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Carpal Tunnel Syndrome: A Retrospective Analysis of Conservative Treatments

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Abstract

Abstract must be 250 words or less per the journal Clinical Rehabilitation.

Objective: The purpose of this study was to identify which conservative occupational therapy (OT) treatment(s) were most effective in reducing pain in patients diagnosed with carpal tunnel syndrome (CTS).
Design: A retrospective study of 222 de-identified treatment cases of patients seen from January 1st, 2004 to December 31st, 2013 were examined. Paired sample *t*-tests determined statistical significance between eight initial and final outcome measures. Binary logistic regressions determined statistical significance of clinically effective treatments that reduced pain at rest and pain with activity.
Setting: The 222 cases were from 31 outpatient rehabilitation clinics offering occupational therapy services.
Subjects: Participants were 18+ years of age and treated by an occupational therapist for conservative treatment of CTS.
Methods: Twenty-two treatments were analyzed for statistical significance using the VAS at rest and VAS with activity. For cases with a clinical significance in the VAS at rest and VAS with activity, frequencies were used to identify predominant treatments utilized.
Results: Massage was found to be statistically significant ($p=0.027$) in reducing pain at rest among those with a clinically significant reduction in pain at rest. Therapeutic exercises were found to be statistically significant ($p=0.026$) in reducing pain with activity among those with a clinically significant reduction in pain with activity. Therapeutic exercise, ultrasound, and manual therapy techniques were used in over 50% of treatments.
Conclusion: This study found therapeutic exercise and massage to be statistically significant treatments in the conservative treatment of CTS. Further investigation is warranted to determine specific methods of treatment labeled as therapeutic exercises and massage.

Keywords
Carpal tunnel syndrome, occupational therapy, conservative treatment

Introduction

Carpal Tunnel Syndrome (CTS) is the most well-known and common form of median nerve entrapment (Carlson et al., 2010; Ibrahim, Khan, Goddard, & Smitham, 2012; Moraska et al., 2008; O'Connor, Page, Marshall, & Massy-Westropp, 2012). The carpal tunnel area is defined by the carpal bones and the transverse carpal ligament (Gursoy, Kolukisa, Kocaman, Celebi, and Kocer, 2013; Ibrahim et al., 2012). The median nerve is located under the transverse carpal ligament in the wrist (Gursoy et al., 2013). CTS occurs as a result of compression and/or traction on the median nerve at the wrist (Chammas, 2014; Moraska et al., 2008; O'Connor et al., 2012). The median nerve innervates sensory function to the thumb, index, middle and the inside portion of the ring finger as well as innervating motor function to allow for opposition of the hand (Ibrahim et al., 2012; Moraska et al., 2008). The median nerve is composed of 94% sensory fibers and 6% motor fibers at the carpal tunnel level (Kostopoulos, 2004). Moraska et al. (2008) defines motor dysfunction as a loss of coordination and muscle weakness due to decreased grip and pinch strength. Moraska et al. (2008) also defines sensory impairment as: pain, numbness, tingling, and burning sensations. Symptoms of CTS include: tingling and pain in the thumb, index, middle and radial half of the ring finger (Hall et al., 2013; Moraska et al., 2008; O'Connor et al., 2012). Discomfort and pain from CTS can negatively impact activities of daily living, sleep, and employment (Kostopoulos, 2004; Moraska et al., 2008). The exact etiology of CTS is unknown (Hall et al., 2013; O'Connor et al., 2012).

Associated causes of CTS may include: fractures and inflammatory diseases, systemic factors such as diabetes or metabolic conditions, and mechanical factors resulting from repetitive movements (Hall et al., 2013; O'Connor et al., 2012). Additional risk factors for developing CTS involve: occupational tasks, rheumatoid arthritis, hypothyroidism, gout, and pregnancy (Shi

& MacDermid, 2011). Other risk factors include manual work in cold environments, obesity, and compromised health (Hall et al., 2013).

