
Occupational Therapy Interventions for Work-Related Injuries and Conditions of the Forearm, Wrist, and Hand: A Systematic Review

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KEY WORDS

- evidence-based practice
- forearm injuries
- hand injuries
- occupational diseases
- occupational therapy
- wrist injuries

A systematic review of the literature related to effective occupational therapy interventions in rehabilitation of individuals with work-related forearm, wrist, and hand injuries and illnesses was conducted as part of the Evidence-Based Literature Review Project of the American Occupational Therapy Association. This review provides a comprehensive overview and analysis of 36 studies that addressed many of the interventions commonly used in hand rehabilitation. Findings reveal that the use of occupation-based activities has reasonable yet limited evidence to support its effectiveness. This review supports the premise that many client factors can be positively affected through the use of several commonly used occupational therapy-related modalities and methods. The implications for occupational therapy practice, research, and education and limitations of reviewed studies are also discussed.

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Focused Clinical Question

What occupational therapy interventions are effective in the rehabilitation of individuals with work-related injuries or conditions of the forearm, wrist, and hand?

Objectives of the Evidence-Based Literature Review

Occupational therapy practitioners are interested in the ability of individuals to engage in meaningful and relevant occupations and therefore must address many factors of human structure and function that enable performance and allow for occupational engagement. Workers are a population susceptible to injuries to the arm and hand resulting from accidents and cumulative trauma occurring at the work site. Occupational therapy practitioners treat many of these injuries and conditions and the ensuing occupational dysfunction. This article highlights the evidence related to treatment of the hand, wrist, and forearm that can be used by clinicians to support interventions commonly provided to injured workers with the objective of returning them to full occupational engagement.

Statement of Problem and Background

According to the Centers for Disease Control and Prevention (2001), hand injuries are consistently ranked as the second most common workplace injury: Each year, 1,080,000 emergency room visits are generated by workers with hand injuries. The U.S. Department of Labor recognizes hand injuries as the most preventable workplace injury (Garner, 2005). In addition, the U.S. Bureau of Labor Statistics (2008) reported that injuries to the upper extremities

account for >23% of all workplace injuries and that carpal tunnel syndrome (CTS) in particular accounted for an average of 28 days of lost work. Other musculoskeletal conditions, including conditions affecting the muscles, tendons, joints, cartilage, and nerves, accounted for 29% of all worker compensation injuries in 2007; injury to each of these types of connective tissue can occur in the hand, wrist, and forearm (U.S. Bureau of Labor Statistics, 2008).

Occupational therapy practitioners working in hand and outpatient rehabilitation facilities will treat a significant portion of individuals with upper-extremity injuries as they enter the rehabilitation phase of their recovery. Injuries and conditions included in this review include traumatic injuries, such as lacerations, burns, fractures, crushing injuries, and amputations, and cumulative trauma disorders, such as tenosynovitis, CTS, and osteoarthritis (OA). The role of the occupational therapy practitioner is to assist clients as they regain the ability to engage in desired occupations such as work, activities of daily living (ADLs), educational pursuits, leisure, play, social participation, and rest and sleep. By treating the impaired underlying client factors of body structures and functions using occupations, purposeful activities, and various preparatory methods, practitioners work to assist the client in recovery (American Occupational Therapy Association [AOTA], 2008).

Method for Conducting the Evidence-Based Review

The portion of the workers' compensation evidence-based literature review discussed in this article addresses the effectiveness of interventions used in the rehabilitation of individuals with work-related injuries or illness of the forearm, wrist, and hand. Detailed information about the methodology for the entire workers' compensation evidence-based literature review can be found in the article "Methodology for the Systematic Reviews on Occupational Therapy for People With Work-Related Injuries and Illnesses" (Arbesman, Lieberman, & Thomas, 2011) in this issue.

Results

This review includes a total of 36 studies—32 Level I and 4 Level III studies. The findings have been clustered into 12 areas that represent treatments administered or potentially administered by occupational therapists treating work-related and otherwise acquired conditions of the forearm, wrist, and hand. The treatment categories were silicone gel sheeting, massage, splinting, early mobilization, low-level laser therapy, thermal modalities, exercise, gloves, ultrasound, pain control techniques, workplace

interventions, and miscellaneous. Supplemental Table 1 summarizes the studies included in the review and is available online at www.ajot.ajotpress.net (navigate to this article, and click on "supplemental materials").

