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Original Article

Physical therapy in patients with complex regional pain syndrome type I after distal radius fracture: a case series

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Abstract. [Purpose] To describe the effect of a physical therapy program in function improvement and pain reduction in patients older than 60 years with complex regional pain syndrome (CRPS) type I after distal radius fracture (DRF) treated conservatively. [Participants and Methods] Fifty-four patients received a 6 weeks physical therapy program that included in hydrotherapy, manual therapy, and exercises based on motor skill training. Two evaluations were performed, the wrist/hand function was assessed with Patient-Rated Wrist Evaluation (PRWE) questionnaire, the upper extremity function with the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, grip strength with Jamar Dynamometer, and pain intensity with the Visual Analog Scale (VAS). [Results] At the end of the treatment, PRWE showed a decrease of 30.9 points, DASH 34.7 points, and the VAS, 3.4 cm. The grip strength showed an increase of 14.4%. [Conclusion] A physical therapy program based on hydrotherapy, manual therapy, and exercises in a short term improves the function and reduces the pain in patients older than 60 years with CRPS I after DRF treated conservatively.

Key words: Complex regional pain syndrome, Distal radius fracture, Physical therapy

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INTRODUCTION

Distal radius fractures (DRF) are among the most common musculoskeletal injuries, representing 15% to 20% of total fractures treated in emergency services[1, 2)]. Epidemiologic studies have reported a high incidence in white populations, especially among elderly patients[3)]. DRF in patients older than 60 years is typically treated conservatively with closed reduction and plaster cast immobilization[4)]. The reported complication rates of DRF in the literature are highly variable, and these complications may occur from the fracture or its treatment[5)]. The loss of motion (marked deformity, decreased range of motion, finger stiffness), delayed/nonunion consolidation, and Complex regional pain syndrome (CRPS) present the highest levels of incidence[6)].

CRPS is a term coined by the International Association for the Study of Pain (IASP) to describe disorders characterized by spontaneous or stimulus-induced pain that is disproportionate to the inciting event and accompanied by a wide variety of autonomic and motor disturbances in highly variable combinations[7)]. This condition usually, but not exclusively, manifests in response to acute trauma or surgery[8)]. The IASP proposed a taxonomy and consensus-based diagnostic criteria, the umbrella term CRPS has been subdivided into type I and type II. CRPS I is intended to encompass reflex sympathetic dystrophy

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and similar disorders without a nerve injury; while CRPS II occurs after damage to a peripheral nerve[9, 10]. The diagnostic criteria originally proposed by IASP have not been widely accepted, and were shown to lack specificity and internal validity[11, 12]. The Budapest criteria[13], have enhanced diagnostic accuracy and are now widely accepted[8]. The pathophysiological mechanisms underlying CRPS are not fully understood[14]. Current understanding implicates multiple mechanisms including complex contributions from a maladaptive pro-inflammatory response and a disturbance in sympathetically mediated vasomotor control, together with maladaptive peripheral and central neuronal plasticity[14–17].

Guidelines for the treatment of CRPS I recommend an interdisciplinary multimodal approach, comprising pharmacological and interventional pain management strategies together with Physical Therapy (PT), psychological therapy and educational strategies[8, 18–20]. PT programs (therapeutic exercises, manual therapy, or physical agents) are considered the first-line treatment for CRPS I[21, 22], however its effectiveness remains unclear. One review suggests that some PT interventions may assist in the management of patients with CRPS type I, however, since numerous methodological weaknesses it was not possible to determine the effectiveness of PT[23]. One systematic review showed level II of evidence that graded motor imagery is effective in reducing pain in adults with CRPS I, and no evidence was found to support PT interventions frequently recommended in clinical guidelines[24]. Other systematic review showed that graded motor imagery and mirror therapy may provide clinically meaningful improvements in pain and function in people with CRPS I although the quality of the supporting evidence is very low. The effectiveness of other PT interventions is absent or unclear[25].

The objective of the study is to describe in the short term the effect of a PT program in function improvement and pain reduction in patients older than 60 years with CRPS type I after DRF treated conservatively.

PARTICIPANTS AND METHODS

The study was conducted in the physical therapy department at the Clinical Hospital San Borja Arriaran, with the approval of the Ethics Committee of the Central Metropolitan Health Service of Chile. The Ethics Committee of the Central Metropolitan Health Service of Chile approved the study protocol on 14 February 2017. The approval number is 048975. Between 2017 and 2018, fifty-four prospective patients over 60 years old with CRPS type I after DRF were recruited. The diagnosis was performed by a physician based on the Budapest criteria[13]. Patients with psychiatric treatment history before diagnosis with CRPS, with peripheral or central nervous system lesions affecting the upper limb, and with cardiac, pulmonary or neurological diseases, were excluded.

