Clinical Case Report Competition

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Third Place Winner

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The effects of ischemic compressions on trigger points of the upper limb to decrease symptoms of chronic carpal tunnel syndrome
Acknowledgements

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Abstract

**Background:** The subject of this study was a 65 year old female that was diagnosed with bilateral Carpal Tunnel Syndrome (CTS) who complained of constant aching of the wrist and hand. The pain affected activities of daily living that increased at night, resulting in sleep disturbances. It was hypothesized that ischemic compression therapy applied to trigger points in the subscapularis muscles, biceps brachii muscle, bicipital aponeurosis, and pronator teres muscle would decrease symptoms of CTS.

**Method:** Five treatments were given over ten days to the right arm, where the symptoms were more severe. The treatments included general Swedish massage, ischemic compressions, passive and active range of motion, and a deep moist heat application. Home care included contrast arm baths, median nerve gliding exercises, and the continued use of a nocturnal brace. Levine’s Carpal Tunnel Functional Disability Questionnaire, Visual Analog Scale, two-point discrimination testing, goniometer, and a record of the patient’s compliance with home care were used to measure and record findings during the study.

**Results:** After the treatments, the pain perceived by the patient was reduced but the goals of reducing trigger points and nocturnal pain occurrences, and increasing range of motion was not achieved.
Conclusion: This study demonstrated that applying ischemic compressions to treat trigger points did not appear to decrease CTS symptoms.

Keywords: Carpal tunnel Syndrome; Massage therapy; Ischemic compressions; Trigger points, Nocturnal pain
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**Introduction of the Medical Condition**

Carpal tunnel syndrome (CTS), one of the most common peripheral neuropathies, is a condition in which the median nerve is compressed in the carpal tunnel. It occurs more often in middle aged women with an increased prevalence between the ages of 55 to 60 years old.\(^1\)

The symptoms associated with CTS are tingling and numbness in the distribution of median nerve along the lateral side of the hand. Nocturnal pain will disrupt sleep, thereby causing the individual to wake up and shake their hand vigorously to alleviate the discomfort.\(^2\) In chronic cases, atrophy of the thenar eminence can be observed, as well as diminished strength in the thumb flexor, opposition and abductor muscles.\(^1\)

**Hypothesis**

Hains\(^2\) hypothesized that the increase in size of the median nerve that is present with carpal tunnel syndrome patients is due to the nerve being entrapped along its course by trigger points found in the muscles that it travels alongside, or through, prior to entering the carpal tunnel. Hains\(^2\) randomized clinical trial included 55 participants. The experimental group consisted of 37 participants that received the treatments of ischemic compressions applied to trigger points in
subscapularis, biceps brachii, the bicipital aponeurosis, and pronator teres. The remaining 18 participants were in the control group and received ischemic compressions to other muscles. The experimental group experienced a decrease in pain and “perceived improvement in functional capacities over a six month period”. Based on these findings, a similar treatment protocol was carried out by the researcher to test whether it could decrease symptoms of CTS.

*Figure 1. Main trigger points in carpal tunnel syndrome.*

**Common medical intervention**

To date, interventions used for CTS can be classified into surgical and non-surgical measures. Surgery, performed as an open or endoscopic carpal
tunnel release, involves an incision being made into the flexor retinaculum to decrease the pressure on the median nerve and increasing the volume of the carpal tunnel by 15%-20%. Non-surgical options include non-steroidal anti-inflammatory medication, steroid injections, neural and carpal mobilization, and yoga. Splints worn at night have been shown to decrease the mild early stage symptoms experienced by the patient; however, a proper fit is imperative for full compliance. Field found massage therapy decreased CTS symptoms and median nerve pain. There are confictions with regards to the effect of physical occupational activities contributing to the development of CTS; however, modifications made at the workplace have shown a satisfactory response in patients with mild to moderate symptoms.

