OPTIMA LITERATURE REVIEWS

THE EFFECTIVENESS OF PASSIVE PHYSICAL MODALITIES FOR THE MANAGEMENT OF SOFT TISSUE INJURIES AND NEUROPATHIES OF THE WRIST AND HAND: A SYSTEMATIC REVIEW BY THE ONTARIO PROTOCOL FOR TRAFFIC INJURY MANAGEMENT (OPTIMA) COLLABORATION

Kevin D'Angelo, DC,[a] Deborah Sutton, MEd, MSc,[b, c] Pierre Côté, DC, PhD,[d, e, f] Sarah Dion, DC,[a] Jessica J. Wong, DC,[b, g, h] Hainan Yu, MBBS, MSc,[b, c] Kristi Randhawa, MPH,[b, c, i] Danielle Southerst, DC,[j] Sharanya Varatharajan, MSc,[b, c, i] Jocelyn Cox (Dresser), DC,[a] Courtney Brown, MSc, DC,[a] Roger Menta, DC,[a] Margareta Nordin, PT, DrMedSci,[k] Heather M. Shearer, DC, MSc,[c, l, m] Arthur Ameis, MD, FRCPC,[n] Maja Stupar, DC, PhD,[c, o] Linda J. Carroll, PhD,[p] and Anne Taylor-Vaisey, MLS[b]

ABSTRACT

Objective: The purpose of this systematic review was to determine the effectiveness of passive physical modalities compared to other interventions, placebo/sham interventions, or no intervention in improving self-rated recovery, functional recovery, clinical outcomes and/or administrative outcomes (eg, time of disability benefits) in adults and/or children with soft tissue injuries and neuropathies of the wrist and hand.

[a] Graduate Student, Department of Graduate Studies, Canadian Memorial Chiropractic College, Toronto, ON, Canada.
[b] Research Associate, UOIT-CMCC Centre for the Study of Disability Prevention and Rehabilitation, University of Ontario Institute of Technology (UOIT) and Canadian Memorial Chiropractic College (CMCC), Toronto, ON, Canada.
[c] Adjunct Professor, Division of Graduate Education and Research, Canadian Memorial Chiropractic College, Toronto, ON, Canada.
[d] Canada Research Chair in Disability Prevention and Rehabilitation, University of Ontario Institute of Technology, Oshawa, ON, Canada.
[e] Associate Professor, Faculty of Health Sciences, University of Ontario Institute of Technology, Oshawa, ON, Canada.
[f] Director, UOIT-CMCC Centre for the Study of Disability Prevention and Rehabilitation, Toronto, ON, Canada.
[g] Associate Clinical Research Scientist, Graduate Education and Research Programs, Canadian Memorial Chiropractic College, Toronto, ON, Canada.
[h] Instructor, Division of Graduate Studies, Canadian Memorial Chiropractic College, Toronto, ON, Canada.
[i] Instructor, Division of Undergraduate Education, Canadian Memorial Chiropractic College, Toronto, ON, Canada.
[j] Research Coordinator, Rebecca MacDonald Centre for Arthritis and Autoimmune Disease, Mount Sinai Hospital, Toronto, ON, Canada.
[k] Professor, Departments of Orthopedic Surgery and Environmental Medicine, Occupational and Industrial Orthopedic Center, NYU School of Medicine, New York, NY.
[l] Clinical Research Manager, UOIT-CMCC Centre for the Study of Disability Prevention and Rehabilitation, University of Ontario Institute of Technology (UOIT) and Canadian Memorial Chiropractic College (CMCC), Toronto, ON, Canada.
[m] Senior Clinical Research Scientist, Graduate Education and Research Programs, Canadian Memorial Chiropractic College, Toronto, ON, Canada.
[n] Lecturer, Certification Program in Insurance Medicine and Medico-legal Expertise, Faculty of Medicine, University of Montreal, Montreal, QC, Canada.
[o] Postdoctoral Fellow, UOIT-CMCC Centre for the Study of Disability Prevention and Rehabilitation, University of Ontario Institute of Technology (UOIT) and Canadian Memorial Chiropractic College (CMCC), Toronto, ON, Canada.
[p] Professor, School of Public Health and Injury Prevention Centre, University of Alberta, Edmonton, AB, Canada.
Submit requests for reprints to: Deborah A Sutton, BSc(OT), MEd, MSc, UOIT-CMCC Centre for the Study of Disability Prevention and Rehabilitation, 6100 Leslie St, Toronto, ON, Canada, M2H 3J1. (e-mail: *deborah.sutton@uoit.ca*).

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Methods: We systematically searched MEDLINE, EMBASE, PsycINFO, and the Cochrane Central Register of Controlled Trials, accessed through Ovid Technologies, Inc, and CINAHL Plus with Full Text, accessed through EBSCO host, from 1990 to 2015. Our search strategies combined controlled vocabulary relevant to each database (eg, MeSH for MEDLINE) and text words relevant to our research question and the inclusion criteria. Randomized controlled trials, cohort studies, and case-control studies were eligible. Random pairs of independent reviewers screened studies for relevance and critically appraised relevant studies using the Scottish Intercollegiate Guidelines Network criteria. Studies with low risk of bias were synthesized following best evidence synthesis principles.
Results: We screened 6618 articles and critically appraised 11 studies. Of those, 7 had low risk of bias: 5 addressed carpal tunnel syndrome (CTS) and 2 addressed de Quervain disease. We found evidence that various types of night splints lead to similar outcomes for the management of CTS. The evidence suggests that a night wrist splint is less effective than surgery in the short term but not in the long term. Furthermore, a night wrist splint and needle electroacupuncture lead to similar outcomes immediately postintervention. Finally, low-level laser therapy and placebo low-level laser therapy lead to similar outcomes. The evidence suggests that kinesio tape or a thumb spica cast offers short-term benefit for the management of de Quervain disease. Our search did not identify any low risk of bias studies examining the effectiveness of passive physical modalities for the management of other soft tissue injuries or neuropathies of the wrist and hand.
Conclusions: Different night orthoses provided similar outcomes for CTS. Night orthoses offer similar outcomes to electroacupuncture but are less effective than surgery in the short term. This review suggests that kinesio tape or a thumb spica cast may offer short-term benefit for the management of de Quervain disease. (J Manipulative Physiol Ther 2015;38:493-506)
Key Indexing Terms: *Carpal Tunnel Syndrome; De Quervain Disease; Ultrasonography; Laser Therapy; Low-Level; Orthotic Devices; Review Literature as Topic*