CTS is present in approximately 3% of the general population (Gursoy et al., 2013; Ibrahim et al., 2012; O'Connor et al., 2012). There is a higher incidence of CTS in women (Ibrahim et al, 2012; O'Connor et al., 2012). Females are four times more likely to develop CTS in their forties and fifties than males (O'Connor et al., 2012). Most individuals, both male and female, have bilateral CTS (Ibrahim et al., 2012).

The literature supports both surgical and conservative approaches for the treatment of CTS (Bickel, 2010; Moraska et al., 2008; O'Connor et al., 2012). The treatment for severe CTS often involves surgery, while mild to moderate CTS is often treated conservatively (Ibrahim et al., 2012; O'Connor et al., 2012). Approximately 400,000-500,000 surgical cases of CTS occur each year, costing roughly $60,000 per case, whereas conservative treatments cost roughly $5,000 (Elliott & Burkett, 2013). Nonsurgical interventions include the use of orthoses, medications, massage therapy, neural mobilization, exercises, modalities, ergonomic modifications, as well as other alternative therapies (Carlson et al., 2010; Moraska et al., 2008; O'Connor et al., 2012). There is limited research regarding the efficacy of different conservative treatment approaches (Bickel, 2010; Carlson et al., 2010; Moraska et al., 2008; O'Connor et al., 2012).

Literature Review

A review of the literature has identified several conservative treatment interventions that have reported to be effective, one of the most common treatments is massage (Bickel, 2010). A study evaluating the efficacy of treating CTS with massage, completed for 30 minutes twice a

week for six weeks, demonstrated decreased pain and disability (Bickel, 2010). Another pilot study demonstrated the effects of massage and mobilization therapies for CTS, which reported significant improvements in hand symptoms and function as assessed by the Boston Carpal Tunnel Questionnaire (Maddali Bongi et al., 2013). In this study, participants experienced a reduction in tingling, hand pain, sensitivity, and night awakening (Maddali Bongi et al., 2013). Moraska et al. (2008) also evaluated the effects of massage and found that participants had improved grip strength after their seventh massage therapy session. Moraska et al. (2008) concluded that massage therapy may be an advantageous therapeutic approach for individuals with CTS.

Occupational therapy treatment noted as manual therapy techniques include mobilization and manipulation treatments as well as manual traction (National Government Services, 2011). A systematic review by O'Connor et al. (2012) cited increased patient satisfaction in those that had received a metal instrument-assisted soft tissue mobilization as compared to manual soft tissue mobilization. Carlson et al. (2010) described carpal bone mobilization exercises include both tendon and nerve gliding and reported an improvement in axonal transport and nerve conduction. Page, O'Connor, Pitt, and Massy-Westropp (2012) further discussed the need to specifically evaluate the effectiveness of exercises and mobilizations for individuals with CTS. National Government Services (2011) states that mechanical traction therapy is used for pain-relief and is often combined with other treatments.

Ultrasound is supported in the literature as a conservative treatment approach for CTS (Bakhtiary & Rashidy-Pour, 2004; Ebenbichler et al., 1998; Oztas, Turan, Bora, & Karakaya, 1998; Piravej & Boonhong, 2004). Ebenbichler et al. (1998) found that 68% of participants receiving ultrasound treatment reported improvement or remission of CTS symptoms versus

38% of those receiving a placebo treatment. Increases in hand and finger pinch strength and overall improvement in patient ratings were also noted (Ebenbichler et al., 1998). A study by Oztas et al. (1998) demonstrated a statistically significant improvement in pain with the treatment of ultrasound assessed by the Visual Analog Scale (VAS). Another study by Bakhtiary & Rashidy-Pour (2004) determined a patient's pain ratings decreased by 3.1 cm on the 10 cm VAS scale with ultrasound therapy over laser therapy. Piravej & Boonhong (2004) also found low intensity ultrasound to be effective in the treatment of mild to moderate CTS.

Gokoglu et al. (2005) found that the delivery of dexamethasone sodium phosphate through iontophoresis was successful at reducing CTS symptomatology. Additionally, Banta (1994) reported that iontophoresis was shown to be effective in 58% of the study's participants.