**Etiology**

CTS occurs when there is increased pressure within the carpal tunnel. The cause of CTS is idiopathic in 50% of cases and for the other half the causative factor could include a fracture of the distal radius, a dislocated carpal bone, and swelling of the common flexor tendon sheath. Most cases of CTS are chronic and many have developed over time as a result of repetitive flexion and extension. Other factors that can reduce the space of the carpal tunnel are inflammation, trauma, tumors, and anatomical abnormalities. Regional conditions including
osteoarthritis and rheumatoid arthritis, and systemic conditions including diabetes, hypothyroidism, and pregnancy can also lead to the development of CTS.\textsuperscript{[1]}

**Anatomy & Pathology**

The median nerve originates from the brachial plexus and travels through the axilla down the arm between the biceps and triceps, through the two heads of pronator teres in the forearm, and then passes between flexor digitorum superficialis and flexor digitorum profundus. It then enters, along with the tendons of flexor digitorum superficialis, flexor digitorum profundus, and flexor pollicis longus, through the carpal tunnel.\textsuperscript{[7]} Tortora and Derrickson\textsuperscript{[8]} stated “The carpal tunnel is a narrow passageway formed anteriorly by the flexor retinaculum and posteriorly by the carpal bones” (p. 384).

Multiple sites of compression or entrapment of the median nerve along its route can cause it to become inflamed and double in size prior to entering the carpal tunnel.\textsuperscript{[2]} Aroori and Spence\textsuperscript{[1]} found that the inability of the median nerve to transmit nerve impulses was due to the decrease of nutrients and oxygen from micro-vascular insufficiency. Another theory put forth is that the symptoms of CTS could be due to long term use of vibrating tools.\textsuperscript{[1]}
Research findings

Surgery is used primarily in the cases of moderate to severe symptoms as well as with individuals with idiopathic CTS.\textsuperscript{[1]} The results of this surgical method are controversial: some participants state that they continue to experience CTS symptoms and any gains made post surgery are lost in less than two years\textsuperscript{[2]} while others state the operation is the only treatment that provides a cure for those suffering from moderate to severe symptoms.\textsuperscript{[1]}

McGrath’s study stated, “steroid injection into the wrist is often successful. It may cause symptoms to worsen temporarily but can produce complete or significant pain relief in 60 to 70\% of patients for weeks to years” (p. 12).\textsuperscript{[1]}

Some other causative factors have association to occupations that involve exposure to vibration, or repeated and sustained flexion, extension, ulnar or radial deviation of the wrist seen in assembly work.\textsuperscript{[9]} Andersen et al. discovered a correlation between computer mouse use to incidents of sensory symptoms along median nerve distribution in a study of 5,000 Danish professional technicians. However, the use of a computer keyboard did not prove to be a causative factory to developing CTS.\textsuperscript{[9]}
Sleep positions, especially in aging females, supports the disease forming habit of sleeping in with wrist flexion through the night which adds a compressive force to the contents of the carpal tunnel and therefore causes restricted blood flow and nerve compression leading to numbness, tingling, and pain.\textsuperscript{[10]}

**Patient history**

Patient is a 65 year old female who has worked for the past 16 years as an executive assistant. Her duties include typing and writing, and include frequent use of a computer mouse. Her hobbies include gardening, knitting, sewing, and reading. The symptoms of carpal tunnel syndrome affect her ability to enjoy her hobbies as well as hamper activities of daily living such as carrying grocery bags, household chores, and opening jars.

Her doctor diagnosed her with bilateral carpal tunnel syndrome about five years ago, with the symptoms being worse in her dominant (right) hand. The diagnosis was made after administering several manual tests, computed tomography (CT) and magnetic resonance imaging (MRI) scans. The doctor made recommendations for her to see a physiotherapist and use a day brace and night splint. The patient attended physiotherapy once and did not continue as the
pain from the visit was beyond her tolerance. She has not worn the night splint for the past three years as she finds it uncomfortable, yet uses the day brace at night when the aching pain in her hand and wrist is unbearable.

Her medical history includes asthma, Finkelstein’s syndrome in the right hand, and osteoarthritis in the neck (sixth cervical vertebra), wrists and distal phalangeal joints in her hands (bilaterally). She is presently taking ramipril and felodipine for hypertension.

**Observations & Palpation**

The right distal radial forearm was found to have a palpable non-tender mass. The right wrist, above the scaphoid, was slightly enlarged and tender with moderate palpation, and the right thenar eminence appeared slightly swollen and larger, compared to left side.

Functional tests of grip and handshake bilaterally were administered and were found to be within normal limits and pain free.
Movement

Measurement of all ranges of motion was done with a manual goniometer.\[^{[11]}\] Testing of the elbow presented with a normal active range of motion in flexion and extension bilaterally, as well as pronation of the left elbow. Supination bilaterally and pronation of the right elbow showed a decrease in range, most notably in supination of the right elbow.

