Exercise for Rehabilitation and Treatment: Summary of Research

Summarizing research findings to evaluate the effectiveness of exercise for rehabilitation and treatment of orthopedic conditions

Summary 21: Carpal tunnel syndrome

June 2010

Q: In individuals with carpal tunnel syndrome, does the addition of tendon or nerve gliding exercises to other conservative treatments improve outcomes?

To answer this question, we performed a comprehensive search of the PubMed database (March 2010) for randomized, controlled trials and systematic reviews that addressed this specific research question. 1

Five studies met the criteria for inclusion in this review, comparing steroid injection and splinting to tendon and nerve gliding exercise (1); the addition of neural mobilization to education, splinting and tendon gliding exercise (2); splinting combined with ultrasound, tendon nerve gliding exercise, or both (3); and splinting compared to tendon and/or nerve gliding exercise (4,5).

Three studies (1,3,5) followed the tendon and nerve gliding exercise protocol described by Totten and Hunter (6), one study utilized only the nerve gliding exercises (4), and another study utilized modifications of the tendon gliding exercises (2). Patients with severe thenar atrophy were excluded in all cases, though only two studies specifically stated inclusion criteria of intermediate stage CTS (1,4). Four studies included patients with bilateral symptoms (2,3,4,5).

A: Bardak et al found significantly improved symptoms and function with 6 wks of steroid injection and splinting with and without exercise, but no significant improvement was shown with exercise alone (1). Baysal et al also showed significantly improved pain, function, and symptoms with 3 wks of splinting plus either exercise or ultrasound, but no significant difference between the treatments (3). Pinar et al showed that 10 wks of splinting alone or splinting plus nerve gliding exercise significantly improved pain and most physical tests, and the addition of exercise significantly improved grip strength (4). Similarly, Akalin et al compared 4 wks of splinting with and without exercise and found that both significantly improved outcomes, with the addition of exercise resulting in significantly better pinch strength (5).

Based on this review, it can be concluded that tendon and nerve gliding exercise may be considered a useful adjunct to the conservative management of patients with intermediate stage CTS. However, it is not clear whether exercise alone is more effective than other conservative treatments such as splinting or ultrasound. Sample exercises from VHI PC-Kits have been provided based on examples from these studies.

Arm on table with thumb-up. Bend hand back at wrist.  

Alternate way: Use other hand to bring hand up, then let go.

Wrist extension (assistance) from VHI PC-Kits: Occupational Therapy, Wrist #3

Stand with right arm in front of body, palm up. Use opposite hand to pull hand and fingers back.

Median nerve mobilization IV from VHI PC-Kits: Neurodynamic, Upper Extremity #4
Table 1: Overview of Research Studies

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<th>Overview</th>
<th>Description of Intervention</th>
<th>Results &amp; Conclusions</th>
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**Hypothesis/Aim:** To compare standard conservative treatment (CT), CT with tendon and nerve gliding exercises (TN), and TN only among patients with inter-mediate stage carpal tunnel syndrome (CTS).

**Subjects:** 111 adults (3 male; 108 female) with a mean age of 49 yrs (range 22-74) and average duration of symptoms of 13 mos in the CT and CT+TN groups and 19 mos in the TN group.

The following criteria were utilized: diagnosis of intermediate stage CTS by clinical and electro-physiologic criteria; and without bilateral CTS, prior steroid injection or splinting for CTS, thenar atrophy, diabetes, thyroid disease, rheumatoid arthritis, peripheral neuropathy, or cervical radiculopathy.

**Groups:** Subjects were randomized into 3 groups.

1. Standard conservative treatment (CT, n=41)

**Duration:** The length of the intervention was 6 wks.

**CT:** Standard treatment consisted of a steroid injection and splinting. Subjects received 3 mg betamethasone into the carpal groove. Subjects wore a neutral splint during the day and night for 3 wks, and during the night only for an additional 3 wks.

**TN:** For 6 wks, subjects performed 5 tendon and 6 nerve gliding exercises as described by Totten and Hunter. Exercises were demonstrated, written instructions were provided, and subjects met with a physiotherapist weekly. Exercise was preceded by 5 min of a contrast bath (4 min warm, 1 min cold). All exercises were done with neck and shoulder in neutral and elbow in 90° flexion. Exercises were done 3x/day, with 5 reps of each exercise and a 7 sec hold for each position.

**Outcome Measures:** Assessments were completed at baseline, 8 wks post-treatment, and 11 mos (patient satisfaction by phone).