Under prior informed consent, two evaluations were performed, one at the beginning of the treatment and the other on week 6, at the end of the PT program. In these assessments, the wrist/hand function was evaluated with the Patient-Rated Wrist Evaluation (PRWE) questionnaire[26], the upper extremity function with the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire[27], grip strength with Jamar Dynamometer[28], and pain intensity with the Visual Analog Scale (VAS)[29].

All patients received a PT program consisted of 15 minutes of active wrist and hand exercises in a whirlpool at a temperature of 34°C[30]. Then, joint mobilization was applied to the radiocarpal joint. During the first 2 weeks, participants received grade II or III of Maitland techniques, at a dose of 1 cycle per second for 1 minute. In the remaining 4 weeks, sustained grade I gliding Kaltenborn method was performed in both anteroposterior and posteroanterior directions, in a neutral position with the distal radius stabilized. Treatment then progressed to incorporate the end of range movement with the mobilization grade II technique[31, 32]. The applied dose was left to the discretion of the physical therapist but based on examined findings and the patient's tolerance. Finally, exercises based on motor skill training were prescribed to reorganize cortical plasticity and achieve motor learning[33–35]. Three specific exercises were performed: (1) controlled grip strength exercise with visual pressure biofeedback; (2) a reverse dart-throwing exercise with precision of the first interosseous space; and (3) a scapular retraction exercise. To avoid pain and muscle fatigue, patients were doing short duration and low- intensity exercises. The dose was 8–10 times for each exercise, maintaining the task for 5 seconds with 10–30 seconds of rest in between. The program consisted of 12 sessions, 2 times a week, and approximately 1-hour-long session[36].

All collected data were entered into the Excel for tabulation, and the statistical analysis was performed with the Stata 11.0 program. The quantitative variables are presented as a mean and standard deviation (SD). To determine the statistical tests to be used to analyze the data, normal distribution was first evaluated with the Shapiro-Wilk test. To perform the comparison of the data pre and post treatment for the PRWE, DASH, grip strength, and VAS variables, the t-test or the Mann-Whitney test was used. A value of $p<0.05$ was accepted as statistically significant.

RESULTS

The results of the basal characteristics of the group studied are presented in Table 1. During the study there were no losses or withdrawals, and at the end of the PT program no patient informed of complications associated to the treatment received.

At the moment of analyzing the normality hypothesis with the Shapiro-Wilk test, this was rejected for the grip strength and VAS variables ($p<0.05$). In accordance with this, the t-test was used to carry out the comparison of the PRWE and DASH variables, and the Mann-Whitney test was used for the grip strength and VAS variable. Table 2 shows the values of the evaluated variables pre and post PT treatment, and the effect of the treatment. For the functional variables, the PRWE showed

Table 1. Baseline characteristics of patients with CRPS I after DRF treated conservatively

Variables	Patients with CRPS I (n=54)
Gender female, number (%)	46 (85.2)
Age (years), mean ± SD	65.3 ± 3.9
Symptoms duration (weeks), mean ± SD	5.5 ± 1.2
Dominant hand affected, number (%)	40 (74.1)

CRPS: Complex Regional Pain Syndrome; DRF: Distal Radius Fracture; SD: Standard Deviation.

Table 2. Comparison of the results between baseline and the 6th week

Variables	Baseline (mean ± SD)	At 6th week (mean ± SD)	Difference (mean ± SD)	CI 95% difference	p value
PRWE (0–100 points)	68.7 ± 10.5	35.6 ± 15.8	30.9 ± 13.7	40.6–20.2	0.00 †
DASH (0–100 points)	70.8 ± 6.5	35.3 ± 13.4	34.7 ± 13.4	43.1–24.4	0.00 †
Grip strength (*) (0–100 %)	18.8 ± 13.5	32.2 ± 23.5	14.4 ± 12.1	22.3–1.5	0.18 ‡
VAS (0–10 cm)	7.6 ± 0.97	3.8 ± 1.5	3.4 ± 1.1	4.4–2.8	0.00 ‡

SD: Standard Deviation; CI 95%: Confidence Intervals 95%; PRWE: Patient-Rated Wrist Evaluation questionnaire; DASH: Disabilities of the Arm, Shoulder and Hand questionnaire; (*): The result was expressed as a percentage relative to the unaffected side; VAS: Visual Analog Scale.
† p value: obtained with Student's t-test for dependent samples.
‡ p value: obtained with the Mann-Whitney test for dependent samples.

a decrease of 30.9 points (p=0.000), and the DASH 34.7 points (p=0.000). For the pain the VAS showed a decrease of 3.4 cm (p=0.000), and the grip strength showed an increase of 14.4% (p=0.185).