Soft tissue injuries and neuropathies of the wrist and hand are common.[1-3] These disorders are associated with pain, loss of motor function, and disability[4] and have significant personal, societal, and economic impact.[1] Soft tissue injuries and neuropathies of the wrist and hand can occur in the supporting ligaments and capsules of the distal radioulnar, radiocarpal, intercarpal, midcarpal, carpometacarpal, and intermetacarpal joints and may involve the triangular fibrocartilage complex.[5] They may also involve tendons and muscles in the forearm, wrist, thenar, hypothenar, intrinsic, and extrinsic muscles of the hand. Injuries may also create distal neuropathies involving the median, ulnar, or radial nerves near the wrist.[5]

In the Dutch general population, 29% of all nonpathologic complaints of the neck and upper extremity are attributed to the hand and wrist.[1] In Ontario, sprains and strains of the wrist extensors are the most common reasons for workers' compensation claims related to the hand and wrist.[6-8] Common conditions affecting the wrist and hand can include de Quervain disease, trigger finger, carpal tunnel syndrome (CTS), Guyon canal syndrome, and oarsman's wrist (intersection syndrome).[1] The point prevalence of de Quervain disease ranges from 5.3% to 8.7% among automobile workers[9] and affects more females (1.3%) than males (0.5%) in the general population.[10,11] The natural course of de Quervain disease has not been described.[11] Trigger finger has an estimated lifetime prevalence of 2.6% in a group of nondiabetics 30 years of age and older.[12] Occupational studies report that the annual prevalence of nonspecific tendinitis of the hand, wrist, and elbow was 31% and 2% for trigger finger.[11,13]

With a point prevalence ranging from 2.7% to 3.8%, CTS is the most common nerve entrapment affecting the wrist and hand.[14] In the general population, CTS is more common in females (5.3%) than males (2.1%).[15] In the United States, CTS ranks first as the main cause of work absenteeism with a median of 34 lost work days per claim and an average lifetime cost of $30 000 per injured worker.[16-18] With approximately 400 000 median nerve decompression procedures performed annually at a cost of US $2 billion, surgery for CTS is not only the most common but also the most costly upper extremity disorder treatment in the United States.[1,19,20] The natural history of CTS is not well understood, although increased severity and duration may lead to progressive functional and sensory impairment.[21,22] Other neuropathies also contribute to the burden of illness, albeit far less frequently. It is estimated that 0.6% of work sickness episodes are attributed to Guyon canal syndrome (ulnar nerve entrapment at the wrist).[23]

Therefore, identifying effective interventions to manage soft tissue injuries and neuropathies of the wrist and hand is important. Passive physical modalities, including physico-chemical modalities (eg, ultrasound and low-level laser therapy [LLLT]) and orthoses (eg, splint and brace), are treatments that are used in the management of these disorders.[4,19,24] Several systematic reviews have examined the effectiveness of passive physical modalities for the management of soft tissue injuries and neuropathies of the wrist or hand. In 2010, Huisstede et al[25] reported that a splint for the treatment of de Quervain disease was less effective than cortisone injection, in the short term for pain

relief. However, they reported no evidence to support the use of LLLT.[25] Two reviews investigated the effectiveness of splinting for the management of CTS.[19,24] One review found limited evidence that a neutral wrist splint was more effective than a splint with the wrist in 20° of extension.[24] No evidence was found to support the use of a nocturnal hand brace/splint or wearing a wrist splint full time for the management of CTS.[19,24] Moreover, reviews suggest that ultrasound, magnet therapy, magnetic field therapy, heat wrap therapy, and cupping therapy were not effective for the management of CTS.[19,24,26] The conclusions of these reviews must be interpreted with caution because methodological limitations may have influenced their results. Specifically, these systematic reviews synthesized evidence from studies with a high risk of bias and small sample sizes. Therefore, a systematic review of adequate methodological quality is needed to evaluate the effectiveness of passive physical modalities for the management of soft tissue injuries and neuropathies of the wrist and hand.

The purpose of this systematic review was to determine the effectiveness of passive physical modalities compared to other interventions, placebo/sham interventions, or no intervention in improving self-rated recovery, functional recovery, clinical outcomes, and/or administrative outcomes (eg, time of disability benefits) in adults and/or children with soft tissue injuries and neuropathies of the wrist and hand.

Methods

Registration

This review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on March 12, 2014 (CRD42014008900).

Eligibility Criteria

Population. This review targeted studies of adults diagnosed with soft tissue injuries and neuropathies of the wrist and hand. We included grade I to II sprain/strains or nonspecific pain of the wrist or hand (excluding major pathology), CTS, de Quervain disease, and other soft tissue injuries and neuropathies of the wrist and hand as informed by available evidence. We defined sprains and strains according to the classification proposed by the American Academy of Orthopaedic Surgeons.[27,28] A sprain involves a stretch and/or tear of a ligament that occurs when a ligament or joint is placed under excessive load.[27,28] A strain involves injury to a muscle and/or tendon that occurs when the muscle is placed under a forcible stretch, either passively or during muscle contraction.[27,28] We excluded soft tissue injuries and neuropathies of the wrist and hand due to major pathology (eg, fractures, dislocations, osteoarthritis, infection, neoplasms, or systemic disease) including grade III sprains/strains.

Interventions. We defined a passive physical modality as a physical treatment involving a device that does not require active participation by the patient.[29] For the purpose of our review, we divided passive physical modalities into 2 categories: physicochemical and structural.[30,31] Physicochemical modalities produce a thermal or electromagnetic effect. Physicochemical modalities include cold, heat, or light application affecting the body at the skin level or light, ultrasonic, or electromagnetic radiation affecting structures beneath the skin.[31] Structural modalities include nonfunctional assistive devices that may either facilitate a state of rest in an anatomically neutral position (eg, arm supports) or actively inhibit or prevent movement (eg, cast or rest orthoses). In contrast, functional assistive devices (eg, taping and tenodesis orthoses) may align, support, or otherwise indirectly facilitate function in the affected region.

