martin et al., 2005).

Assessment instruments

Due to their validated reproducibility, internal consistency and responsiveness to clinical change, principal assessment was the self-administered carpal tunnel questionnaires; namely the 11 question symptom severity, and the eight question functional status questionnaires (Levine et al.,

1993). Two point callipers provided additional outcome assessment by measuring sensory discrimination at the pulp of the distal phalanx of the three digits fully supplied by the median nerve. The natural process of aging causes sensory perception to deteriorate from 2.8 to 4.6 mm between the second and eighth decades of life (Shooter, 2005). Measurements to determine two-point discrimination in this study group were set at 6, 5, 4, and 3 mm. The results were recorded as either positive or negative at each reading.

The initial measurement of 6 mm was set to accommodate the loss of sensory perception that is a symptom of CTS. This value is 30% greater than that required by a healthy 80-year-old individual to discern between two points, and considered suitable as starting position since the maximum age in this sample was 59 years. The remaining values included the normal healthy range, facilitating pre/post test comparisons of any possible changes. To ensure test uniformity, the weight of the calliper (0.018 kg) was the limit of pressure applied. Exceptions occurred with blanching of the skin, in which case the pressure was restricted to that point. Changes determined by the Phalen test, and the Tinel test also contributed to outcome assessment.

A FDX Force Ten algometer (FDX-Wagner Instruments) was implemented to determine the amount of pressure applied to the participant by the therapist. The aggregate of three pressure readings for each point location (Fig. 1) were recorded. These point locations are: (a) a common trigger point in the extensor digitorum muscle, approximately 4 cm distal to the anterior crease of the elbow. (b) A proximal point approximately 4 cm from the distal crease in the wrist, medial to the radioulna joint. (c) At a point on the transverse carpal ligament approximately 2 cm from the distal crease in the wrist, and at the origin of the thenar eminences. The measurements were recorded when the participant felt that the pressure exerted by the Algometer, approximated the pressure exerted by the therapist.

Treatment protocol

A registered remedial therapist with 13 years experience in chronic musculoskeletal dysfunction performed the treatment protocol, which consisted of 30 min of massage therapy, twice a week for six weeks. The massage techniques involved were: (a) effleurage, which is the application of smooth flowing strokes of the hand to the muscles, designed to relax the muscles and to promote blood and lymph return (Moraska, 2005). (b) Petrissage or kneading, which is an action where the therapist grasps and squeezes the muscle while lifting it away from underlying structures in a continuous kneading motion, designed to reduce muscle soreness, hypertonicity, local swelling, soften fascia and release adhesions. (c) Friction, either cross fibre or longitudinal friction, which is applied with brisk circular or linear strokes with the thumb or fingers. The application of this technique initiates a local inflammatory response, intended to release adhesions and scar tissue, increase circulation and deactivate trigger-point referral patterns.

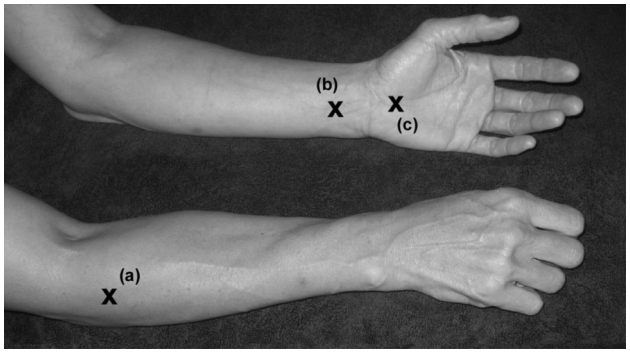

Figure 1 The three points measured by the algometer. (Illustration supplied by author).

Treatment commenced on the torso with the participant in the prone position, incorporating 3 min of effleurage, petrissage and longitudinal stroking to the neck and upper trapezius muscle. The next 5 min involved specific longitudinal and cross fibre stroking to the infraspinatus and teres muscles, with petrissage to the deltoid muscles. The participant then turned supinely, with the next 5 min involving longitudinal and cross fibre techniques to the coracobrachialis, the pectorals minor, and the subscapularis muscles.

The forearm and wrist received 12 min of petrissage and longitudinal stroking, with the participant performing concentric contractions of the wrist extensors for approximately 30—60 s. The concentric contraction was made by the participant, at the same time that the therapist performed longitudinal stroking in the proximal direction from the transverse carpal ligament. The final 5 min included deep transverse friction and deep longitudinal stroking to the transverse carpal ligament, with deep pressure to the musculotendinous junctions of the wrist. The participants guided the therapist at all times concerning acceptable massage pressures. A minimum of three days between sessions facilitated recovery from any residual soreness.

Statistical analysis

Descriptive results were expressed as mean and standard deviation, and Wilcoxon signed rank comparisons were made of the paired pre/post-test data for any significant ($p < 0.001$) differences between the scores. The dichotomous data was generated by the Tinel and the Phalen tests, and evaluated by McNemar's test to determine any significant ($p < 0.05$) relationships.

Results

Group characteristics

The participants (Table 1) had endured the syndrome for an average of 6.2 years, with 66% having the condition for more than 2 years.

