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Sensorimotor interventions and assessments for the hand and wrist: A scoping review

Kristin Valdes OTD, OT, CHT[a,b,*], Nancy Naughton OTD, OTR/L, CHT[c], Lori Algar OTD, OTR/L, CHT[d]

[a] Drexel University, Philadelphia, PA, USA
[b] Hand Works Therapy, 744 the Rialto, Venice, FL 34285, USA
[c] Professional Orthopedics Associates, Scranton, PA, USA
[d] Northeast Orthopaedic and Hand Surgery, Waterbury, CT, USA

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ABSTRACT

Study design: Scoping review.
Introduction: Sensorimotor deficits can impair function and may be present in individuals with common upper extremity conditions.
Purpose of the study: To provide clinicians with an understanding of the usefulness of the assessments to evaluate sensorimotor function and the interventions reported in the literature to effect positive change in our patients with sensorimotor deficits affecting the hand and wrist.
Methods: A systematic search produced seventeen studies involving sensorimotor retraining and assessment of sensorimotor performance for the upper extremity.
Results: Sensorimotor interventions and assessments found in the literature vary in regards to their effectiveness in restoring sensorimotor function in subjects with a number of conditions that affect hand and wrist function.
Conclusions: There is a potential value of sensorimotor interventions for individuals with specific upper extremity conditions. There is a need for further studies to improve treatment of sensorimotor deficits and understanding of sensorimotor interventions.

Introduction

Sensorimotor deficits can impair function and may be present in individuals with common upper extremity conditions. Researchers have reported sensorimotor deficits exist in patients with common upper extremity conditions such as carpal tunnel syndrome,[1] distal radius fracture,[2] and complex regional pain syndrome (CRPS).[3] Patients with lateral epicondylitis (LE) exhibit delayed reaction times and slower movement speeds[4–6] and subjects with chronic wrist pain demonstrated poorer motor control skills than healthy individuals.[7] In addition, patients with hand osteoarthritis applied unnecessary grip force[8] and required increased time to successfully manipulate objects[9] allusive to decreased sensory information in the digits.[10]

The sensory motor system

The sensorimotor system is defined as a component of the motor control system and is used to describe the physiologic integration of the neurosensory and neuromuscular processes responsible for providing the body with coordination and dynamic stability.[11–13] The sensorimotor system includes joint position sense, perception of force, and neuromuscular control mechanisms processed and integrated by the central nervous system.[14,15] Both afferent and efferent signals enter the central nervous system at the spinal level through a reflex activation or at higher levels after transmission to the brainstem and cerebral cortex.[15,16] The constant and dynamic integration and comparison between afferent and efferent data provide neuromuscular control and proprioception[17] and facilitate dynamic joint stability.[16]

Our environment requires dynamic and spontaneous interactions in order to function. We are able to manipulate objects with our vision occluded and move about in dark spaces. This ability emerges from input provided by proprioceptors. Sherrington described proprioception when he stated, “in muscular receptivity we see the body itself acting as a stimulus to its own receptor-the proprioceptors.”[18] The hand’s cutaneous sensory input provides us with the information for object recognition and sensory feedback signals from its receptors through central pathways to target areas within the brain in order to modulate precise movement and

* Corresponding author. Hand Works Therapy, 744 the Rialto, Venice, FL 34285, USA. Tel.: +1 941 927 6862; fax: +1 941 484 5510.
E-mail address: hotglassgal@comcast.net (K. Valdes).

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appropriate force control.[19] Orthopedic injuries affecting the hand may require immobilization that can result in joint stiffness, pain, and loss of feedback to mechanoreceptors of the ligaments. The injury may also include peripheral nerve injury that impairs sensory function and limits feedback to and from the sensorimotor system.

The purpose of sensorimotor training

Sensory motor training educates patients through the application of sensorimotor activities to better attend to sensory cues so that the brain can generate more appropriate motor commands, educate the patient to interpret sensory information correctly, and promote sensorimotor control of the hand.[9] Exercises prescribed during non-operative or postoperative rehabilitation and injury prevention programs meant to enhance neuromuscular control can include plyometrics, manual rhythmic stabilization, oscillations using oscillatory devices, and other techniques.