Dincer, Cakar, Kiralp, Kilac, & Dursun (2009) describe the use of a neutral positioning orthosis as one of the most commonly used conservative treatment methods for CTS. Apfel, Johnson, & Abrams (2002) confirmed this finding when evaluating the use of a neutral position orthosis with cadavers, which resulted in a decreased pressure in the carpal tunnel. Hall et al. (2013) supports the use of an orthosis in combination with client education to decrease CTS symptomatology while improving functional abilities. Carlson et al. (2010) discussed the potential benefits of clients wearing an orthosis even for a short-term to decrease CTS symptomatology.

Thermogenic treatment modalities are also an option for the treatment of CTS (Al Matly, Jebril, AbuTariah, & Albostani, 2014; Janssen, Schwartz, & Velleman, 2009). A study by Janssen et al. (2009) demonstrated no significant change in hand volume with the use of contrast bath protocols. Another study reported the use of paraffin baths combined with exercise resulted in significant improvements in pain and finger strength (Al Matly et al., 2014).

National Government Services (2011) defines therapeutic procedures as an effort to reduce impairment and restore function through a therapist's clinical skills and/or resources. The code therapeutic exercise is used for: strengthening, increasing endurance, range of motion (actively, active with assistance, or passively) and flexibility (National Government Services, 2011).

Investigation into treatment options of CTS is necessary due to the financial impact demonstrated by lost work time, treatment costs, and the number of people affected (Elliott & Burkett, 2013; Gursoy et al., 2013; Ibrahim et al., 2012; Moraska et al., 2008; O'Connor et al., 2012). CTS greatly impacts society due to the economic costs associated, up to $1 billion in direct medical costs, and lost productivity (Bickel, 2010; Field et al., 2004; Moraska et al., 2008). Additionally, a multitude of treatments were identified in the literature review, with limited information regarding their effectiveness. This significance warrants further research into conservative treatment options for CTS.

Therefore, the purpose of this study was to identify which conservative occupational therapy treatment(s) were most effective in reducing CTS symptomology.

Methods

The data for this retrospective study was provided by a national provider of rehabilitation services from 31 outpatient clinics. The data was extracted from a secure, electronic database by an employee using a three-tiered system to filter the cases in the database. The documented body region (hand/wrist) was used in combination with the terms "carpal tunnel" in the injury classification category, "carpal" and/or "tunnel" in the referring diagnosis category, or "carpal" and/or "tunnel" in the treating diagnosis category. The data collection and methodology for this study was approved by the Human Research Review Committee at XXXX.

The final dataset received from the rehabilitation company included 639 de-identified cases. Each case represented data from the treatment of a patient seen at one of the 31 outpatient treatment centers for CTS between January 1st, 2004 and December 31st, 2013. Inclusion criteria (Figure 1) required participants to be over 18 years of age and treated by an occupational therapist for the treatment of CTS. Participants excluded were those that had documented: tendonitis, de Quervain's tenosynovitis, lateral/medial epicondylitis, carpal tunnel release of the affected region, steroid injection, pregnancy, diabetes mellitus, metabolic disorders, rheumatoid arthritis, or a cyst/tumor. Data from the 222 remaining cases was used in the statistical analysis of this study.