Assessment questionnaires

The symptom severity and functional status questionnaires (Table 2) demonstrated significant ($p < 0.001$) change at

Table 1 Personal details of participants (mean ± SD).

	N	Age yrs	Weight kg	Height cm	BMI kg/m^2	Symptom duration yr
Female	14	51 (±4.8)	73 (±15.7)	161 (±7.7)	28.0 (±4.74)	6.7 (±5.9)
Male	7	46 (±6.7)	89 (±20.2)	174 (±5.8)	29.5 (±6.9)	5.3 (±5.7)

week two when compared to baseline, and again at week six when compared to week 2, before plateauing in the four weeks post treatment.

Objective measures

The results generated by two-point discrimination (Table 3) demonstrated significant ($p < 0.001$) improvement at week six when compared to baseline, and again at week ten when compared to week six, but not at week two.

The Tinel test (Table 4) demonstrated significant ($p < 0.05$) change at week six, whereas the Phalen test required ten weeks to register significant change.

Pressure measurements

During the course of the trial, the mean pressures applied to the participants as measured by an algometer, increased as the severity of the syndrome lessened, and the individual's pain tolerance rose accordingly. Further, it became apparent that gender and muscle size influenced the pressure tolerance. Given the differing pain tolerances, muscle tonicity and musculature of the participants (one male weighed 124 kg and one female weighed 54 kg), it was not plausible to administer identical pressures on each participant. Therefore, in the interest of treatment reproducibility, the tables (Table 5) were gender segmented.

Discussion

The principal aim of this study was to evaluate the efficacy of massage therapy as a treatment for CTS. Although outcome measures such as two-point discrimination, and the tests of Phalen and Tinel are well recognised, the patient's primary concern is symptom severity and functional liability (Burke et al., 2007). Necessitating a patient centred assessment that is fulfilled by the highly validated, self-administered carpal tunnel questionnaires, which operate on a scale between 1 and 5, with 1 representing no symptoms or functional disability, and 5 being extreme pain or maximum disability.

A four-way between study comparison of symptom severity and functional liability, based on treatment effect (Fig. 2) over time, found the current study offers an advantage over prior studies involving massage therapy (Moraska et al., 2008; Burke et al., 2007), but was of less benefit than surgery in reducing symptoms (Badger et al., 2008).

Surgery demonstrated a score reduction of 1.56; the current study demonstrated 1.28 or 68% score reduction, and the previous massage studies demonstrated reductions of 0.5 and 0.9 respectively. The results generated by the functional status questionnaire found that the current study offered an advantage over the other modalities of massage alone or surgery. The functional status in the current study improved by 0.97 or a 79% score reduction, the surgical score improved by 0.74, and the previous massage therapy studies improved the score by 0.3 and 0.6 respectively. The above comparisons demonstrate the combination of massage and trigger-point therapy as a viable therapy. However, caution is necessary when making comparisons between studies due to differences in population characteristics, pre-test scores and post-test timelines. Nonetheless, the level of significance attained in the current study demonstrates the benefit of including specify trigger-point therapy into the treatment protocol.

An additional benefit of massage therapy generally, may be intervention without dissection. A computational analysis of carpal bone biomechanics defined the ramifications of dissecting the transverse carpal ligament, as carpal bone migration and compromised biomechanics as a possible cause of post-operative complications (Guo et al., 2009). Complications such as pain, numbness, scar tenderness and

Table 2 Descriptive results and statistical analysis for symptom severity and functional status scores.

Symptom severity	Mean	Median	Lower quartile	Upper quartile
Baseline	2.87[a]	2.72	2.50	3.31
Week 2	2.07[b]	2.00	1.77	2.22
Week 6	1.55[c]	1.45	1.27	1.82
Week 10	1.59[c]	1.45	1.18	1.90
Functional status				
Baseline	2.22[a]	2.13	1.63	2.76
Week 2	1.63[b]	1.63	1.19	2.07
Week 6	1.34[c]	1.33	1.00	1.57
Week 10	1.25[c]	1.25	1.00	1.44

A different superscript indicates a significant ($p < 0.001$) difference between the scores.

Table 3 Descriptive results and statistical analysis for two point discrimination scores.

Two point discrimination	Mean	Median	Lower quartile	Upper quartile
Baseline	4.84[a]	4.67	4.00	5.50
Week 2	4.44[a]	4.33	3.83	5.17
Week 6	4.05[b]	4.00	3.50	4.33
Week 10	3.70[c]	3.67	3.00	4.17

A different superscript indicates a significant ($p < 0.001$) difference between the scores.

Table 4 Dichotomous data generated by the Tinel test and Phalen test.

Tinel test	Positive	Negative
Baseline	17	4[a]
Week 2	16	5[a]
Week 6	6	15[b]
Week 10	5	16[b]
Phalen test		
Baseline	17	4[a]
Week 2	16	5[a]
Week 6	14	7[a]
Week 10	10	11[b]

A different superscript indicates a significant ($p < 0.05$) difference between the scores.

weakened grip were also identified (Manktelow et al., 2004; Atroshi et al., 2006).