Silicone Gel Sheeting

One Level I systematic review found that when compared with no treatment, the development of hypertrophic scarring was reduced and the elasticity of established scar was increased through the use of silicone gel sheeting (O'Brien & Pandit, 2006).

Massage

Two Level I studies were reviewed that discussed scar massage and deep transverse friction massage. Scar massage was found to reduce pain and itching from scars associated with burns and to decrease anxiety and depressed mood (Field et al., 2000). Deep transverse friction massage applied to tendonitis was not found to have a clinically important benefit (Brosseau et al., 2002).

Splinting

Five Level I studies reviewed splinting as a beneficial preparatory technique. Two articles described splinting for reducing signs and symptoms of OA of the thumb carpometacarpal joint, and three articles described splinting for CTS (Egan & Brosseau, 2007; Muller et al., 2004; O'Connor, Marshall, & Massy-Westropp, 2003; Wajon & Ada, 2005; Werner, Franzblau, & Gell, 2005). Carpometacarpal splints that immobilize the basal joint of the thumb and wrist immobilization splints that hold wrists in neutral while leaving digits free were described. Both pathologies benefitted from splint use; splints designed for each diagnosis were effective regardless of variations in style. Definitive schedules and durations of splint wear were not established through the studies reviewed. CTS splint studies had participants wearing devices nightly while sleeping or both day and night (Muller et al., 2004; Werner et al., 2005).

Techniques for Increasing Range of Motion

Three Level I systematic reviews and one Level I randomized controlled trial (RCT) investigated techniques for improving musculoskeletal status after upper-extremity injury. Two reviews explored the use of early mobilization (before 21 days after injury) on acute injuries and hand fractures; both reviews concluded that early mobilization can be effective in facilitating earlier return to work, decreasing pain and swelling, and preserving range of motion (ROM) when used in selected postsurgical cases (Michlovitz, Harris, & Watkins, 2004). Results of a study

exploring static wrapping versus passive ROM for increasing finger joint motion found that passive exercise was effective in increasing ROM of metacarpophalangeal joints and that static wrapping was most effective in increasing ROM of interphalangeal joints (Richard, Miller, Finley, & Jones, 1987).

Low-Level Laser Therapy

The results of one Level I systematic review that investigated low-level laser therapy (LLLT) for pain reduction and ROM were inconclusive (Brosseau et al., 2004). In 2007, an RCT was conducted to evaluate the efficacy of LLLT in patients with rheumatoid arthritis (RA) with CTS (Ekim, Armagan, Tascioglu, Oner, & Colak, 2007). Findings from this study indicated that improvements in functional status and decrease in pain did occur and that these improvements were significantly greater in the treatment group than the placebo group at end of treatment and at 3 mo. They did not, however, find that improvements in other parameters (Tinel and Phalen signs, grip and pinch strength, results of electrophysiological examination and symptom severity) were significantly different between placebo and treatment group. Conversely, a Level I study that compared the efficacy of ultrasound and LLLT treatments in mild to moderate CTS found that improvement was significantly more pronounced in the ultrasound group than in the LLLT group for motor latency, motor action potential amplitude, finger pinch strength, and pain relief (Bakhtiyari & Rashidy-Pour, 2004).

Thermal Modalities

One Level I systematic review explored the effectiveness of cryotherapy for treating acute soft-tissue injuries. This study did not establish an optimal mode or duration of ice application but did find marginal evidence that ice treatments combined with exercise can be effective in reducing pain after surgery and after sprain (Bleakley, McDonough, & MacAuley, 2004). A Level I study investigating the use of continuous low-level heat wraps found this intervention to be effective for improving pain and functional status in common conditions of the wrist such as CTS, OA, and strain or sprain (Michlovitz, Hun, Erasala, Hengehold, & Weingand, 2004).

A Level I systematic review of contrast baths as a technique to increase circulation and decrease edema of the hand conducted by Breger-Stanton, Lazaro, and MacDermid (2009) found that the baths may increase superficial skin temperature and blood flow, but evidence of the effect on edema is conflicting. No relationship between the physiological effects and hand function has

been determined (Breger-Stanton et al., 2009). Similarly, a study investigating the effects of contrast baths on edema in people with CTS found no significant effect on hand volume either before or after release (Janssen, Schwartz, & Vellman, 2009).