Comparison Groups. Studies that compared a passive physical modality to another passive physical modality, placebo/sham intervention, no intervention, or an alternate intervention were included.

Outcomes. Eligible studies included one of the following outcomes: self-rated recovery, functional recovery (eg, return to activities, work, or school), clinical outcomes (eg, pain, health-related quality of life, and depression), administrative data (eg, time on benefits), or adverse events.

Study Characteristics. Eligible studies met the following criteria: (1) English language; (2) published in a peer-reviewed journal between January 1, 1990, to January 19, 2015; (3) randomized controlled trials (RCTs), cohort studies, and case-control studies; (4) an inception cohort of at least 30 subjects per treatment arm for RCTs (a minimum sample size of 30 is required for nonnormal distributions to approximate the normal distribution; it is assumed that data are normally distributed when determining the difference in sample means between treatment arms)[32] or 100 subjects per exposed group for cohort studies with the specified injury; and (5) studies including other grades of sprains or strains must provide separate results for subjects with grade I or II sprain/strain. Exclusion criteria included the following: (1) guidelines, letters, editorials, commentaries, unpublished manuscripts, dissertations, government reports, books and book chapters, conference proceedings, meeting abstracts, lectures and addresses, consensus development statements, and guideline statements; (2) pilot studies, cross-sectional studies, case reports, case series, qualitative studies, nonsystematic and systematic reviews, clinical practice guidelines, biomechanical studies, laboratory studies, and studies not reporting on methodology; (3) cadaveric or animal studies; and (4) studies on patients with severe injuries (open wounds; fractures; full-thickness tears of surrounding structures; grade III sprain/strains; dislocations of the elbow, forearm, wrist, or hand; and osteoarthritis of these regions).

Information Sources

We developed our search strategy in consultation with a health sciences librarian, and it was reviewed by a second librarian using the Peer Review of Electronic Search Strategies Checklist.[33,34] We searched MEDLINE and EMBASE, considered to be the major biomedical databases, and PsycINFO for psychological literature, through Ovid Technologies, Inc; CINAHL Plus with Full Text for the nursing and allied health literature through EBSCOhost; and the Cochrane Central Register of Controlled Trials for any studies not captured by the other databases through Ovid Technologies, Inc. Our search strategies combined controlled vocabulary relevant to each database (eg, MeSH for MEDLINE) and text words relevant to our research question and the inclusion criteria (refer to Appendix A for the MEDLINE search strategy). We conducted our searches from January 1990 to January 2015. We used a broad search strategy that would include a wide range of soft tissue injuries and neuropathies. The results for soft tissue injuries and neuropathies of the elbow and forearm are reported in a separate manuscript.

Study Selection

Eligible studies were selected through a 2-phase screening process. In phase I, randomly paired reviewers independently screened titles and abstracts to determine eligibility. Studies were classified as relevant, possibly relevant, or irrelevant. In phase II, the same reviewers independently reviewed the manuscripts of possibly relevant studies to make a final determination of eligibility. Reviewers met to resolve disagreements and reach consensus in both phases. We involved a third independent reviewer if consensus could not be reached.

Assessment of Risk of Bias

Independent reviewer pairs critically appraised the internal validity of eligible studies using the Scottish Intercollegiate Guidelines Network (SIGN) criteria (Table 1).[42] The SIGN criteria assist with evaluating the impact of selection bias, information bias, and confounding on the results of a study. We did not use a quantitative score or a cutoff point to determine the internal validity of studies.[43] Rather, the SIGN criteria were used to assist reviewers in making an informed overall judgment on the internal validity of studies. This methodology has been previously described.[44-49]

We critically appraised the following methodological aspects of RCTs: (1) clarity of the research question, (2) randomization method, (3) concealment of treatment allocation, (4) blinding of treatment and outcomes, (5) similarity of baseline characteristics between treatment arms, (6) cointervention/contamination, (7) validity and reliability of outcome measures, (8) attrition, (9) intention-to-treat analysis, and (10) comparability of results across study sites (where

Table 1. *Risk of Bias for Accepted RCTs Based on the SIGN Criteria*

Author, Year	Research Question	Randomization	Concealment	Blinding	Similarity at Baseline	Similarities Between Arms	Outcome Measurement	Percent Drop-Out[a]	Intention to Treat	Multiple Sites
Baker et al (2012)[35]	Y	Y	Y	CS	CS	Y	Y	4 wk: lumbrical orthosis, 16%; general orthosis, 12% 6 mo: MANU, 22%; CAMP TIELLE, 26.2%	Y N	NA NA
De Angelis et al (2009)[36]	Y	CS	N	Y	Y	Y	Y			
Evcik et al (2007)[37]	Y	CS	Y	Y	Y	Y	Y	All subjects completed study (0%)	NA	NA
Gerritsen et al (2002)[38]	Y	Y	Y	Y	Y	N	Y	1 mo: surgery, 8%; orthosis, 1.1% 3 mo: surgery, 10.3%; orthosis, 3.4% 6 mo: surgery, 11.5%; orthosis, 5.6% 12 mo: surgery, 16.1%; orthosis, 6.7% 18 mo: surgery, 21.8%; orthosis, 11%	Y	CS
Homayouni et al (2013)[39]	Y	Y	N	CS	Y	CS	Y	All subjects completed study (0%)	CS	NA
Kumnerddee and Kaewtong (2010)[40]	Y	Y	N	Y	Y	Y	Y	5 wk: orthosis, 3.2%; acupuncture, 0%	CS	CS
Mardani-Kivi et al (2014)[41]	Y	CS	CS	CS	Y	CS	Y	Corticosteroid injection + thumb spica cast, 9.0%; corticosteroid injection, 14.7%	Y	NA

CAMP TIELLE, rigid wrist brace; *CS*, Cannot say; *MANU*, soft hand brace; *N*, no; *Y*, yes.
[a] Percent drop-out included drop-out and loss to follow-up.

applicable). All reviewers were trained in the evaluation of studies using the SIGN criteria. Consensus between reviewers was reached through discussion, with the involvement of an independent third reviewer if consensus could not be reached. We contacted authors when additional information was needed to complete the critical appraisal. Studies with a low risk of bias were included in our best evidence synthesis.[49]

Data Extraction and Synthesis of Results

The lead author extracted data from studies with low risk of bias and prepared evidence tables (Table 2). Data extraction was independently checked by a second reviewer. Meta-analysis was not performed due to the heterogeneity of the low risk of bias studies. A qualitative synthesis of the low risk of bias studies was performed according to the principles of best evidence synthesis.[49] The following minimal clinically important difference (MCID) thresholds were used: Boston Carpal Tunnel Syndrome Questionnaire, severity of symptoms 0.16/5 and functional status scale 0.47/5[52]; Shortened Disabilities of the Arm, Shoulder, and Hand (QuickDASH) 8/100[53]; visual analog scale (VAS) 14/100 mm or 14% difference[54,55]; grip strength 6.5 kg (19.5%)[56]; and 2/10 difference on the Numeric Rating Scale (NRS).[57] We stratified our results by disorder type and duration (ie, recent [< 3 months], persistent [≥ 3 months], or variable [all durations included]).