Unlike the results of the questionnaires that found significant change from as soon as two weeks, there was no significant ($p < 0.001$) change in two-point discrimination until week six, with further significant change at week ten. This delayed response to treatment is consistent with a study that found greater significant improvement in neural latencies six months post-operatively, compared to one month (Mondelli et al., 2000). Since two-point discrimination is a quantitative, effective measure of sensory perception (Periyasamy et al., 2008), the changes are expected to parallel those of neural conduction, both being linked to the health of the median nerve.

Similarly, the delay in recording significant ($p < 0.05$) response to treatment demonstrated by the Tinel test until week six, and the Phalen test until week ten is consistent with a delay in median nerve recovery. However, the results of these tests are not consistent with the findings of a previous study that found no significant change at any time point (Field et al., 2004). The reason for this incongruity is uncertain considering the improvement demonstrated by other tests in that study. For instance, that study reported significant change in median peak latency, symptom severity and grip strength. Since such improvements are conditional on a recovering median nerve, the expectation is for the tests of Phalen and Tinel to reflect that.

Table 5 Algometry measurements in kg, by point location.

	Mean	SD	Min	Max
Female point location				
Transverse carpal ligament	6.6	1.1	4.7	8.6
Radioulna joint	4.1	0.8	2.9	5.7
Extensor digitorum muscle	2.7	0.6	1.8	3.8
Male point location				
Transverse carpal ligament	9.4	2.1	6.1	11.8
Radioulna joint	6.3	1.6	3.7	8.4
Extensor digitorum muscle	3.7	0.1	2.3	4.9

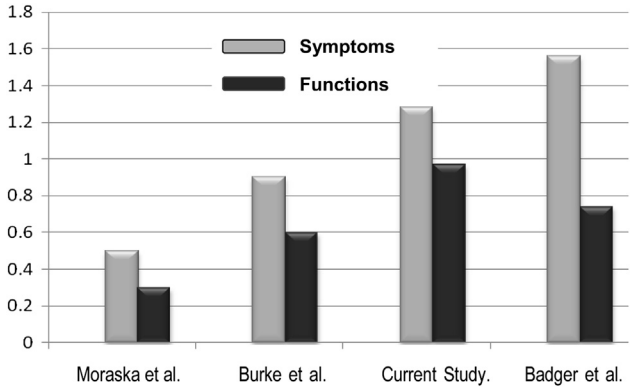

Figure 2 The treatment effect size was determined by subtracting the final post-test score from the pre-test score − Timelines listed below. Moraska et al. = 10 wk. Burke et al. = 18 wk. Current study = 10 wk. Badger et al. = 36 wk.

The majority of previous research has focussed primarily on releasing the median nerve at the wrist. However, that does not accommodate the possible involvement of more proximal neuropathy. While this is a different approach in the treatment of CTS, it is supported by previous reports of active trigger-points referring pain (Ge et al., 2006; Smith et al., 2008; Ge et al., 2008), and reproducing the CTS array of symptoms (Skubick et al., 1993; Qerama et al., 2009). Although a previous study included massage to the proximal sections of the median nerve and brachial plexus, the infraspinatus and subscapularis muscles were omitted (Moraska et al., 2008). Conversely, the current study applied pressure to those locations, exacerbating the symptoms of CTS in some individuals, as did pressure to the pectoralis minor and the extensor digitorum muscles to a lesser degree.

Finally, to increase the reproducibility of the treatment protocol within this current research, an algometer measured the pressure applied to the participant. Whilst the intra-individual values produced by an algometer are constant, the inter-individual values have demonstrated a five-fold variance (Persson et al., 2004). Variability was also evident in the current study, making a table of pressure readings questionable as a definite means of treatment reproducibility. Conversely, the exact pressure required to elicit change in an individual with CTS is unknown. Therefore, until research has defined pressure requirements more precisely, the pressure table presented in this study could offer therapists a preliminary point of reference in reproducing the pressure required to effect change in this syndrome.

The participants of the current research had endured the syndrome for an average of 6.2 years. As such, the possibility of spontaneous disappearance of the syndrome was unlikely in the majority of participants. Furthermore, other published studies found no significant changes in control groups with this syndrome (Garfinkel et al., 1998; Tal-akabi and Rushton, 2000; Manente et al., 2001; Burke et al., 2007). Therefore, the use of a control group was not considered necessary as this may be redundant, and causing unnecessary inconvenience to the controls.

Conclusions

Massage therapy demonstrated effectiveness in the treatment of CTS, with significant symptom reduction and functional improvement from as soon as two weeks. The trigger-points identified in this study are capable of exacerbating/producing the symptoms of CTS in some participants, necessitating treatment to all possible sites of entrapment. An additional benefit of massage therapy generally in the treatment of this syndrome, is intervention without dissection of the transverse carpal ligament.

Given the involvement that proximal trigger-points have in exacerbating the symptoms of CTS, the recommendation is that comparative studies be implemented to discern the level of involvement of these points. Meanwhile, manual therapists should include all possible sites of entrapment into their treatment protocol.

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