Exercise and Arthritis

Three Level I systematic reviews explored the use of hand exercise for individuals with RA and aerobic exercise for those with OA. One study suggested that appropriate exercise (ROM, strengthening, endurance, motor control) might lead to long-term strength changes and short-term changes in hand stiffness in those with RA (Wessel, 2004). This study did not target a work-related condition per se, but results may be generalized to various work-related inflammatory conditions.

A separate study conducted in 2008 investigated a home-based daily exercise program for hand OA and found modest increases in grip and pinch strength, but this benefit did not result in change in self-reported hand function or in pain level (Rogers & Wilder, 2009). A third study investigating the effectiveness of different exercise intensities on people with OA found no difference between high- and low-intensity aerobic exercise but did find that both types improved functional status as determined by client reports of decreased pain and ability to engage in desired activities. Members of the low-intensity group performed better than the control group (Brosseau, MacLeay, Robinson, Wells, & Tugwell, 2003). Rogers and Wilder (2007) completed a Level III pre- and post-test design study that investigated the effects of a 2-year full-body strengthening program on older individuals with radiographic evidence of hand OA and minimal dysfunction. Findings indicated improvements in static and dynamic grip strength when a whole-body strength-training routine that included gripper exercise was completed (Rogers & Wilder, 2007).

Gloves

One Level III study addressed the effects of pressure-garment work gloves with suede palms versus standard-pressure garment gloves on functional hand use of individuals with hand burns. Improved function resulted from the use of pressure-garment work gloves, and clients preferred this glove to standard-pressure garments for functional activities including work-related activities (Weinstock-Zlotnick, Torres-Gray, & Segal, 2004).

Ultrasound

Ultrasound treatments were described in three Level I studies. One systematic review found limited evidence that

ultrasound may be an effective adjunct for the treatment of CTS; treatment parameters, as well as frequency and duration, were not discussed (O'Connor et al., 2003). A second systematic review found that 20 treatments of deep, pulsed 15-min ultrasound decreased symptoms (e.g., numbness and tingling, morning stiffness, and paresthesias), reduced sensory loss, and improved strength and median nerve conduction. This systematic review also indicated that ultrasound administered for fewer sessions and for shorter periods was not effective (Muller et al., 2004). A third systematic review that examined the use of ultrasound for the treatment of musculoskeletal disorders found little supportive evidence and recommended further investigation (van der Windt et al., 1999).

Pain Control Techniques

Two brief cognitive interventions for decreasing pain during dressing changes for clients with burns were described in one Level I study. Findings indicated that sensory focusing, which involves instructing the client to focus on the present moment and not to anticipate pain, resulted in higher levels of pain relief than did distraction (listening to music), which yielded no benefit. Sensory focusing also changed the memory of the painful procedures (Haythornthwaite, Lawrence, & Fauerbach, 2001).

Workplace-Based Interventions

One Level I systematic review investigated the available evidence for workplace-based interventions designed to decrease pain and increase functional status in individuals with upper-extremity disorders. The results obtained through this particular systematic review indicate that evidence is insufficient to identify effective workplace rehabilitation interventions (Williams, Westmorland, Schmuck, & MacDermid, 2004).

Miscellaneous

Several reviewed articles represent studies that cannot be categorized as the others. For this reason, the studies are considered *miscellaneous* and include topics such as use of function-based activities, biopsychosocial treatment, measurement of functional outcomes, various conservative treatments for musculoskeletal disorders, sensory re-education, and treatment of writer's cramp.

Function-Based Activities. The efficacy of therapeutic activities that simulate ADL function versus traditional therapeutic exercises in the management of injured hands was explored in one RCT. Findings indicated that individuals with acute and chronic hand injuries who were given ADL simulations had statistically significant higher

levels of improvement in areas assessed than did those who underwent traditional exercise-based treatment (Guzelkucuk, Duman, Taskaynatan, & Dincer, 2007).

Biopsychosocial Treatment of Repetitive Stress Injuries.

A systematic review examined the effectiveness of two biopsychosocial rehabilitation approaches for repetitive stress injuries of the upper extremity (these conditions are comparable to cumulative trauma disorders described elsewhere in this article). The rehabilitation programs described included a physician consultation and a psychological, social, or vocational intervention or combination of the preceding. The two studies included in the review did not find scientific evidence for the effectiveness of this approach (Karjalainen et al., 2000).