Ulnar deviation of the wrist was within normal limits bilaterally. Hypermobility was measured with radial deviation bilaterally, more so in left wrist. Minimal pain was felt with active ulnar deviation of the left wrist at end range of movement.

All resisted movements of the elbow and wrist were graded five out of five (normal) with no pain.

Manual muscle testing bilaterally of subscapularis, biceps brachii, pronator teres, flexor digitorum superficialis, flexor digitorum profundus, and flexor pollicis longus were graded as a five (normal) out of five with the exception of the right pronator teres and flexor pollicis longus, which were graded a four (good) out of five.\[^{[12]}\]
Neurological

Tingling and numbness were experienced by the patient at night when wearing the day brace to bed.

Two-point discrimination was tested, using a paper clip with a 10mm space between the prongs, on both hands in the median nerve distribution to assess for sensation impairment. Two areas on the left hand and one on the right hand showed a discrepancy in the ability to discriminate whether one or two prongs were felt.

Referred pain

An ache and soreness from the wrist traveling distally to the thumb was felt bilaterally, but more intensely on the right. During the assessment, the patient experienced referred pain down the right arm to the wrist as well as some digits when her right subscapularis, biceps brachii, bicipital aponeurosis, and pronator teres were palpated for trigger points.
Special tests

Tests were performed along the course of the medial nerve to assess for the possibility of multiple compression sites. Adson maneuver, costoclavicular syndrome, pronator teres syndrome, Tinel’s sign at the wrist, carpal compression, Phalen’s (wrist flexion), prayer, Finkelstein, and upper limb tension tests (ULTT1) were all performed. Cervical compression was not performed, as the patient was not comfortable with the application of pressure onto cervical spine due to the diagnosis of osteoarthritis in the neck made by her medical doctor.

Treatment goals

1. Decrease trigger points in subscapularis, biceps brachii, bicipital aponeurosis, and pronator teres on the right side.
2. Decrease occurrences of nocturnal pain in the right arm/hand.
3. Decrease median nerve compression on right side.
4. Increase pronation and supination of right elbow in active range of motion by five degrees.
Treatment given

1. Treatment began with a five minute Swedish massage of the upper back and general mobilization of the right glenohumeral and scapulothoracic joint.

2. Five minutes of compressions and longitudinal stroking was performed on the left arm for a reflex effect.

3. The same treatment was applied to the right arm.

4. Markings were applied to the patient’s arm starting from the crease between the arm and forearm (bicipital aponeurosis) and then every two centimeters from that point up until the axilla (biceps brachii). A mark was placed an inch distal to the crease, and then two inches at a 45 degree angle medially and superiorly (pronator teres). Photographs of markings seen in Figures 2 and 3.
Figure 2. Measurement and markings for bicipital aponeurosis and biceps brachii muscle.

Figure 3. Markings for pronator teres muscle.
Figure 4. Common trigger points in subscapularis muscle (the location of upper left and lower “X” on the left side were used in treatment).[13]

5. Thumb tip pressure was applied to common areas of the subscapularis muscle, where trigger points are found, for 15 seconds. Just medial to the mid-lateral border of the anterior scapula and then one inch cephalic.

6. Starting at the proximal markings and working distally, thumb tip pressure (one thumb placed over the other thumb) was applied for five seconds along the course of the biceps.

7. Thumb tip pressure was applied for 15 seconds on the bicipital aponeurosis and the pronator teres markings.
8. Referral pain was experienced by the patient during the compression was recorded during each treatment. The results can be seen in Table 1.

9. 20 longitudinal strokes were applied to the right arm following the ischemic compressions.

10. The right arm was then taken through three repetitions of passive range of motion of each of the muscles that were treated.

11. A thermaphore was applied to provide deep moist heat to her right arm, from axilla to wrist, for five minutes.

12. The patient actively completed the same range of motion actions were repeated three times actively by the patient as the therapist.