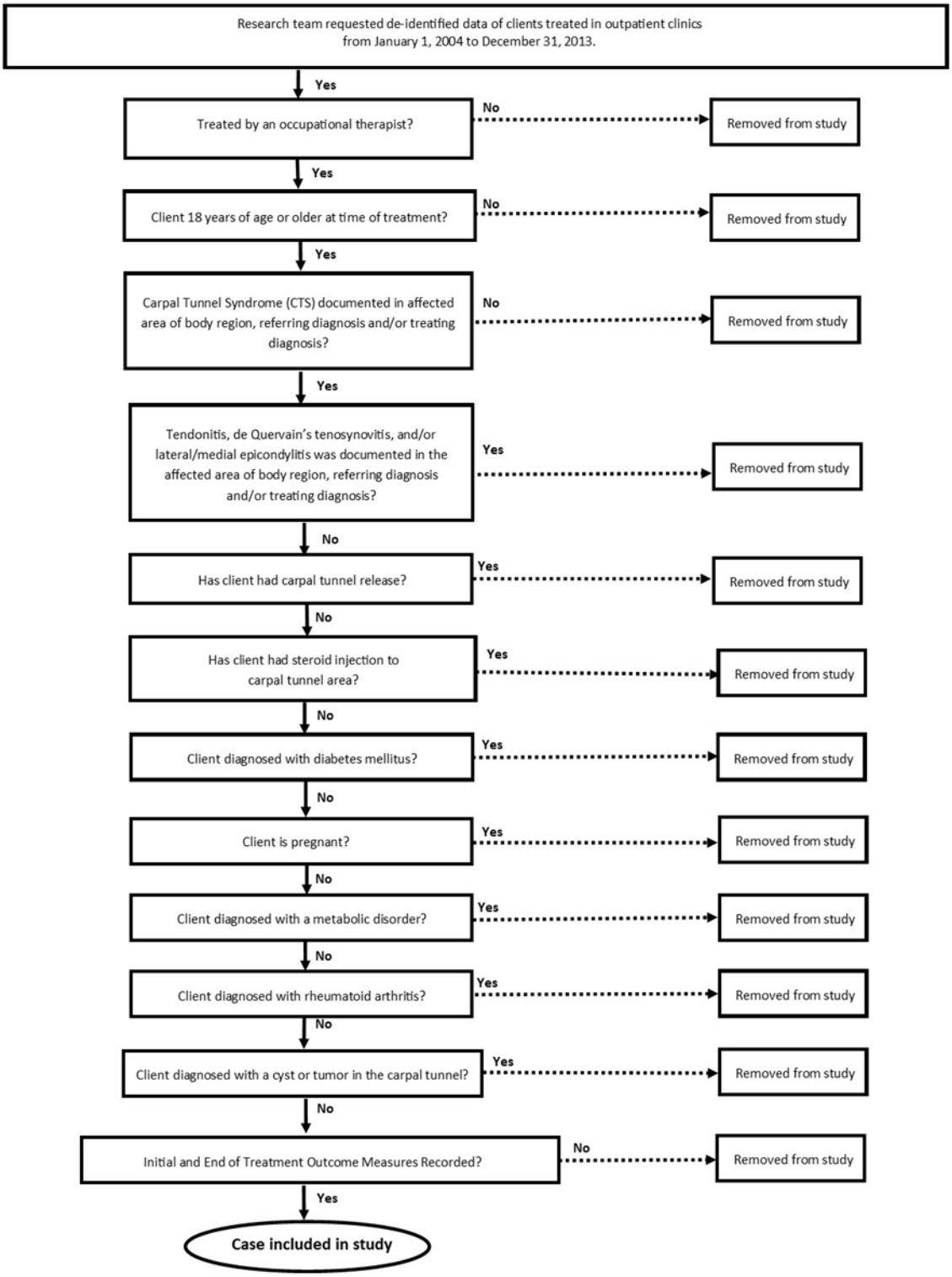

Figure 1. Inclusion criteria for cases evaluating conservative treatment of CTS.

Data from the included cases were imported into the Statistical Package for the Social Sciences (SPSS), version 20, by IBM, for statistical analysis. Descriptive statistics were utilized to summarize the demographics of the dataset, which included the patient's age, gender, average number of days from onset of symptoms to initial visit, affected area (e.g. right, left, bilateral), and the average time period between the initial evaluation and discharge from treatment. Treatment codes were analyzed by running frequencies of use in the dataset.