Statistical Analyses

We computed the interrater reliability for the screening of articles using the κ coefficient and 95% confidence intervals (CIs).[58] We also computed the percentage agreement for critical appraisal for low and high risk of bias studies. Similarly, we computed the difference in mean change between groups and 95% CI to quantify the effectiveness of interventions. The computation of the 95% CI for the difference in mean change is based on the assumption that the preintervention and postintervention outcomes are highly correlated ($r = 0.8$).[50,51]

Reporting

The systematic review was organized and reported based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[59]

Results

Study Selection

We screened 6618 citations for eligibility (Fig 1). The interrater agreement for the screening of articles was κ of 0.91 (95% CI, 0.86-0.96). After screening, 11 articles were eligible for critical appraisal. We contacted the authors of 5 studies[35-37,60,61] to clarify methodological aspects of their trial, and 3 responded.[35,37,60] The percentage agreement for critical appraisal of articles was 63.7% (7/11 studies). For the studies where reviewers disagreed, we reached consensus through discussion and/or the involvement of a third reviewer. Five studies on CTS[35-40] and 2 studies on de Quervain disease[39,41] had low risk of bias and were included in our evidence synthesis. We did not find studies with a low risk of bias that investigated the management of other wrist or hand soft tissue injuries or neuropathies.

Study Characteristics

All studies with a low risk of bias were RCTs. Of these, 5 investigated the management of adults with CTS,[35-40] and 2 investigated the management of de Quervain disease.[39,41] The studies investigated the effectiveness of night orthoses (4/7) and LLLT (1/7) for CTS and kinesio tape (1/7) and a thumb spica cast (1/7) for de Quervain disease.

Risk of Bias

We critically appraised 11 RCTs. Of those, 7 had a low risk of bias,[35-41] and 4 had a high risk of bias.[60-63] The methodological limitations of the studies with high risk of bias included either failure to describe or inadequate: randomization methods (4/4),[60-63] allocation concealment and blinding (4/4),[60-63] similarities in cointerventions between treatment arms (4/4),[60-63] intention-to-treat analysis (3/4),[61-63] and similarities in baseline characteristics between treatment arms (2/4).[62,63]

All studies with low risk of bias had a clearly defined research question and used valid and reliable outcome measures (7/7)[35-41](Table 1). Further strengths included similarity in baseline characteristics across intervention groups (6/7)[36-41]; similar cointerventions between treatment arms (4/7),[35-37,40] and clearly described blinding (4/7).[36-38,40] The follow-up rate was 80% or higher in 5 studies.[35,37,39-41] The studies with low risk of bias also had methodological limitations. Specifically, the randomization method was inadequately described in 3 RCTs,[36,37,41] and it was unclear whether the allocation of treatment was concealed in 3 studies.[36,37,39]

Summary of Evidence

Carpal Tunnel Syndrome of Variable Duration

Low-Level Laser Therapy (LLLT). Evidence from 1 RCT suggests that LLLT and placebo LLLT lead to similar outcomes for the management of CTS when added to the use of a night wrist splint (Table 2).[37] In their trial, Evcik et al[37] randomized patients to 10 visits (over 2 weeks) of (1) LLLT (pulsed mode, wavelength 830 nm, 14 J total) or (2) placebo LLLT (no irradiation). Both groups used the same night splint. There were no statistically significant or clinically important differences between groups in hand grip or pinch strength. There was a statistically significant difference in motor distal latency at 12 weeks (mean change difference, 0.03 [95% CI, 0.05-0.55])

Table 2. *Evidence Table for Accepted RCTs on Passive Physical Modalities for the Management of Soft Tissue Injuries and Neuropathies of the Wrist and Hand*