1. **Symptoms & Function:** Symptom total points score (STP) was used to evaluate symptoms such as pain, tingling, and nocturnal numbness (1=symptoms, 0=no symptoms). Functional status (FSS) was evaluated on a 5-point scale (1=easy to 5=impossible) for 7 ADLs (e.g., writing, buttoning clothes, carrying groceries).

2. **Physical Exam:** Tinel's sign, Phalen test, reverse Phalen test, compression test, and 2-pt discrimination (2PD).

3. **Long-term success:** A phone survey was used to assess success after 11 mos as excellent/good (asymptomatic), fair (symptoms during activities), or poor (persistent symptoms).

**Results:**

**Dropouts.** No dropouts were reported.

**Symptoms & Function.** All 3 groups showed improved STP scores after treatment (p<0.01), with greater improvements in the CT and the CT+TN groups (p<0.001). All 3 groups showed improved FSS after treatment (p<0.001), with greater improvements in CT and CT+TN (p<0.001). There were no differences between CT and CT+TN.

**Physical exam.** Significant improvement was shown for all physical tests in the CT group (except 2PD) and the CT+TN group (except Tinel's sign and 2PD). Only the compression test showed significant improvement among the TN only group. No between-group comparison was reported.

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1. Bardak, 2009

http://www.vhikits.com/newsletter/?issue=21
2. CT+tendon and nerve gliding exercise (CT+TN, n=35)
3. Tendon and nerve gliding (TN, n=35)

Success. More patients in the CT (73%) and CT+TN (71%) groups reported "excellent/good" results compared to the TN group (49%).

Conclusions: The authors concluded that conservative treatment, with or without the addition of tendon and nerve gliding exercises, was effective in improving outcomes among patients with intermediate-stage carpal tunnel syndrome. Tendon and nerve gliding exercises alone were not as effective. However, it should be noted that the TN-only group displayed greater severity of symptoms at baseline with a longer duration than the other groups.

Outcome Measures: Assessments were completed at baseline, 1 mo and 6 mos.

1. Function: 2 self-administered questionnaires were utilized including Disabilities of the Arm, Shoulder, and Hand (DASH) and The Brigham and Women's Hospital Carpal Tunnel Syndrome Questionnaire (CTSQ). The CTSQ consisted of a symptom severity scale (SSS) and functional scale (FSS).

2. Nerve mobility: Amount of elbow extension during the upper limb tension test (ULTT) with a median nerve bias was measured (R1 value).

Results:

Drop-outs. At 1 mo follow-up, 8 subjects from the SC group and 7 from the SC+NT group withdrew. At 6 mos follow-up, 5 subjects from the SC group and 11 from the SC+NT group withdrew. Results were not analyzed with intention to treat (n=29 analyzed).

Function. There were no significant differences found between the 2 groups in either the DASH (p=0.2) or CTSQ-SSS (p=0.08) at either follow-up. There was a significant interaction in the CTSQ-FSS score over time (p=0.02), however, no post-hoc analyses were reported.

Nerve mobility (R1). There was no significant difference found over time between the 2 groups (p=0.4).

Compliance. The SC group had a significantly higher self-reported compliance at month 6 (approximately: 50% vs 38%).

Conclusions: The authors concluded that the addition of neurodynamic mobilization among patients with carpal tunnel syndrome (CTS).

Subjects: 60 adults 9 male; 51 female) with a mean age of 53 yrs (range 32 -75) and duration of symptoms from 1 month to over 2 yrs.

The following criteria were utilized: CTS symptoms ≥1 month; diagnosis confirmed by nerve conduction velocity test; median nerve paresthesia in ≥2 digits; and without previous CTS surgery, severe symptoms of CTS such as thenar atrophy or ulcerations, peripheral neuropathies such as diabetes, or other conditions that would interfere with CTS treatment or preclude exercise.

Groups: Subjects were randomized into 2 groups.

1. Standard care (SC, n=28)
2. SC+NM: In addition to the SC interventions, subjects also performed a neurodynamic mobilization exercise. Subjects stood sideways about an arm's length from a wall and placed a hand on the wall with fingers facing down. They gently leaned their head away from the wall for 5 sec. The exercise progressed according to tolerance from bent elbow to straight.

Duration: Single instructional session with indefinite continuance of home exercise program.