The SAFUQ is an outcome measure used to record how pain in the upper extremity affects activities of daily living (Agility Health, 2009). The FCS is an outcome measure of a client's ability to function and perform activities of daily living (Agility Health, 2011). Both the SAFUQ and the FCS have not been researched. The initial and final measurements of the eight outcome measures the Self Assessed Function of the Upper Quarter [SAFUQ], Functional Classification Scale [FCS], VAS for pain at rest and with activity, strength of flexion and extension, and active range of motion of flexion and extension) were compared using a paired sample *t*-test to determine a difference in mean value and if the difference was statistically significant results. Further analysis using the results of the VAS at rest and with activity were performed due to the demonstrated validity and reliability of the VAS in the literature (Williamson & Hoggart, 2005). The assessment of wrist strength in flexion/extension and active range motion of wrist flexion/extension was also provided in the dataset as outcome measures (Agility Health, 2011). There were no studies in the literature to cite the use of wrist strength in flexion/extension or range of motion in the assessment of CTS treatment. Therefore, the use of the SAFUQ, FCS, strength assessments, and range of motion were not further analyzed in this study. The remaining six outcome measures were not utilized in this study due to a lack of research on the validity and reliability of the outcomes for CTS.

Two binary logistic regressions were used with 22 treatments, identified as the independent variables. The VAS at rest and with activity was identified as the dependent variables to determine which determined which treatments were statistically significant based on a clinically significant different for both pain at rest and pain with activity. Further analysis was completed to determine the frequency of the 22 treatments with the VAS at rest and the VAS with activity after recoding cases that had a clinically significant difference. A reduction of 2 cm or 20 mm on the 10 cm/100 mm VAS scale demonstrates a clinically significant difference as reported by Grilo, Treves, & Preux (2007).

Results

Four hundred, seventeen cases were excluded from the original dataset presented by the rehabilitation company, resulting in 222 cases for analysis. Of the 222 cases, the mean age of patients was 50 ± 17 years old (range 19 to 90 years). As for gender, 73% of the cases were female patients, 20% were male patients, and 7% of patient's gender was not coded. The average number of days from the onset of symptoms to the initial visit was 74 ± 118 days (range from 0 to 1,110 days). Forty-one percent were treated for bilateral CTS. Thirteen percent of patients had symptoms in the right hand, 9% patients had symptoms in the left hand, and 38% patients were coded as undetermined. The average time period between a patient's initial evaluation and discharge was 40 ± 25 days (range from 4 to 143 days).

A total of 28 current procedural terminology (CPT) codes were used in the dataset for treatment. Of the 28 treatments, six were not considered for further analysis due to the nature of the code (e.g. occupational therapy evaluation and re-evaluation, G code modifiers, and one code for physical test). The remaining treatment codes were then used as an identifier of actual treatments used in practice. The twenty-two treatments were further studied for frequency of use

in therapy in the dataset. Treatments used in over 50% of cases included: therapeutic exercises (93%), ultrasound (64%), and manual therapy techniques (58%) (Table 1).

Table 1. Frequencies of treatments used by therapists for the conservative treatment of CTS in the dataset of the included 222 cases. The codes referenced in the dataset, the following were excluded from further analysis due to the nature of their code: OT Evaluation, OT re-evaluation, G codes for electrical stimulation unattended, self-care limitations for current status, self-care limitations for projected goal status, and physical performance test.

Treatment	**# of cases (%)**
Therapeutic Exercise	207 (93.2)
Ultrasound	143(64.4)
Manual Therapy Techniques	128(57.7)
Iontophoresis	70(31.5)
Whirlpool	61(27.5)
Therapeutic Activities	53(23.9)
Hot/Cold Pack	49(22.1)
Paraffin Bath	22(9.9)
Massage	19(8.6)
Self Care Home Management	19(8.6)
Orthotic(s) management and training	18 (8.1)
Electrical Stimulation-attended	8(3.6)
Electrical Stimulation-unattended	6(2.7)
Orthotic Fitting and Training	4(1.8)
Static Short Arm Splint	3 (1.4)
Aquatic therapy with therapeutic exercises	2(0.9)
Checkout for orthotic/prosthetic use, established patient	2(0.9)
Application of Finger Splint	1(0.5)
Balance Coordination Kinesthetic Sense	1(0.5)
Community Work Reintegration Training	1(0.5)
Mechanical Traction Therapy	1(0.5)
Wrist hand orthosis, off the shelf	1(0.5)

For each outcome measure, a paired samples *t*-test was used to determine a statistically significant difference between initial and final evaluations. All outcome measures were statistically significant indicating an improvement from initial to final evaluation, or an improvement throughout the course of treatment. The mean values from initial to final evaluation of the following outcome measures are indicated in Table 2. Patients did not improve from their initial to final visit on the following outcome measures: the SAFUQ, FCS, strength measurement of flexion and extension, and active range of motion in flexion and extension. See table 2 for detailed information of the paired sample *t*-test.