Author(s), Year	Subjects and Setting; Number (n) Enrolled	Interventions; Number (N) of Subjects	Comparisons; Number (n) of Subjects	Follow-Up	Outcomes	Key Findings [a]
CTS						
Baker et al (2012)[35]	Adults (>18 years old) Pittsburgh, PA, referred from 2 surgeons and recruited by telephone and study flyer placed at local hand clinics (2008-2010). Case definition: signs and symptoms of mild to moderate CTS with an absence of thenar atrophy and 2-point discrimination of 5 mm or less; n = 124	Lumbrical splint worn at night with lumbrical stretches (≥4 wk); lumbrical splint: custom fit to place the wrist at 0° of extension and the MCP joints at 0°-10° of flexion; lumbrical stretching: palm down with the PIP and DIP joints flexed, and press downward over the MCP joints with the opposite hand and massage; n = 31	General splint worn at night with lumbrical stretches (≥4 wk); general splint: custom fit to ensure 0° of extension; same lumbrical stretches and massage as lumbrical splint group; n = 34	4 wk Outcomes at 12 and 24 wk could not be used due to high drop-out and the lack of control of cointerventions	Primary outcome: CTQ, SSS (1-5) (11 items) and FSS (1-5) (8 items); DASH (1-5) (30 items). Secondary outcomes: adherence was tracked by self-report survey.	Difference in mean change (lumbrical splint − general splint) [b]: CTQ-SSS (1-5): 4 wk, −0.08 (95% CI, −0.34 to 0.18) CTQ-FSS (1-5): 4 weeks, −0.17 (95% CI, −0.45 to 0.11) DASH (0-100): 4 wk, −2.5 (95% CI, −10.02 to 5.02) Adherence with the splint only at 4 wk: lumbrical splint, 17/23 (73.9%); general splint, 21/28 (75%) Adherence with the exercises only at 4 wk: lumbrical splint, 16/24 (66.7%); general splint, 23/29 (79.3%) Adherence with both at 4 wk: lumbrical splint, 13/22 (59.1%); general splint, 18/28 (64.3%)
De Angelis et al (2009)[36]	Adults from Italy (≥18 years old) referred to an electrodiagnostic laboratory (2004-2005). Case definition: clinical signs/symptoms and electrophysiological diagnosis of CTS; n = 120	Soft hand brace: MANU hand brace worn every night for 3 mo; n = 59	Rigid wrist splint: CAMP TIELLE polyethylene splint worn every night for 3 mo; n = 61	3 and 9 mo	Primary outcomes: BCTQ, SSS (1-5) and FSS (1-5); VAS (0-100 mm) Secondary outcomes: median nerve DML (milliseconds), median SCV (m/s), SNAP (μV).	Difference in mean change score (soft hand brace − rigid wrist splint [c]): BCTQ SSS (1-5): 3 mo, −0.06 (95% CI, −0.34 to 0.18); 9 mo, 0.07 (95% CI, −0.28 to 0.36) BCTQ FSS (1-5): 3 mo, 0.19 (95% CI, −0.16 to 0.34); 9 mo, 0.17 (95% CI, −0.22 to 0.35) VAS paresthesia (0-100 mm): 3 mo, −10.20 (95% CI, −20.69 to 1.76); 9 mo, −2.40 (95% CI, −13.71 to 10.91) VAS pain (0-100 mm): 3 mo, 0.10 (95% CI, −7.10 to 11.36); 9 mo, 3.10 (95% CI, −6.42 to 16.67) SNAP (μV): 3 mo, 4.06 (95% CI, 0.37-6.85) No differences in DML and SCV.
Evcik et al (2007)[37]	Adults from Turkey (25-78 years old) Case definition: CTS diagnosed clinically and electromyographic study; n = 81	LLLT and night splint by PT; LLLT: 5×/week for 2 wk, over the wrist; wavelength of 830 nm with 30-s irradiation (pulse mode with 0.60 W/cm^2 at 1000 Hz); night wrist orthosis worn at night for 2 wk; n = 41	PLLLT and night wrist splint; same protocol as previous group with placebo laser (no irradiation); n = 40	4 and 12 wk	Primary outcome: hand grip strength (kg) with Jamar dynomometer and pinch-grip strength (kg) with a pinch gauge	Difference in mean change score (LLLT − PLLLT): [b] Hand grip strength (kg): 4 wk, −1.30 (95% CI, −3.20 to 0.60); 12 wk, −1.80 (95% CI, −3.75 to 0.15)

					Secondary outcomes: VAS (0-10 cm); CTSAQ SSS (1-5) (11 items) and FSS (1-5) (8 items); electrodiagnositic testing (MDL, SDL, SA, MA, MNV, and SNV).	Pinch grip strength (kg): 4 wk, −0.30 (95% CI, −0.71 to 0.11); 12 wk, −0.60 (95% CI, −1.02 to −0.18) MDL (msn): 12 wk, 0.30 (95% CI, 0.05-0.55) No difference for all other secondary outcomes.
Gerritsen et al (2002)[38]	Adults in the Netherlands (≥18 years old); recruited by neurologist (1998-2000). Case definition: clinical signs with electrophysiological confirmation of CTS; n = 176	Wrist splint worn at night (≤6 wk) and during day if desired; pain medication if necessary; n = 89	Surgery: open carpal tunnel release by a surgeon; pain medication if necessary; ROM exercise and use of hand as tolerated after surgery; n = 87	3, 6, 12, and 18 mo	Primary outcomes: general improvement (6-point ordinal scale from "completely recovered" to "much worse"); no. of nights awakening due to pain [0-7]; severity of main complaint, paresthesia during the day, paresthesia during the night, hypoesthesia (NRS 0-10). Secondary outcomes: SSS (11 items, 1-5) and FSS (8 items, 1-5); severity of complaints rated by a PT (NRS 0-10); nerve conduction studies (ms; DSL index finger, median ulnar difference ring finger, and DML median nerve). Adverse events	Success rates ("completely recovered" or "much improved"): [b] Surgery vs wrist splint: 3 mo, surgery RR 1.38 (95% CI, 1.08-1.76); 6 mo, surgery RR 1.29 (95% CI, 1.08-1.55); 12 mo, surgery RR 1.14 (95% CI, 0.95-1.37); 18 mo, surgery RR 1.06 (95% CI, 0.86-1.29) Difference in mean change score (wrist splint − surgery): No. of nights awakening due to pain (0-7): 3 mo, −0.40 (95% CI, −1.40 to 0.70); 6 mo, −1.0 (95% CI, −2.0 to −0.10); 12 mo, −0.70 (95% CI, −1.70 to 0.20); 18 mo, −0.40 (95% CI, −1.40 to 0.60) Severity of the main complaint (NRS 0-10): 3 mo, −1.9 (95% CI, −2.80 to −1.00); 6 mo, −2.2 (95% CI, −3.10 to −1.40); 12 mo, −1.30 (95% CI, −2.20 to −0.40); 18 mo, −1.20 (95% CI, −2.30 to −0.20) Severity of paresthesia during the day (NRS 0-10): 3 mo, −2.6 (95% CI, −3.60 to −1.60); 6 mo, −1.8 (95% CI, −2.80 to −0.80); 12 mo, −1.50 (95% CI, −2.50 to −0.50); 18 mo, −1.30 (95% CI, −2.50 to −0.30) Severity of paresthesia during the night (NRS 0-10): 3 mo, −1.1 (95% CI, −2.20 to 0.00); 6 mo, −1.3 (95% CI, −2.40 to −0.20); 12 mo, −0.70 (95% CI, −1.80 to

(continued on next page)

Table 2. (*continued*)