Measurement of Functional Outcomes. One Level III descriptive study investigating the use of client-centered assessments found that clients who underwent treatment using common occupational therapy techniques improved significantly. The improvement in functional performance resulting from the interventions were measured using the Canadian Occupational Performance Measure (Law et al., 1994); the Disabilities of Arm, Shoulder and Hand questionnaire (Hudak, Amadio, Bombardier, & the Upper Extremity Collaborative Group, 1996); and the SF-36 (Brazier et al., 1992). The Community Integration Questionnaire was not found to be an effective measure of hand therapy outcomes (Case-Smith, 2003).

Conservative Methods for Musculoskeletal Treatment. A systematic review sought to determine the efficacy of conservative interventions such as exercise, massage, ergonomics, splinting, multidisciplinary treatment, group and individual therapy, and manual therapy. Results indicated limited evidence to support ergonomic keyboards and individual exercise. This study did not find benefit in general ergonomic modifications to the workplace (Verhagen et al., 2006).

A systematic review conducted to assess the effectiveness of conservative treatment of CTS included studies that addressed treatments such as (or including) locally injected steroids, vitamin B6 regimen, steroid versus nonsteroidal anti-inflammatory drugs and diuretics, ultrasound versus laser therapy, exercise therapy, and splints. The review found strong evidence that the use of local and oral steroids is effective and moderate evidence that vitamin B6 is not effective and that full-time use of splints is effective. Limited or conflicting evidence was found indicating that nonsteroidal anti-inflammatory drugs, diuretics, yoga, laser, and ultrasound are effective and that exercise and botulinum toxin B are ineffective (Piazzini et al., 2007).

Sensory Reeducation. A systematic review of commonly used superficial tactile techniques such as rubbing

skin with graded texture wands to reeducate or enhance sensory awareness after peripheral nerve injuries found limited evidence to support their effectiveness (Oud, Beelen, Eijffinger, & Nollet, 2007).

Intervention for Writer's Cramp. A Level III pre- and postintervention assessment study of the effects of a handwriting training and auditory feedback program for individuals with writer's cramp was reviewed. Findings from this study suggested improvements in the form of decreased pressure and grip force used during writing tasks such as those found in jobs requiring the worker to write often or through multiple layers of paper. Subjective writing performance and pain also improved (Baur, Fürholzer, Marquardt, & Hermsdörfer, 2009)

Discussion and Implications for Practice, Education, and Research

When treating clients with work-related injuries and conditions, occupational therapists choose treatment methods and procedures available to them from a wide variety of commonly used approaches. This systematic review supports the premise that several popular preparatory methods can be effective for improving client factors (physiological and structural) that may then lead to improved ability to engage in desired occupations.

Implications for Practice

Interventions such as splinting for OA and CTS have been shown to have positive effects (Muller et al., 2004; Piazzini et al., 2007; Werner et al., 2005). Splints that support the thumb carpometacarpal joint were found to be effective in decreasing osteoarthritic pain of this joint. The splint's specific design did not appear to affect outcome when the painful joint was immobilized, thus allowing selection of the design that best meets the client's functional and esthetic needs.

Exercise as a means of effecting change in CTS and OA symptoms improved strength in bodies and hands with OA but did not decrease pain. Enhanced strength may lead to increased functional abilities if strength and endurance are negatively affecting occupational engagement. If exercise is used as treatment of osteoarthritic joints, pain levels must be continually monitored because severe pain can significantly diminish hand use.

Studies of physical agent modalities—treatment tools used frequently by occupational therapy practitioners in hand rehabilitation settings—were varied. All physical agent modalities described in this review, such as LLLT; ultrasound; and application of ice, heat, and contrast baths, require further study. As a result of limited em-

pirical evidence, clinicians must be familiar with their application and desired therapeutic effects and must closely monitor client response to intervention to ensure that the expected therapeutic effect without harm is being realized (Ekim et al., 2007; Michlovitz, Hun, et al., 2004; van der Windt et al., 1999).