Table 2. Paired sample *t*-test of the outcome measures used in the study: Self Assessed Function for Upper Quarter [SAFUQ]; Function Classification Scale [FCS]; Visual Analog Scale [VAS] assessed at rest; Visual Analog Scale [VAS] assessed during activity; Active range of motion [AROM; measured in degrees]. *Indicates a negative value is reflective of a positive change.

Paired Sample *t*-Test Paired Differences			
	Mean ± Std. Deviation	Difference in Means	Sig. (2-tailed)
Pair 1-Initial SAFUQ	3.13 ± 1.051	-0.531*	0.00
Final SAFUQ	3.66 ± .956		
Pair 2-Initial FCS	3.51 ± 0.956	-1.341*	0.00
Final FCS	4.86 ± 1.293		
Pair 3-Initial VAS at rest	4.02 ± 0.197	1.6	0.00
Final VAS at rest	2.42 ± 0.189		
Pair 4-Initial VAS with activity	6.41 ± 0.186	2.471	0.00
Final VAS with activity	3.94 ± 0.211		
Pair 5-Initial Strength Extension	3.62 ± 0.056	-0.454*	0.00
Final Strength Extension	4.07 ± 0.054		
Pair 6-Initial Strength Flexion	3.63 ± 0.056	-0.493*	0.00
Final Strength Flexion	4.13 ± 0.055		
Pair 7-AROM Extension	54.80 ± 1.002	-5.871	0.00
Final AROM Extension	60.67 ± 1.026		
Pair 8-AROM Flexion	61.54 ± 1.303	-6.426	0.00
Final AROM Flexion	67.97 ± 1.137		

Among patients with a clinically significant improvement in pain at rest from initial to final evaluation, massage was found to be statistically significant ($p=0.027$). Among patients with a clinically significant improvement in pain with activity from initial to final evaluation, therapeutic exercises were found to be statistically significant ($p=0.026$), complete results found in Table 3-4.

Table 3. Individual treatments compared to the outcome measure VAS at rest. Massage (p=0.027) was statistically significant.

VAS at Rest Binary Logistic Regression			
		95% C.I. for Exp(B)	
Variables in the Equation	Odds Ratio	Lower	Upper
Electrical Stimulation-unattended	0.175	0.007	4.263
Iontophoresis	0.701	0.325	1.511
Massage	**0.182**	**0.041**	**0.821**
Therapeutic Exercises	0.244	0.048	1.243
Ultrasound	0.626	0.322	1.217

Table 4. Individual treatments compared to the outcome measure VAS with Activity. Therapeutic Exercise (p=0.026) was statistically significant.

VAS with Activity Binary Logistic Regression			
		95% C.I. for Exp(B)	
Variables in the Equation	Odds Ratio	Lower	Upper
Therapeutic Exercises	0.145	0.027	0.789
Massage	0.42	0.128	1.381
Orthotic Fitting and Training	0.472	0.02	11.171
Therapeutic Activities	0.799	0.337	1.896
Paraffin	0.82	0.329	2.048

Eighty-five cases were found to have clinically significant improvements in pain at rest. Treatments used in over 50% of cases included therapeutic exercises (92%), ultrasound (59%), and manual therapy techniques (57%), Table 5.

Table 5. Frequencies of treatments used in cases with clinically significant results when using the VAS at rest, n=85.