Author(s), Year	Subjects and Setting; Number (n) Enrolled	Interventions; Number (N) of Subjects	Comparisons; Number (n) of Subjects	Follow-Up	Outcomes	Key Findings [a]
						0.40); 18 mo, −0.60 (95% CI, −1.70 to 0.60) SSS (1-5): 3 mo, −0.40 (95% CI, −0.70 to −0.20); 6 mo, −0.40 (95% CI, −0.70 to −0.20); 12 mo, −0.40 (95% CI, −0.70 to −0.10); 18 mo, −0.40 (95% CI, −0.60 to −0.10) FSS (1-5): 6 mo, −0.50 (95% CI, −0.70 to −0.20) Adverse events: Overall: splint, 46/89 (52%); surgery, 58/87 (67%) Painful/hypertrophic scar: surgery, 61% (53/87); splint, 22% (20/89) Stiffness: surgery, 28% (24/87); splint, 35% (31/89) Skin irritation: surgery, 22% (19/87); splint, 9% (8/89) Wound hematoma: surgery, 11.5% (10/87); splint, 1% (1/89) Infection: surgery, 6% (5/87); splint, 2% (2/89) Reflex sympathetic dystrophy: 1 case surgery
Kumnerddee and Kaewtong (2010)[40]	Adults from Thailand (≥ 18 years old). Case definition: clinical signs/symptoms and electrophysiological diagnosis of mild to moderate CTS; n = 61	Wrist splint worn at night (5 wk); n = 31	Electroacupuncture by physiatrist: 2×/week for 5 wk; 1 Hz continuous direct current over 6 acupoints (HeGu/LI 4, QuChi/LI 11, DaLing/PC 7, and LaoGong/PC 8 and 2 BaXie points/EX-UE9); n = 30	5 wk	Primary outcome: Thai version of BCTS (11-item SSS [1-5 scale] and 9-item FSS [1-5 scale]) Secondary outcomes: pain severity (VAS 0-100 mm); analgesic intake. Adverse events.	Difference in mean change score (splint − acupuncture [d]): BCTS SSS (1-5): 5 wk, −0.11 (95% CI, −0.33 to 0.10) BCTS FSS (1-5): 5 wk, −0.05 (95% CI, −0.25 to 0.16) Pain severity (0-100 mm): 5 wk, −9.63 (95% CI, −18.20 to −1.07) Adverse events: acupuncture, 6/30 temporary bruising; orthosis, no adverse events reported
De Quervain Disease						
Homayouni et al (2013)[39]	Adults (18-65 years old), Shiraz, Iran, from a physical medicine and rehabilitation clinic (September 2011 to December 2012).	KT applied by PT (4×/week for 1 mo): 3 pieces of Kinesio tape (Tem Tx, Korea) (i) 1″ × 6″, EPB insertion along radial aspect of the wrist and onto extensor surface to origin	Multimodal physiotherapy applied by PT (every 3 d for 10 sessions): 10-min paraffin bath (mineral oil and paraffin, 1:6, 53°C); 5-min pulsed ultrasound (1 MHz, 1 W/cm^2	Immediately after 1-mo intervention	Primary outcome: pain severity (VAS 0-100 mm) Adverse events.	Difference in mean between KT and multimodal physiotherapy VAS (0-100 mm): −27 (95% CI could not be calculated) $P < .001$ in favor of KT No adverse events.

	Case definition: >4 wk; pain, swelling, and tenderness over the first extensor compartment and positive Finkelstein test; n = 60	of APL; (ii) 2″ × 4″, wrist extended, dorsum of hand to distal forearm, 1″ proximal to styloids; (iii) volar side of distal radius, stretched obliquely to dorsum of hand; n = 30	under water); 20-min reciprocal and low TENS (4 Hz, 200 milliseconds); 5-min gentle clockwise and nonclockwise friction massage of APL and EPB tendons; n = 30			
Mardani-Kivi et al (2014)[41]	Adults from Iran (≥18 years old). Case definition: pain on radial side of wrist; tenderness at first dorsal compartment; positive Finkelstein test; VAS pain >6/10; n = 67	Thumb spica cast + 1 corticosteroid injection by physician: fiberglass thumb spica cast removed after 3 wk (patients were then encouraged to move wrist and fingers); 40 mg methylprednisolone acetate with 1-mL lidocaine 2% in the first dorsal compartment at the point of maximal tenderness by physician; advice to reduce physical activities and rest as much as possible; n = 33	One corticosteroid injection by physician: 40 mg methylprednisolone acetate with 1-mL lidocaine 2% in the first dorsal compartment at the point of maximal tenderness; advice to reduce physical activities and rest as much as possible; n = 34	3 wk	Secondary outcomes: pain intensity (VAS 0-10 cm); function (Quick DASH 0-100)	Difference in mean change score (thumb spica cast + corticosteroid injection − corticosteroid injection): Quick DASH (0-100): 3 wk, 10 (95% CI, 5.52 to 14.48) Pain intensity VAS (0-10 mm): 3 wk, 1.3 (95% CI, 1.0-1.6)

APL, abductor pollicis longus; *BCTQ*, Boston Carpal Tunnel Questionnaire; *BCTS*, Boston Carpal Tunnel Syndrome Outcome Scales; *CTQ*, Carpal Tunnel Questionnaire; *CTSAQ*, Carpal Tunnel Syndrome Assessment Questionnaire; *DASH*, Disabilities of the Arm, Shoulder and Hand; *DIP*, distal interphalangeal joint; *DML*, distal motor latency; *DSL*, distal sensory latency; *EPB*, extensor pollicis brevis; *FSS*, functional status scale; *KT*, kinesio tape; *MA*, motor amplitude; *MCP*, metacarpalphalangeal joint; *MDL*, motor distal latency; *MNV*, motor nerve velocity; *PIP*, proximal interphalangeal joint; *PLLLT*, placebo LLLT; *PT*, physical therapy; *ROM*, range of motion; *SA*, sensory amplitude; *SCV*, sensory conduction velocity; *SDL*, sensory distal latency; *SNV*, sensory nerve velocity; *SSS*, symptom severity scale; *TENS*, transcutaneous electrical nerve stimulation.

[a] For secondary outcomes, only clinical or statistical significant differences are reported.

[b] Calculated by OPTIMa team.[50,51]

[c] Analysis of covariance adjusted for sex, age, and baseline covariate score.

[d] Analysis of covariance adjusted for baseline value.