SC: Subjects received education, splinting, and exercise. Education included ergonomics and lifestyle modifications. Subjects wore a neutral splint at night and during heavy ADLs, but not continuously during the day. Subjects performed 8 tendon-gliding exercises 3-5x/day, 10 reps each. Verbal and written instructions were provided. Exercises were modified from Totten and Hunter (6) and included: wrist extension with hook grasp to wrist flexion with finger extension; use opposite hand on extended fingers to pull the wrist up; fully open hand and then squeeze into a fist; hook grasp; half fist exercise (MCP,PIP flexion with DIP and thumb extension); full fist exercise; and 2 hand tendon gliding exercises.

SC+NM: In addition to the SC interventions, subjects also performed a neurodynamic mobilization exercise. Subjects stood sideways about an arm's length from a wall and placed a hand on the wall with fingers facing down. They gently leaned their head away from the wall for 5 sec. The exercise progressed according to tolerance from bent elbow to straight.

Hypothesis/Aim: To compare standard of care vs standard of care with neurodynamic mobilization among patients with carpal tunnel syndrome (CTS).

2) Heebner, 2008
2. Standard care and neurodynamic mobilization exercise (SC+NM, n=32)

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<table>
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<th>Hypothesis/Aim: To compare the effectiveness of splinting, tendon and nerve gliding exercise, ultrasound, and the combination of treatments among patients with bilateral carpal tunnel syndrome (CTS)</th>
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**Subjects:** 36 women (72 wrists) with a mean age (by treatment group) of 48, 50 and 51 yrs and duration of symptoms of 1.5, 1.4 and 1.4 yrs. The following criteria were utilized: diagnosis of bilateral CTS using clinical symptoms and EMG testing and without clinical or EMG evidence of axonal degeneration of the median nerve, previous CTS treatment with steroids or splinting, thyroid disease, diabetes, or systemic peripheral neuropathy.

**Groups:** Subjects were randomized into 3 groups (24 wrists/group).

1. Splinting and exercise (SE, n=24 wrists)
2. Splinting and ultrasound (SU)

**Duration:** The length of the intervention was 3 wks.

**Splinting:** Subjects wore a custom-made neutral splint to be worn during the day and night for 3 wks.

**Tendon and nerve gliding exercise:** For 3 wks, subjects performed 5 tendon and 6 nerve gliding exercises as described by Totten and Hunter (9). Written instructions were provided. All exercises were done with neck and shoulder in neutral and elbow supinated and in 90° flexion. Exercises were done 5x/day, with 10 reps of each exercise and a 5 sec hold for each position.

**Ultrasound:** Subjects received a total of 15 ultrasound treatments over the course of 3 wks (15 min treatment/day, 5 days/wk). Ultrasound was administered to the palmar carpal tunnel area (frequency of 1MHz, intensity of 1W/cm², pulsed mode 1:4, transducer 5 cm²).

**Outcome Measures:** Assessments were completed at baseline, after treatment (3 wks) 8 wks, and approx 1 yr later (phone survey only).

1. **Pain & Function:** Pain was measured on a visual analog scale (VAS) from 0 (no pain) to 10 (severe pain). Questionnaires evaluated symptoms (11 questions) and function (8 questions). A phone survey was used for long term follow up (*poor*=continuing symptoms to *excellent*= asymptomatic).
2. **Physical tests & EMG:** Tinel's sign, Phalen test, 2-point discrimination, and grip and pinch strength tests were evaluated. Median nerve motor distance latency (MDL) and sensory distal latency (SDL) were assessed by EMG.

**Results:**

- **Drop-outs:** 4 subjects (8 wrists) from the SU group and 4 subjects (8 wrists) from the SEU group withdrew. Results were not analyzed with intention to treat (n=56 wrists analyzed).

- **Pain & Function.** Pain, function, and symptom questionnaires showed significant improvement in all 3 groups after 3 and 8 wks (p<0.05). There were no significant differences between the groups. After 1 yr, significantly more subjects in the SEU group reported to be *excellent* (n=8, 65%) compared to the SE (n=0) and SU groups (n=3, 25%, p<0.05).

- **Physical tests & EMG.** All 3 groups showed significant improvements after 3 and 8 wks in Tinel's sign and Phalen test, and after 8 wks in hand grip and pinch strength (p<0.05). In the 2 groups completing exercise (SE, SEU), significant improvement in SDL was found at 3
ultrasound (SU, n=24 wrists)
3. Splinting, exercise, and ultrasound (SEU, n=24 wrists)

and 8 wks (p<0.05). No significant differences were shown in 2-point discrimination or MDL, and there were no significant differences between the groups.

Conclusions: The authors concluded that conservative treatment including 3 wks of exercise, ultrasound, and splinting are effective for patients with CTS. Based on the long term follow-up, they indicated more favorable results for the combined approach (SEU), although these long term results are based only on a subjective phone survey.

