Journal of Hand Therapy 29 (2016) 183–190

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

JHT Read for Credit Article #413.
Special Issue: Wrist

Proprioception retraining for a patient with chronic wrist pain secondary to ligament injury with no structural instability

Olga L. Hincapie PT, DPT, CHT[a,*], Jeananne S. Elkins PhD, DPT, MPH[b], Laura Vasquez-Welsh MsOT, CHT[a]

[a] NYU Langone Medical Center, Center for Musculoskeletal Care, Hand Therapy Service, New York, NY, USA
[b] Northeastern University, College of Professional Studies, Boston, MA, USA

ARTICLE INFO

Article history:
Received 20 September 2015
Received in revised form
26 February 2016
Accepted 3 March 2016

Keywords:
Carpal ligaments
Wrist
Dart-throwing motion
Proprioception retraining
Sensorimotor

ABSTRACT

Study Design: Case report.
Introduction: Previously published studies demonstrate the importance of the sensory innervation of the carpal ligaments and the implication for the sensorimotor control of the wrist. In addition, this case considers key rehabilitation concepts to include the dart-throwing motion and the stabilizing effect of the forearm muscles.
Purpose of the Study: To describe the rehabilitation program for a patient with chronic wrist pain, diagnosed with a partial tear of the dorsal intercarpal ligament and a sprain of the scapholunate ligament of the right wrist.
Methods: The patient participated in a staged treatment plan over a 3-month period (20 sessions), which began with a focus on proprioceptive awareness and joint position sense retraining. The treatment progressed to strengthening of specific muscles to enhance stability of the wrist joint. The patient completed the Quick Disabilities of the Arm, Shoulder and Hand and the patient-rated wrist evaluation on initial evaluation, re-evaluation at ninth session, and discharge at 20th session.
Results: Raw scores in the Quick Disabilities of the Arm, Shoulder and Hand and the patient-rated wrist evaluation improved from 33 and 61.5 on initial evaluation to 18 and 17.5 on discharge, respectively.
Conclusions: Sensorimotor techniques including proprioceptive retraining may improve pain, neuromuscular control, and functional outcomes in patients with chronic wrist pain due to ligament injury. The effectiveness of proprioceptive retraining needs to be evaluated in a well-designed randomized controlled trial recruiting this patient population.
Level of evidence: 5.

Introduction

A stable and pain-free wrist is foundational to performing the myriad of motions needed for daily living. For example, a stable wrist allows for grip strength for the heavy labor worker when carrying heavy loads, precision for a skilled surgeon when setting a broken bone, and a wide range of motion (ROM) for a musician when playing in a symphony. All the wrist joints (radiocarpal, midcarpal, and intercarpal) must operate seamlessly to attain maximal ROM and optimize function. The combination of wrist motion and stability (dynamic stability) provides the fundamental basis to maximize hand function and enable a wide range of tasks from precise fine motor control to power grip activities. Dynamic wrist stability is influenced by proprioceptive and neuromuscular activity.[1-3]

Proprioception is considered a subcomponent of the sensorimotor system.[4] It includes afferent information arising from receptors that contribute to postural control, joint stability, and motor control. Proprioception consists of 3 submodalities: kinesthesia, joint position sense (JPS), and sense of force or resistance.[4,5] Proprioceptive information originates from mechanoreceptors present within muscles, tendons, ligaments, and skin. From a joint stability perspective, neuromuscular control reflects the unconscious activation of dynamic restraints occurring in preparation for and in response to joint motion and loading for the purpose of maintaining and restoring functional joint stability.[4,5] Proprioceptive information is imperative for neuromuscular control. With wrist ligament injuries, in addition to the mechanical deficit, there is decreased afferent input from the mechanoreceptors, thus affecting the sensorimotor contribution to the dynamic stability of the joint.[6,7]

In the last 10 years, hand therapists have gained a better understanding of wrist biomechanics and sensory innervation of the wrist ligaments. Research by Hagert et al[8,9] revealed variations in

* Corresponding author. NYU Langone Medical Center, Center for Musculoskeletal Care, 333 East 38th Street, 5th Floor, New York, NY 10016, USA. Tel.: +1-646-501-7077; fax: +1-646-501-7235.
E-mail address: olga.hincapie@nyumc.org (O.L. Hincapie).

0894-1130/$ – see front matter © 2016 Hanley & Belfus, an imprint of Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jht.2016.03.008

the distribution of mechanoreceptors and nerve endings both within the ligament and within the joint. The dorsal and triquetral wrist ligaments (dorsal radiocarpal, dorsal intercarpal, dorsal scapholunate, palmar lunotriquetral, and triquetrocapitate/hamate) are richly innervated, whereas the radial and volar wrist ligaments have relatively little innervation.[8] This anatomic difference is associated with function: the dorsal and triquetral ligaments are sensory dynamic-stabilizing structures, and the radial and volar ligaments constrain and guide movement at the wrist joint.

Additional research has demonstrated the stabilizing effects of the forearm muscles on the carpal bones.[10] The flexor carpi radialis, flexor carpi ulnaris (FCU), and extensor carpi radialis longus (ECRL) are considered friendly muscles for the stability of the scapholunate joint, whereas the extensor carpi ulnaris is considered potentially harmful for scapholunate joint stability.[11] All the aforementioned studies emphasize the importance of proprioceptive re-education as part of the rehabilitation program for patients with wrist ligament injury.