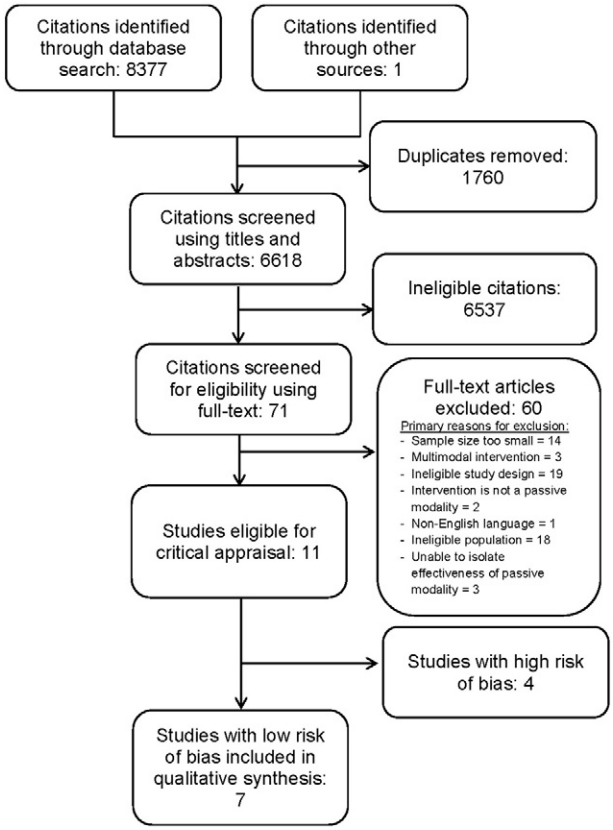

Fig 1. *Identification and selection of articles.*

favoring LLLT. However, the clinical significance of this difference is unknown.

Orthoses. Evidence from 2 RCTs suggests that different types of night orthoses lead to similar outcomes for the management of CTS (Table 2).[35,36] We only used the 4-week follow-up results of the RCT of Baker et al[35] because of the high dropout rate at the 12- and 24-week follow-ups. Baker et al randomized participants to (1) a custom fabricated lumbrical splint (wrist at 0° extension, metacarpophalangeal joints in 0°-10° flexion) or (2) a modified generic splint (wrist at 0° of extension and no lumbrical restraint) custom fit by a hand therapist. Both splints were worn at night for 4 weeks, and both groups completed a home program of lumbrical stretching and massage. No statistically significant or clinically important differences were reported immediately postintervention (4 weeks).

In an RCT by De Angelis et al,[36] patients with CTS were randomized to (1) a MANU soft hand brace or (2) CAMP TIELLE rigid wrist brace each to be worn nightly for 3 months. Patients who wore the MANU soft wrist brace had improved sensory nerve action potential (SNAP) (mean change difference, 4.06; 95% CI, 0.37-6.85) compared to the CAMP TIELLE rigid wrist brace at 3-month follow-up only. The clinical importance of this difference is unknown (Table 2). No other statistically significant or clinically important differences were observed between groups.

Persistent Carpal Tunnel Syndrome

Orthoses vs Surgery. Evidence from 1 RCT suggests that a night wrist orthosis is less effective than surgery for the management of CTS in the short term (up to 6 months) but led to similar outcomes in the long term (at 12 and 18 months postintervention) (Table 2).[38] Gerritsen et al[38] randomized patients to (1) a custom or prefabricated neutral wrist splint to be worn at night (and during the day if desired) for a minimum of 6 weeks or (2) open carpal tunnel release surgery followed by range of motion exercises and advice to use the hand. Patients treated with surgery were more likely to report recovery at 3 months (relative risk [RR], 1.38 [95% CI, 1.08-1.55]) and 6 months (RR, 1.29 [95% CI, 1.08-1.55]) than those receiving night wrist splints. Patients treated surgically also reported clinically important reductions in the severity of day paresthesia at 3 months and in the severity of their main complaint at 6 months. There were no statistically significant or clinically important differences between night splints and surgery in the long term (12 and 18 months).

Orthosis vs Acupuncture. Evidence from 1 RCT suggests that a night wrist splint offers similar outcomes to electroacupuncture for the management of mild to moderate CTS (Table 2).[40] Kumnerddee and Kaewtong[40] randomized patients to a prefabricated neutral wrist splint worn at night for 5 weeks or electroacupuncture (using points HeGu/LI 4, QuChi/LI 11, DaLing/PC 7, LaoGong/PC 8, and 2 BaXie points/EX-UE9) twice weekly for 5 weeks. A statistically significant but not clinically important difference in pain severity was observed at 5 weeks favoring those receiving electroacupuncture (mean change difference, −9.63 [95% CI, −18.20 to −1.07]). No statistically significant or clinically important differences for secondary outcomes of symptom severity or function were observed.

de Quervain Disease of Variable Duration

Kinesio Tape vs Multimodal Physiotherapy. Evidence from 1 RCT suggests that kinesio tape offers greater benefit than multimodal physiotherapy immediately postintervention for de Quervain disease (Table 2).[39] Homayouni et al[39] randomized patients to (1) kinesio tape applied by a physiotherapist 4 times per week for 1 month or (2) paraffin bath, ultrasound, and friction massage by a physiotherapist every 3 days for 1 month. A statistically significant and clinically important improvement in pain severity (mean change difference VAS, −27/100 mm; $P < .001$) was observed immediately postintervention (1 month) favoring those receiving kinesio tape.

Thumb Spica Cast and Corticosteroid Injection vs Corticosteroid Injection. Evidence from 1 RCT suggests that a thumb spica cast plus corticosteroid injection offers greater benefit than a corticosteroid injection alone immediately postintervention for de Quervain disease (Table 2).[41] Mardani-Kivi et al[41] randomized patients to a fiberglass thumb spica cast worn for 3 weeks and a

corticosteroid injection or corticosteroid injection alone. Both groups were advised to reduce physical activities and rest as much as possible. A statistically and clinically important improvement in function (mean change score QuickDash, 10.0 [95% CI, 5.52-14.48]) was observed immediately postintervention (3 weeks) favoring the thumb spica cast plus corticosteroid injection.