Frequencies of Treatments VAS at Rest

Treatment	Cases where treatment was utilized (%)
Therapeutic Exercises	78(91.8)
Ultrasound	50(58.8)
Manual Therapy Techniques	48(56.5)
Iontophoresis	25(29.4)
Whirlpool	22(25.9)
Therapeutic Activities	20(23.5)
Hot/Cold Pack	15(17.6)
Orthotic(s) management and training	8(9.4)
Paraffin Bath	8(9.4)
Self Care Home Management	7(8.2)
Electrical Stimulation-attended	5(5.9)
Massage	3(3.5)
Static Short Arm Splint	2(2.4)
Application of Finger Splint	1(1.2)
Aquatic therapy with therapeutic exercises	1(1.2)
Checkout for orthotic/prosthetic use, established patient	1(1.2)
Electrical Stimulation-unattended	1(1.2)
Mechanical Traction Therapy	1(1.2)
Wrist hand orthosis, off the shelf	1(1.2)
Balance Coordination Kinesthetic Sense	0(0.0)
Community Work Reintegration Training	0(0.0)
Orthotic Fitting and Training	0(0.0)

One hundred and seventeen cases were found to have clinically significant improvement in pain with activity. Treatments used in over 50% of cases included therapeutic exercises (90%), ultrasound (62%), and manual therapy techniques (61%), Table 6.

Table 6. Frequencies of treatments used in cases with clinically significant results when using the VAS with activity, n=117.

Frequencies of Treatments VAS with Activity

Treatment	Cases where treatment was utilized (%)
Therapeutic Exercises	105(89.7)
Ultrasound	73(62.4)
Manual Therapy Techniques	71(60.7)
Iontophoresis	37(31.6)
Whirlpool	32(27.4)
Therapeutic Activities	25(21.4)
Hot/Cold Pack	24(20.5)
Orthotic Fitting and Training	11(9.4)
Paraffin Bath	11(9.4)
Self Care Home Management	10(8.5)
Massage	9(7.7)
Orthotic(s) management and training	8(9.4)
Electrical Stimulation-attended	5(4.3)
Electrical Stimulation-unattended	4(3.4)
Static Short Arm Splint	2(1.7)
Application of Finger Splint	1(0.9)
Aquatic therapy with therapeutic exercises	1(0.9)
Balance Coordination Kinesthetic Sense	1(0.9)
Checkout for orthotic/prosthetic use, established patient	1(0.9)
Mechanical Traction Therapy	1(0.9)
Community Work Reintegration Training	0(0.0)
Wrist hand orthosis, off the shelf	0(0.0)

Discussion

In summary, massage was found to be statistically significant (p=0.027) in reducing pain at rest among those with a clinically significant reduction in pain at rest. Therapeutic exercises were found to be statistically significant (p=0.026) in reducing pain with activity among those with a clinically significant reduction in pain with activity. Therapeutic exercise, ultrasound, and manual therapy techniques were used in over 50% of treatments.

This study establishes data that supports the use of occupational therapy and conservative treatment methods in the treatment of CTS. The size of the dataset (639 cases) and the level of detailed information provided in the referring and treatment diagnosis in each case was considered a strength of this study. Descriptive statistics of the dataset provided by the rehabilitation company had similar demographics of age and gender to published demographics in the literature (Bickel, 2010; Gursoy et al., 2013; Ibrahim et al., 2012; O'Connor et al., 2012). The authors felt this was an important detail to associate the study's findings with the general population diagnosed with CTS.

The outcome measures used during treatment were an integral component of the study. Six of the eight outcome measures were a limitation due to the lack of research available on those measures. However, the literature was supportive of the use of the VAS at rest and with activity as an outcome measure for pain in those diagnosed with CTS (Grilo et al., 2007). All of the eight outcome measures were statistically significant in improvement of symptoms from the initial to the final evaluation. The use of the VAS scale was considered a strength due to the measure's validity and reliability in the assessment of pain and that a clinically significant difference was identified (Grilo et al., 2007; Williamson & Hoggart, 2005).