**Remedial exercise**

For home care the patient was given a median nerve gliding exercise to follow three times a day, as long as symptoms were not exacerbated. The exercise had the patient work sequentially through six positions. If symptoms of paresthesia or pain occurred the patient was instructed to hold the position for 5 to 30 seconds, without making the symptoms worse, followed by alternating between the previous symptom-free position and back to the symptom producing position for 10 repetitions, as seen in Figure 5. The patient was given a chart to record compliance.
Hydrotherapy

The patient was instructed to use either a double sink or two large buckets to do a full forearm immersion contrast arm bath once a day for the duration of the study. One was to be filled with hot water (equivalent to temperature used to wash dishes) and one with cold water (as cold as she could tolerate). The recommendation was to perform three cycles of three minutes in hot submersion followed by one minute in cold submersion, always making sure to end with cold and thoroughly dry forearms.
Application of research

Werner’s\cite{15} study of active workers with CTS symptoms showed benefits from a six week nocturnal splinting trial that proved to have long lasting reduction of discomfort experienced in the wrist, hand, and/or fingers.

Nerve tension testing can provide valuable information on where the nerve may have a lesion or be entrapped.\cite{16} Other special tests that provide confirmation of CTS symptoms are Tinel’s at the wrist, Phalen’s, and carpal compression.\cite{17}

Techniques that are performed on the musculoskeletal system to reduce tension and restore the tissues function can also be applied to nerves.\cite{16} The studies of McLellan and Hough found that “the median nerve slides longitudinally in its bed with the limb is moved. In cases of entrapment neuropathies, where longitudinal movement of a peripheral nerve is restricted, continual trauma results from normal movements of the limb.”\cite{16} Therefore, it is important to prescribe median nerve gliding exercises as a remedial exercise to a patient with CTS.

In addition to the nerve gliding exercises, the patient was instructed to do a contrast arm bath. Hydrotherapy of strong contrast arm baths three times a day
was given because “Heat has been shown to increase localized blood flow by vasodilation and also increases connective tissue extensibility, facilitating the gliding of the nerve and tendons. Cold produces analgesia, reducing inflammation and edema.”[4] Rattray[18] recommended a schedule for contrast hydrotherapy of three cycles alternating between three minutes in hot and one minute of cold, always finishing with the cold submersion.

Field[5] discovered that “massage therapy significantly decreased carpal tunnel symptoms, median peak latency and pain, while increasing grip strength”. The treatment included stroking, wringing, and skin rolling techniques applied along the upper limb. The reason for this was thought to be partly due to the gate theory with the stimulation of pressure receptors, and possibly the release of the pain relieving neurotransmitters serotonin and oxytocin.[5]

Management plan

The active problems included carpal tunnel syndrome (bilaterally) and deQuervain’s Tenosynovitis (Finkelstein syndrome) in the right hand. The inactive problems included hypertension and osteoarthritis in the sixth cervical vertebra. The phase of care was rehabilitation, maintenance, and preventative. Domains of involvement included functional issue and decreased range of motion
ISCHEMIC COMPRESSIONS FOR CTS

involving muscles and nerve. Conditional factors were rated as a five (major) and included disease enforced behavior and physical environment.

Home instructions were to have a strong contrast arm bath once a day with three cycles of three minutes in hot and one minute in cold. A median nerve gliding exercise was also given to perform three times a day within pain/symptom tolerance.

Treatment modality included Swedish massage to the upper back and both upper limbs. Trigger point, passive and active range of motion was applied to the right subscapularis, biceps brachii, and pronator teres. A thermaphore was used for deep moist heat to the right arm. The treatment frequency was five treatments over 10 days.

Treatment goals were to decrease trigger points in subscapularis, biceps brachii, bicipital aponeurosis, and pronator teres on the right side, decrease occurrences of nocturnal pain in the right arm/hand, decrease median nerve compression on right side, and increase pronation and supination of right elbow in active range of motion by five degrees.
Outcome markers were for the patient to have a decrease in pain after gardening, gain the ability to hold a book for more than 10 minutes without pain, and to test negative for carpal compression (bilaterally), Phalen’s (left), prayer (bilaterally), Finkelstein (bilaterally), and upper limb tension test 1 (bilaterally) special tests.

**Treatment results and prognosis**

Levine’s Carpal Tunnel (median nerve) Function Disability Form (as cited in Magee[19]) was used as an assessment tool to track changes to the intensity and occurrences of the patient’s symptoms. The questionnaire was utilized prior to the treatment period, on the last day of treatment, and six weeks after the last treatment. The occurrences of nocturnal pain increased from once to two or three times during a two week period. There was no change to the intensity (moderate) of hand or wrist pain at night.