Outcome Measures: Assessments were completed at baseline and 10 wks.

1. Pain: Pain during the day was assessed with a Visual Analog Scale from 0 (no pain) to 10 (severe pain).

2. Physical and electrophysiologic tests: Tests of physical function included the Tinel's sign, Phalen test, grip strength, pinch strength, manual muscle test of the abductor pollicis brevis, light-touch deep-pressure sense (SWM), and 2-point discrimination. Electrophysiologic tests included median and ulnar nerve distal sensory latencies.

Results:

Drop-outs: No drop-outs were reported.

Pain. Pain decreased significantly within both groups after 10 wks (p<0.05), and there were no significant between-group differences.

Physical tests and EMG. Both groups showed significant improvements in grip strength, pinch strength, and SWM (p<0.05). The CT+EX group had a greater improvement in grip strength compared to the CT group (p<0.05). Tinel's sign was no longer present in 47% of the CT+EX group and 25% of the CT group (no statistics reported). Phalen test was still positive in a majority of subjects (95% CT+EX, 100% CT). EMG findings showed that 63% of the CT+EX and 50% of CT group were no longer considered pathologic (no statistics reported).

Conclusions: The authors felt that the addition of nerve gliding exercise

Hypothesis/Aim: To determine if the addition of nerve gliding exercise to conservative treatment improves outcomes among women with early or middle stage carpal tunnel syndrome.

Subjects: 26 women were included in the study.

The following criteria were utilized: 35-55 yrs; female; diagnosis of early or middle-stage CTS using electrophysiologic testing, unilateral or bilateral symptoms, and without history of trauma or previous physiotherapy.

Groups: Subjects were randomized into 2 groups.

1. Conservative treatment (CT, n=12, 16 wrists)
2. Conservative treatment and nerve gliding exercise (CT+EX, n=14, 19 wrists)

Duration: The length of the intervention was 10 wks.

Conservative treatment: Subjects wore a neutral splint during the day and night for 6 wks, and during the night only for the remaining 4 wks. Subjects were provided with education on activity modification (e.g., avoidance of repetitive hand activities and gripping strongly with the first and second fingers.)

Conservative treatment and nerve gliding exercise: Subjects completed conservative treatment as well as 6 nerve gliding exercises as described by Totten and Hunter (6). All exercises were done seated with the head in midline, shoulder in neutral and the forearm on a table with the elbow in 90° flexion. Exercises were done 5x/day, with 10 reps of each exercise.
enhanced conservative treatment among women with CTS. However, this conclusion is not supported by the minimal group differences reported at the 10 wk follow-up.

Outcome Measures: Assessments were completed at baseline and 8 wks after completion of treatment. Patient satisfaction was obtained an average of 8 mos after treatment.

1. **Symptoms and functional status.** The Symptoms Severity Scale (SSS) evaluated 11 items including pain, night symptoms, numbness, tingling, and weakness. The Functional Status Scale (FSS) evaluated 8 ADLs (e.g., household chores, carrying grocery bags).

2. **Physical tests:** Physical tests included Phalen test, Tinel's sign, 2-point discrimination, and grip and pinch strength.

3. **Satisfaction:** A phone survey was used to rate patients symptoms as "excellent" (asymptomatic), "good" (occasional), "fair" (frequent but some improvement) or "poor" (continuous with no improvement).

Results:

**Drop-outs.** No drop-outs were reported.

**Symptoms and functional status.** Both groups showed significant improvement in symptoms and function after 8 wks (p<0.001), and there was no significant difference between the groups.

**Physical tests.** Significant improvements were shown in both groups in all physical tests (p<0.001 to p<0.05), except there was no significant change in 2-point discrimination among the splint-only group. There were no significant differences between the groups in any of the measures (p=0.1 to p=0.8) with the exception of greater improvement in pinch strength among the splint plus exercise group (p=0.03).

**Satisfaction.** The long-term follow-up survey showed that 72% of the splint-only group and 94% of splint plus exercise group reported their satisfaction as good or excellent, though the difference between groups was not significant (p=0.09).

Conclusions: The authors concluded that conservative treatment including...
splinting and exercise is effective for patients with carpal tunnel syndrome. However, this appears to be largely based on the patient satisfaction scores as the symptoms and functional status outcomes as well as the physical tests were similar between groups.

Below are the exercises utilized in the 5 clinical trials. A critical review of this article is not included as it is an expert opinion article and not a randomized controlled trial.

Tendon gliding exercises: The starting position for each exercise is straight fingers and wrist.