Hypertrophic scarring responded to both silicone gel sheeting (O'Brien & Pandit, 2006) and scar massage (Field et al., 2000). Gel sheeting was effective in decreasing scar size as measured in area, length, volume, height, and width. Scar massage reduced burn scar pain and itching and decreased anxiety and depressed mood in burn clients. It also assisted in the prevention of hypertrophic scarring and promotion of extensibility of established scar tissue (Field et al., 2000). Cognitive pain control, the use of pressure-garment work gloves with suede palms, exercise for hand strengthening and improved ROM, and general conditioning have been shown to be effective for people who have experienced burns (Haythornthwaite, Lawrence, & Fauerbach, 2001; Weinstock-Zlotnick et al., 2004).

The early mobilization of upper-limb fractures and acute traumatic injuries is supported and has the potential benefits of earlier return to work, decreased pain, decreased swelling and stiffness, and a greater preserved ROM. Evidence suggesting that injured limbs should be mobilized as soon as bone and joint stability are established has supported clinician selection of treatment methods that offer active engagements early in the rehabilitation process (Feehan & Bassett, 2004).

Ergonomic modifications in the workplace are somewhat effective in reducing symptoms of repetitive stress injuries, particularly keyboards, but these areas require further study (Williams et al., 2004). Sensory reeducation techniques, such as rubbing the skin with texture stimulator wands, were found to be limited in their effect on enhancing tactile sensation. When treating clients with impaired tactile sensation leading to functional changes, instruction in the use of compensatory techniques such as monitoring temperature, use of protective gear, and frequent checking of the extremity for injury should be considered. The clinician should assess effectiveness of compensatory techniques. This method of intervention requires further empirical study to determine effectiveness and generalizability to various populations (Oud et al., 2007).

Writers' cramp, also known as *focal dystonia*, can severely limit the work-related abilities of those who write repetitively or who must frequently write through several layers of paper. Focal dystonia causes pain and cramping that can extend beyond the task of writing; it can occur in the hand whenever small graded movements are required.

The use of handwriting training and auditory grip-force feedback were supported in the reviewed study and are consistent with an occupational therapy approach (Baur et al., 2009).

A Level I study supported a more functional approach to treatment through the use of simulated ADL activities after acute injuries; these activities were found to be more effective in leading to desired outcomes than traditional exercise alone (Guzelkucuk et al., 2007).

Implications for Education

In a world of shrinking health care dollars and a call for accountability (Hubbard, 2005), therapists must create intervention plans that include approaches empirically supported in the literature and understand the appropriate use of approaches for which evidence is scant. Training occupational therapist and occupational therapy assistant students in how to find and use evidence appropriately will advance the profession by demonstrating the commitment to ensuring that best-practice methods, modalities, and techniques are consistently chosen for their contribution to positive client outcomes.

Implications for Research

Systematic reviews offer the opportunity to critically appraise contributions to the literature and to discover gaps that continue to exist. Such gaps include those related to the effects of preparatory techniques such as physical agent modalities, splints, and workplace modifications. In addition, the current literature offers little with regard to the effects of an occupation-based approach to assessment and treatment, particularly with regard to injured workers. Graduate students, practitioners, and researchers should seek to answer treatment and reimbursement concerns through sound investigation and review and analysis of the available literature; evidence-based practice is of paramount importance to clients, clinicians, and payers as well as to the profession.

Limitations

Limitations of this review include difficulty drawing general conclusions about the results from systematic reviews that were marked by a paucity of quality studies. Selection and publication bias, poor-quality studies, inadequate description of terms and treatment techniques, potential placebo effect, confounded variables, methodological limitations, potential Hawthorne effect, small sample size, brief intervention periods, poor statistical methodology, and geographical and regional differences in

variables and treatments administered were limitations in both systematic reviews and individual studies.

Conclusions

All methods of intervention discussed in this review require further investigation. Studies using larger sample sizes that consistently measure function as an outcome and address the longevity of improvements would further support the evidence put forth. Generally, this review supports the premise that client factors can be positively affected through the use of common modalities and methods. Occupation-based activities and assessments have reasonable yet limited evidence to support their effectiveness.

Scholars and graduate students of occupational therapy, in collaboration with practitioners, should design and execute empirical studies that add to the literature in the areas described in this review. In addition, practitioners must always examine their clients' unique response when using therapeutic methods and modalities and must understand that no matter how compelling, evidence must be reinforced with clinical decision making. Techniques that do not yet have supportive evidence may indeed be effective but should be used with caution and professional discretion. ▲

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*Indicates studies that were reviewed for this article but are not referred to in the text. All studies reviewed are listed in the evidence table available at www.ajot.ajotpress.net.

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