The patient performed the median nerve gliding exercises fairly consistently two to three times a day. On her first attempt she started to feel symptoms in the third position. As she continued with the exercises she found that on several occasions she was able to get to the fourth position before symptoms of paresthesia began. Continued compliance with the exercise could lead to reaching
the final position symptom free, thus, decreasing median nerve restrictions and possibly decreasing her symptoms of CTS.

The patient’s compliance with the contrast arm bath schedule was 50%. She described the temperature of the hot bath as “hotter than water used to wash dishes” and the cold as “quite cold, enough to make me shiver”. It is of interest that the two evenings when she did not experience night pain occurred after two successive days of contrast arm baths. This finding could lend support to a theory that consistent daily utilization of contrast hydrotherapy could lead to a reduction of nocturnal pain occurrences in CTS patients.
Figure 6. Pain perception over the treatment period.

The Visual Analog Scale\cite{20} was used to assess the patient’s pain pre-treatment and post-treatment. The findings support that the treatment was successful in decreasing the patient’s perception of pain immediately as well as over the treatment period, as seen in Figure 6.

Figure 7. Pronation of elbow over treatment period.
Figure 8. Supination of elbow over treatment period.

There was no change by the final treatment with pronation of the right elbow, as seen in Figure 7. The supination of the right elbow decreased five degrees, shown in Figure 8.

Table 1
Trigger points treated and their location of referred pain.

<table>
<thead>
<tr>
<th>Muscle &amp; Trigger Point(s)</th>
<th>October 29</th>
<th>October 31</th>
<th>November 3</th>
<th>November 5</th>
<th>November 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscapularis</td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Wrist</td>
<td>Wrist</td>
<td>Wrist</td>
<td>Wrist, 3 digits</td>
<td>No referral</td>
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<td></td>
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<td></td>
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<tr>
<td>2</td>
<td>Wrist</td>
<td>Wrist, 1 digit</td>
<td>Wrist, 1 digit</td>
<td>Wrist, 2 digits</td>
<td>Wrist, 1 digit</td>
</tr>
<tr>
<td>1</td>
<td>Wrist</td>
<td>No referral</td>
<td>No referral</td>
<td>No referral</td>
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<tr>
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<td>Wrist</td>
<td>Wrist</td>
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<td>Wrist, 2 digits</td>
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<tr>
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<td>Wrist</td>
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<tr>
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<td>Wrist, 4 digits</td>
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<td>Wrist</td>
<td>Wrist</td>
<td>Wrist, 4 digits</td>
<td>Wrist, 1 digit</td>
</tr>
</tbody>
</table>

Biceps Brachii
The trigger points that were treated did not appear to decrease during the treatment period and in many cases the referral pain from these points increased to include more digits.

The right pronator teres and flexor pollicis longus were graded a four (fair) out of five during the first assessment and by the end of the fifth treatment they were both a five (good) out of five. The carpal compression, prayer, Finkelstein, and ULTT1 were still positive when tested bilaterally, however, Phalen’s test of the left wrist was negative.

The patient’s ability to hold a book for more than 10 minutes pain free was not achieved and a decrease in pain after gardening was not able to be assessed due to this activity no longer occurring with the change of season.
Summary and conclusion

Although the specific goals that were set were not achieved some notable results included a reduction of the patient’s pain perception with treatments, as well as an increase in muscle strength of the right pronator teres and flexor pollicis longus. Phalen’s test of the left wrist tested negative, however, the rest of the outcome markers were not met.

The range of motion of the wrist and elbow was measured using a manual goniometer and thus it is subject to human error. Also, the method used to locate and mark the trigger points was done with a tape measure and although every attempt was made with each treatment to use the same landmarks it is impossible to state with certainty that the ischemic compressions were applied consistently to the same location every time.

Five massage therapy treatments with this patient were not enough in order to support the alternate hypothesis that ischemic compressions alone could reduce her CTS symptoms. The patient’s schedule was not able to commit to further treatments of similar frequency. In addition to more treatments, the researcher postulates that incorporating more techniques, such as myofascial
release and joint mobilizations to the neck and entire upper limb, would prove more likely to lead to a reduction in the frequency and intensity of symptoms experienced by patients suffering from CTS.
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