DISCUSSION

This study was aimed to describe the effect of PT program in function improvement and pain reduction in patients older than 60 years with CRPS I after DRF. Our results showed that in the short term a PT program that included hydrotherapy, manual therapy, and exercises based on motor skill training improved significantly the wrist/hand and upper extremity function, and pain relief, but not a significant increase in grip strength.

Epidemiological studies have reported that 37 to 58% of persons undergoing closed treatment and cast immobilization following DRF go on to develop CRPS type I[37, 38]. The demographic data of the patients included in our study are similar to those described in the literature. The women are 5.8 times more likely than men to develop CRPS after DRF, and the persons who sustain low to medium energy impact DRF are 7.7× more likely to develop CRPS than those who sustain high impact fractures[39]. In relation to the duration of symptoms, in a prospective study CRPS type I arose most frequently at the third or fourth week after the cast removal, especially in women with severe pain and impairment of physical QOL[39]. The risk factors of CRPS I are multifactorial, a recent systematic review on potential risk factors for the onset of CRPS I showed that being female (particularly postmenopausal), ankle intra-articular fractures, distal radius fractures, immobilization, and intense pain in the early phases after trauma are risk factors for the onset[40].

Since the pathophysiological mechanisms of CRPS are essentially unknown and the mechanisms are likely to differ between individual patients, treatment of these disorders is based on trial and error[7]. In our study, we applied a standardized PT program used in patients older than 60 years with DRF extraarticular without immediate complications[36]. All patients began with 15 minutes of active wrist and hand exercises in a whirlpool, we used thermoneutral water immersion (34 °C), which decreases the activity of the sympathetic nervous system, and when combined with the effects of hydrostatic pressure, helps reduce edema and pain perception[30]. In addition, performing active movements in a pain- free range of motion, and in a comfortable environment for the patient, decreases associated reactive and/or evasive behavior as a means of self-protection, thereby reducing the apprehension of movement in the affected area[36]. Then, joint mobilization was used taking as reference the study of Coyle et al.[31], they showed that in the first 2 weeks of treatment, when pain levels are high, the oscillatory techniques are better tolerated and more effective in pain relief and increase wrist function. From week number 3, when pain levels are lower, mainly at rest, the sustained gliding techniques are more effective.

The current evidence supports sensorimotor system alterations as the most clinically relevant impairment after DRF[41]. These deficits have been suggested to result from cortical reorganization, which would be influentially associated with persistent and recurrent pain[33, 42], and have been significantly correlated with poor results in reported functionality and disability[43]. The gradual reintroduction of functional activity using therapeutic exercise with a focus on graduated corticomotor

retraining is founded on the neurophysiology of motor learning[33]. The conscious and voluntary learning of specific motor skills, such as control of scapular retraction, gradual wrist prehensile activity, and subtle manual skills require precision, decreasing the fear of the perceived threat of pain, reducing local rigidity, and modifying the cortical representation of the musculature affected by trauma[33, 35, 42]. This standardized PT program at short- and medium term reduced pain and improved function in patients with DRF extraarticular without complications[36].

There are few studies regarding the effect of PT program in patients with CRPS I after DRF. One randomized clinical trial (RCT) showed that pulsed electromagnetic field treatment does not provide additional benefit to calcitonin and exercise in forty patients with CRPS I after Colles Fracture[44]. Other RCT showed that a six weeks program of graded motor imagery is more effective than usual physiotherapy plus medical management in reducing pain in patients with CRPS after wrist fracture[45]. The last RCT showed that the order in which the components of graded motor imagery are presented affect the magnitude of pain reduction, with laterality recognition followed by imagined movements and mirror movements producing the greatest pain reduction in patients with CRPS after wrist fracture[46].

Regarding our results, the PRWE questionnaire showed a statistically significant decrease, and the difference of 30.9 points is considered a minimal clinically important difference[47]. The DASH questionnaire showed a statistically significant decrease, and the difference of 34.7 points also is the minimum clinically important difference[48]. For the intensity of pain the VAS showed a clinically and statistically significant decrease. The grip strength is the only variable that did not show statistically significant changes at the end of the PT program, despite the increase of 14.4%, these results suggest that while hand strength can improve in patients with CRPS I after DRF, many of these patients do not achieve normal strength at the end of a 6-week intervention.

This study has several limitations. Since it is a descriptive study it does not have a control group, neither was a randomized sample strategy used to select the patients. And also a follow-up was not considered to evaluate the results in the long term. In summary, a PT program based on hydrotherapy, manual therapy, and exercises based on motor skill training in a short term improves the function and reduces the pain in patients older than 60 years with CRPS I after DRF treated conservatively.

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Conflict of interest

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