The dart-throwing motion (DTM) is an essential concept in the rehabilitation of carpal ligament injuries and repairs. The DTM is defined as a plane in which the wrist functional oblique motion occurs from radial extension to ulnar flexion.[12] DTM occurs mostly at the midcarpal joint with minimal involvement of the radiocarpal joint.[12] It is also considered one of the most natural rotations of the wrist that can be performed with minimal muscle force.[13] Functional activities, such as hammering a nail, throwing a ball, drinking from a glass, pouring from a jug, and twisting the lid of a jar, are performed within this path of motion.[14] Biomechanical studies have also demonstrated that tensile stresses over the scapholunate ligament are minimized when performing a task along the DTM plane.[15,16] According to these kinematic findings, scapholunate joint stability can be improved by enhancing sensorimotor control in a DTM plane. Furthermore, integrating the DTM as an exercise to improve proprioceptive feedback can result in improved dynamic stability of the wrist during functional activities and prevent reinjury of the ligaments.

Retraining of proprioception is an accepted and evidence-based component of a rehabilitation program to improve the dynamic stability of the shoulder, ankle, and knee.[17-21] However, the literature is limited with regard to proprioceptive assessment and retraining for the wrist joint after a ligament injury. Karagiannopoulus et al[22] studied the magnitude of wrist and hand sensorimotor impairment after distal radius fracture. Their results demonstrated a significant JPS deficit in those patients after distal radius fracture when compared with healthy controls. Valdes et al[23] presented a scoping review regarding sensorimotor techniques for the wrist and hand. The authors concluded that there is potential value of sensorimotor interventions for individuals with specific upper extremity conditions. However, none of the aforementioned studies addressed the benefits of this approach in patients with chronic wrist pain related to carpal ligament injury.

The purpose of this case report is to examine the proprioceptive impairment in a patient with chronic wrist pain resulting from carpal ligament injury with no structural instability and describe a treatment intervention. The narrative review provided by Hagert[24] served as the foundation for the development of this 6-stage rehabilitation program described in Table 1.

Table 1
Six-stage rehabilitation program[24]

Stage of proprioception rehabilitation	Rehabilitation plan
Stage 1	Basic rehabilitation: edema, pain control, and ROM
Stage 2	Proprioception awareness
Stage 3	JPS
Stage 4	Kinesthesia
Stage 5	Conscious neuromuscular rehabilitation
Stage 6	Unconscious neuromuscular rehabilitation

ROM = range of motion; JPS = joint position sense.

Methods

Patient characteristics

A 43-year-old right-handed female was referred to hand therapy by a hand surgeon. The patient is a doctor in naturopathic medicine who actively practices acupuncture and joint manipulations on a regular basis. In addition, she practices Kuhapdo, a martial art performed with a sword.

The patient described a 6-month history of right wrist pain after a heavy hollow rod fell onto her wrist while exercising at the gym. She was initially evaluated at the emergency room of a local hospital when X-rays were negative for any type of fracture. She was treated with pain medication and immobilized in a prefabricated wrist brace for 4 weeks. The pain continued after the period of immobilization, and her physician obtained a magnetic resonance imaging (MRI) scan. The MRI identified a low-grade partial tear of the dorsal intercarpal ligament along the dorsal aspect of the wrist capsule; the scapholunate interosseous ligament appeared intact. The immobilization was then continued for an additional 6 weeks, at the end of which she attended 4 sessions of therapy with slight improvement in ROM but no improvement in pain. At this point, the patient was evaluated by a hand surgeon who referred her for hand therapy. The corresponding *International Classification of Diseases, Tenth Revision* codes for the diagnoses were S63.391 for traumatic rupture of other wrist ligament and S63.519 for possible sprain of scapholunate ligament. The latter diagnosis was made based on physical examination despite the fact that the scapholunate ligament appeared intact on the MRI.

During the initial hand therapy visit, the patient's main complaints consisted of pain and difficulty with gripping, carrying/lifting, and bearing weight on her hands. The patient's goal was to return to her previous level of pain-free wrist and hand function for ease with her daily activities.

Considering that this was a chronic case with anticipated treatment duration between 10 and 12 weeks, the patient was re-evaluated at 5 weeks (ninth visit) and at the time of discharge at 12 weeks (20th visit).

Evaluation/examination

Pain assessment

Pain status was measured via the pain subscale of the patient-rated wrist evaluation (PRWE). The PRWE is a 15-item questionnaire that is used to rate wrist outcomes based on patient pain and function and is based on an 11-point (0-10) scale. The PRWE provides a reliable and responsive measurement of wrist-related pain and function across a variety of wrist disorders. Furthermore, the individual subscales are sufficiently stable to be used as separate measures of pain, wrist-specific disability, and usual activity/role disability.[25] The pain subscale assesses frequency and intensity of pain as well as pain at rest, on repeated movements, and while lifting a heavy object (5 items). It uses a scale from 0 to 10, where 0 indicates no pain and 10 indicates the worst pain ever experienced or the inability to perform the activity because of pain. The pain score is the sum of the 5 pain items, where the best score is 0 and the worst score is 50.

Range of motion

The therapist used an EZ Read JAMAR 8-inch goniometer (Patterson Medical, Warrenville, IL, USA) to evaluate active range of