Adverse Events

Only 3 of the RCTs with a low risk of bias reported on adverse events. Gerritsen et al[38] noted that 67% of the surgical group and 52% of the wrist splint group reported adverse events during the 18-month follow-up period. Overall, more serious adverse events (such as a painful or hypertrophic scar [61%], skin irritation [22%], wound hematoma [11.5%], infection [6%], and 1 case of reflex sympathetic dystrophy) were associated with surgery. The most frequently reported adverse event for participants wearing wrist splints was stiffness (35%). Twenty percent of participants receiving electroacupuncture reported temporary bruising, whereas none of the night wrist splint recipients reported any side effects in the study by Kumnerddee and Kaewtong.[40] Homayouni et al[39] reported that no adverse events occurred in their RCT.

Discussion

Summary of Evidence

Our systematic review informs the management of CTS and de Quervain disease. Our synthesis does not support the effectiveness of wrist splints for the management of CTS.[35,36,38,40] Similarly, we found evidence that kinesio tape and a thumb spica cast may provide short-term benefits to patients with de Quervain disease.[39,41]

We did not find high-quality studies to inform the management of other soft tissue injuries and neuropathies of the wrist and hand (eg, trigger finger, Guyon canal syndrome, and oarsman's wrist [intersection syndrome]) using passive physical modalities.

Previous Systematic Reviews

Our results include further evidence to support 2 previous systematic reviews that found no evidence to support the use of orthoses and LLLT for the management of CTS.[19,24] However, our results do not agree with the systematic review by Peters-Veluthamaningal et al[11] who reported that a thumb spica splint is less effective than a corticosteroid injection. The conclusion was based on 1 small high risk of bias study with a small sample size (n = 19). Furthermore, the generalizability of the review is limited due to the population targeted in the study (pregnant or lactating women).

Strengths and Limitations

Our review has several strengths. First, our literature search was comprehensive and methodologically rigorous. We searched 5 electronic databases, with the search strategy being reviewed by a second independent librarian to minimize errors. Second, we used clear detailed inclusion and exclusion criteria to identify relevant citations. Third, we used independent pairs of reviewers to screen and critically appraise the literature and used the SIGN criteria to ensure standardization of the critical appraisal process. Fourth, we minimized the risk of bias associated with using low-quality studies by using best evidence synthesis to form our conclusions.

Our review also has limitations. First, studies may have been excluded as our literature search was restricted to the English language. However, previous systematic reviews of clinical trials investigating the impact of language restriction found that it does not lead to bias as most reviews are published in English.[64-66] Second, it is possible that our search may have missed potentially relevant studies despite our broad definition of passive physical modalities. It is difficult to capture all indexed terms for 1 intervention, and we grouped several under the umbrella term of passive physical modalities. In addition, there is a lack of consistency for terminology of various physical modalities. Third, the critical appraisal of articles may vary between reviewers. This potential bias was minimized by using standardized appraisal forms, conducting critical appraisal training sessions for reviewers, and using a consensus process to determine study admissibility.

Implications of the Research

The findings of our review will assist clinicians in making evidence-based decisions regarding the management of soft tissue injuries and neuropathies of the wrist and hand. Utilization of evidence-based interventions is important to minimize the personal, societal, and economic impact of disability associated with these conditions.[1] Drawing upon the current highest quality evidence, patient and clinician preferences can be taken into account in the selection of a night wrist splint design for CTS. Furthermore, electroacupuncture may be considered as an alternate intervention to a night wrist splint for mild or moderate CTS. Kinesio tape or a thumb spica cast are alternatives to consider for the management of de Quervain disease. Passive physical modalities for which there is no evidence are not recommended for the management of CTS and de Quervain disease. The clinician may further draw upon research to identify other modalities for which there is high-quality evidence to develop a complete program of care. Clinicians should not use passive physical modalities in a program of care to manage other soft tissue injuries and neuropathies of the wrist and hand, as there currently is no evidence to support its use.

Recommendations for Future Research

There continues to be a paucity of studies of high methodological quality examining the effectiveness of passive physical modalities for the management of soft tissue injuries

and neuropathies of the wrist and hand. Future research should address this important gap in the literature. Future studies should include appropriate randomization methods with concealment, study groups must be similar at baseline, valid and reliable outcome measures should be used, and analysis should be by intention to treat. Specific attention should be made to the unit of analysis, with clear methodology for management of participants with bilateral involvement. Furthermore, studies to identify the role of passive physical modalities for the management of soft tissue injuries and neuropathies of the wrist and hand other than those identified in our systematic review (CTS and de Quervain disease) are required.

Conclusion

This review clarifies the role of night orthoses for the short-term management of CTS. Different night orthosis designs provided similar outcomes for CTS of variable duration. Night orthoses offer similar outcomes to electroacupuncture but are less effective than surgery in the short term. Furthermore, this review suggests that kinesio tape or a thumb spica cast may offer short-term benefit for the management of de Quervain disease. No high-quality studies to inform the use of passive physical modalities for the management of other soft tissue injuries and neuropathies of the wrist and hand were found.

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Contributorship Information

Concept development (provided idea for the research): P.C., K.D., S.D., A.A., A.T.V., De.S., H.Y., H.S., J.W., M.N., M.S., S.V., K.R.
Design (planned the methods to generate the results): P.C., H.Y., J.W., M.N., S.V., K.R.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): P.C., K.D., A.A., De.S., H.S., M.N.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): P.C., K.D., C.B., R.M., S.D., J.C., A.A., De.S., H.Y., J.W., M.N., S.V., K.R., D.S.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): P.C., K.D., S.D., A.A., De.S., L.C., H.S., M.N., M.S.
Literature search (performed the literature search): P.C., A.A., A.T.V., M.N.
Writing (responsible for writing a substantive part of the manuscript): P.C., K.D., S.D., J.C., A.A., De.S., M.N.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): P.C., K.D., C.B., R.M., S.D., J.C., A.A., A.T.V., De.S., L.C., H.Y., J.W., M.N., M.S., S.V., K.R., D.S., H.S.

Practical Applications

- This study found that evidence on the management of soft tissue injuries and neuropathies of the wrist and hand is limited.
- The design of night orthosis does not have an impact on clinical outcomes, offers similar outcomes to electroacupuncture, and is less effective than surgery for the short-term management of CTS.
- Kinesio tape or a thumb spica cast may offer short-term benefit for the management of de Quervain disease.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jmpt.2015.06.006.

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