Other outcome measures used in the data included the SAFUQ, FCS, strength and active range of motion. The SAFUQ is an outcome measure used to record how pain in the upper extremity affects activities of daily living (Agility Health, 2009). The FCS is an outcome measure of a client's ability to function and perform activities of daily living (Agility Health, 2011). Both the SAFUQ and the FCS have not been researched. Therefore, the validity and reliability of the SAFUQ and the FCS is unknown as well as the number of cases in the dataset that would indicate a clinically significant difference. The assessment of wrist strength in flexion/extension and active range motion of wrist flexion/extension was also provided in the dataset as outcome measures (Agility Health, 2011). There were no studies in the literature to cite the use of wrist strength in flexion/extension or range of motion in the assessment of CTS treatment. Therefore, the use of the SAFUQ, FCS, strength assessments, and range of motion were not further analyzed in this study.

Hand therapy utilizes different therapeutic interventions to restore functional use of the upper extremities (Carlson et al., 2010). Based on individual patient need, treatments are then chosen depending on the severity of symptoms, patient needs and goals, and comorbidities (Carlson et al., 2010). Due to the number of treatments, small sample sizes resulted, making the analysis of combinations of treatments ineffective.

Therapeutic exercise was the sole treatment determined to be statistically significant for pain with activity among those with a clinically significant difference. Therapeutic exercises are commonly utilized when a disease or injury has impacted a patient's functionality (National Government Services, 2011). According to National Government Services (2011), this treatment covers a wide variety of exercises that are used for restoration of strength, endurance, range of motion, and flexibility. The amount of assistance can vary by the therapist when using this code,

for example: active, active-assisted, or passive participation (National Government Services, 2011). Further research is needed on the treatment of therapeutic exercises.

Massage was the sole treatment determined to be statistically significant for pain at rest, measured by the VAS. Clinical trials support the use of massage therapy for treatment of pain and functional abilities as demonstrated by Field et al. (2004). The literature found fewer carpal tunnel symptoms and electrodiagnostically shorter median peak latency for those diagnosed with CTS (Field et al., 2004). This study's participants also reported improvement in functional activity and reduced pain and increased grip strength (Field et al., 2004). Additional research regarding the type of massage utilized with those diagnosed with CTS is needed.

A limitation of this finding is the scope of actual treatments that make up therapeutic exercise and massage may encompass. Investigation of each case in the dataset to determine the specific treatments coded as "therapeutic exercise" or "massage" was not available per to the researchers. Therefore, further studies, which analyze specific treatments, coded as therapeutic exercise or massage would complement the findings presented in this study.

In cases that had a clinically significant difference for pain at rest and with activity, three treatments were identified as being used in over 50% of the cases. Those treatments include therapeutic exercise, ultrasound and manual therapy techniques. Further research is needed before conclusions could be made regarding the effectiveness of the three treatments.

Additional research is warranted in treatments used in the data which were not found in the literature. Those treatments include the use of aquatic therapy, community work reintegration, mechanical traction, self-care home management, and whirlpool therapy.

Page et al. (2012) discusses the need to specifically evaluate the effectiveness of exercises and mobilizations for individuals with CTS. Due to the study's retrospective nature, a limitation of the study is the uncontrolled accuracy of the medical protocols (Hess, 2004). Another limitation of the study is therapists coded patients that were 90 years or older as 90+, not the patient's actual age. Inconsistency in the documentation of final outcome measures on the final day of treatment is also a limitation due to cancellations and no-show visits.

From the reported data, massage had a statistically and clinically significant effect on pain at rest and therapeutic exercise had a statistically and clinically significant effect on pain with activity. The top three treatments that occupational therapists utilized while treating CTS include: therapeutic exercise, ultrasound, and manual therapy techniques. Results from this study warrant further research as to each of the treatments effectiveness in the conservative management of CTS.

Ethics

There are no ethical issues regarding this study. De-identified data was used in this study and no financial benefits were provided.

Clinical Messages

- This study suggests statistically and clinically significant results for the use of massage to reduce pain at rest and therapeutic exercises to reduce pain with activity in the treatment of CTS.
- Further research is warranted to determine specific treatment protocols for massage and therapeutic exercises.

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