Previous research related to sensorimotor intervention for the upper extremity

There is not currently a comprehensive, summary of the evidence describing the effects of sensorimotor intervention exercises on upper extremity function. Swanik et al[20] reported that 6 weeks of shoulder plyometric training may enhance specific aspects of sensorimotor system function based on their research with female swimmers. However, Padua et al[21] reported that a similar program provided no benefit to proprioception and neuromuscular control in healthy individuals, but did improve function. Improvements in active elbow joint position sense acuity improved in healthy individuals after neuromuscular training exercises.[22]

There have been 2 systematic reviews that have synthesized the evidence regarding phase I and phase II sensory reeducation programs on hand sensibility following peripheral nerve repair.[23,24] Both reviews found limited evidence for the effectiveness of sensory reeducation following peripheral nerve injury. These reviews looked at the sole intervention of sensory reeducation techniques, which is one component of sensorimotor training.

Sensorimotor deficits are more frequently assessed and sensorimotor interventions are more commonly included in rehabilitation programs for individuals who sustained a stroke compared to those with orthopedic injuries.[25–30] However, close review of the evidence on sensorimotor training and upper extremity function for individuals with stroke reveals limited evidence specific to this topic. There is emerging evidence that somatosensory training for the hand positively influenced hand function and postural control in stroke patients.[31,32] Two systematic reviews looked at the effectiveness of mirror therapy as a sensorimotor intervention to regain motor function after stroke.[33,34] Both reviews indicated that many of the studies had methodological flaws, but they did demonstrate that mirror therapy was effective in upper limb treatment of stroke patients and patients with CRPS.

Purpose and research question

There is not currently a comprehensive summary of the evidence describing the effects of sensorimotor intervention exercises on upper extremity function. For individuals that have sensorimotor deficits it has been reported that a multi-task intervention does not isolate the effects of training on a single sensory task, and a comprehensive sensorimotor program is recommended.[35] No review has ever been performed on the topic of multi-intervention sensorimotor programs or neuromuscular interventions for the hand and wrist, which is a concern for clinicians who treat patients with functional sensorimotor deficiencies. To optimally prevent hand and wrist injuries and treat and rehabilitate injured patients, we must evaluate the capacity of sensorimotor interventions to restore or enhance sensorimotor system function and other variables impacting performance. There is currently a gap between an understanding of sensorimotor impairments and the selection of remedial strategies to improve function. The aim of this scoping review is to evaluate and summarize the evidence on the effect of sensorimotor interventions on sensorimotor outcomes in wrist and hand conditions.

Identification of the research question

The specific scoping review question is: "What is known from the existing literature about the recommended application, purpose, and effectiveness (including types of outcome measures) of sensorimotor interventions in the treatment of patients with hand and wrist sensorimotor deficits or CNS dysfunction."

Methods

Identification and selection of studies

A scoping review can be useful when emerging evidence is present but there is a lack of randomized controlled trials (RCTs).[36] A scoping review does not consider the quality of studies to be paramount, but hopes to understand the extent and level of the work that has been completed within a defined subject area.[37]

Inclusion criteria

- The document reported on a primary study that examined a sensorimotor intervention that could be performed in the clinic with readily available equipment on patients with any hand or wrist condition, clients with CNS impairments, or normal subjects.
- The study was written in English.
- Participants in the studies were adults over 18 years of age.
- All study designs were included (e.g. RCTs, quantitative studies, qualitative studies or mixed methods).
- The study was published within the past 15 years.
- Studies published up to August, 2013 were included in this review.

Exclusion criteria

- Studies were excluded if they involved interventions or special equipment not available in the average clinical practice (i.e. special machinery or robotic instrumentation).
- Studies were excluded if the sole intervention was a sensory reeducation program.
- Studies published before 1999 were excluded.

Search strategy

A computer search was conducted using the following databases: PubMed, PEDro, CINAHL, OVID, EBSCO, ProQuest Central, and ProQuest Nursing and Allied Health. The three authors (KV, NN, LA) did separate searches and discussed their findings to jointly determine if each paper identified was eligible. Bibliographies of relevant papers were searched and additional hand searches were performed to identify potential additional studies. Search terms included: wrist, hand, sensorimotor, proprioception, neuromuscular training, tactile discrimination, motor cortex, and kinesthetic.