1. "Straight": Fingers and thumb are straight.
2. "Hook": Fingers are flexed at the PIP joint, with thumb straight.
3. "Fist": Fingers are flexed at MCP, PIP, and DIP joints, with thumb straight.
4. "Table top": Fingers are flexed at MCP, with PIP, DIP and thumb straight.
5. "Straight Fist": Fingers are flexed at MCP and PIP, with DIP and thumb straight.

Nerve gliding exercises: The starting position is position 1.

1. Wrist neutral, flex fingers and thumb.
2. Wrist neutral, extend fingers and thumb.
3. Wrist and fingers extended, thumb neutral.
4. Wrist, fingers, and thumb extended.
5. Position 4, with forearm supinated (palm up).
6. Position 5, with opposite hand stretching thumb.
Table 2: Additional Exercises from VHI Exercise Kits

The exercises included in this newsletter are intended only as a sampling of exercises from the different VHI exercise collections that might be relevant to the topic discussed. Their inclusion in this newsletter does not represent any rehabilitation protocol or any suggested exercise progression that could be used with patients. Using the order of the exercises to create a rehabilitation program for patients is inappropriate and could result in serious injury.

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<th>Level: Beginning-Intermediate</th>
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<td>Kit</td>
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<tr>
<td>Orthopedic</td>
<td>Hand, Wrist &amp; Elbow</td>
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<td>Occupational Therapy</td>
<td>Finger</td>
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Pinch middle knuckle of selected finger of involved hand to prevent bending. Bend end knuckle until stretch is felt. Hold. Relax. Straighten finger as far as possible.

Pinch bottom knuckle of selected finger of involved hand to prevent bending. Actively bend middle knuckle until stretch is felt. Hold. Relax. Straighten finger as far as possible.

With fingers and knuckles straight, bend middle and tip joints. Do not bend large knuckles.

Start with fingers straight. Bend knuckles and middle joints. Keep fingertip joints straight to touch base of palm.
Table 2: Additional Exercises from VHI Exercise Kits (cont.)

The exercises included in this newsletter are intended only as a sampling of exercises from the different VHI exercise collections that might be relevant to the topic discussed. Their inclusion in this newsletter does not represent any rehabilitation protocol or any suggested exercise progression that could be used with patients. Using the order of the exercises to create a rehabilitation program for patients is inappropriate and could result in serious injury.

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<td>Neurodynamic</td>
<td>Upper Extremity</td>
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<td>Sitting with elbows on table and palms together, slowly lower wrists to table until stretch is felt. Keep palms together throughout the stretch. Hold. Relax.</td>
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<td>Stand with palm flat on wall, fingers down, elbow bent. Sidestep away from wall, straightening elbow.</td>
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References


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1 PubMed database was used to identify peer-reviewed research publications that addressed the specific clinical question (population, diagnosis, treatment, and outcome). For inclusion, studies must be a randomized controlled trial (RCTs) and published in English. A maximum of 10 RCTs were reviewed, with strength of design and publication year determining which studies to include.

2 No study footnotes needed.

3 Statistical definitions: 1) P-value (p) denotes the level of significance, where p<0.05 indicates a statistically significant result. 2) 95% Confidence Interval (95% CI): a range that contains the true population estimate 95% of the time. A smaller range indicates an estimate that is more precise. 3) Relative Risk (RR) is a ratio of proportions (ProportionTreatment / ProportionControl). RR less than 1.0 indicates the treatment group has a decreased risk of developing the condition/disease compared to the control group, while RR greater than 1.0 indicates the treatment group has an increased risk. 4) Incidence Risk Ratio (IRR) is the ratio of two incidence rates; the incidence rate among the treatment group divided by the incidence rate in the control group. IRR gives a relative measure of the effect of a given treatment with values less than 1.0 favoring the treatment. 5) Hazard Ratio (HR) is the relative likelihood of experiencing a particular event; an HR of 0.5 indicates that one group has half the risk of the other group. HR is broadly equivalent to RR, but is useful when the risk is not constant with respect to time as it uses information collected at different times. 6) Odds Ratio (OR) is the odds of an event happening in the treatment group expressed as a proportion of the odds of an event happening in the control group and can be interpreted similar to the RR. 7) Likelihood Ratio (LR) is the likelihood that a given test result would be expected in a patient with the target disorder compared to the likelihood that the same result would be expected in a patient without that disorder. The LR is used to assess how good a diagnostic test is and to help in selecting an appropriate diagnostic test(s) or sequence of tests.