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CLINICAL MANAGEMENT: CRPS

Complex regional pain syndrome—2: physical therapy management

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Abstract Part I of this article reviewed the history, etiology and underlying mechanisms of CRPS I and II. The current article reviews the available research of physical therapy treatment interventions for patients with CRPS. As outlined in Part 1 of this article, there continues to be much uncertainty about the underlying mechanisms of CRPS. It remains challenging to develop evidence-based guidelines for physical therapy or for any other discipline. There is a paucity of prospective randomized clinical trials. The majority of published reports are case reports or consensus-based. Although the article is written primarily from a physical therapy perspective, the clinical guidelines are also of interest to other health care providers. Given the complexity and scope of CRPS, an interdisciplinary management approach is recommended.
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Introduction

The available literature on physical therapy management of persons with CRPS is mainly case-report-based or consensus-based. Few prospective randomized clinical trials have been reported. Although randomized clinical trials are widely used to evaluate clinical practice and commonly accepted as ''hard evidence'', they may not necessarily be the only or even preferred methodology to evaluate the efficacy of clinical approaches (Gatchel and McGeary, 2002; Moore and Petty, 2001). Moore and colleagues have proposed a 5-grade hierarchy of evidence ranging from randomized clinical trials to clinical expertise with each level contributing to the development of evidence-based management (see Box 1) (Moore et al., 1995).

There are many other problems in evaluating the current physical therapy literature on CRPS. Even though two major IASP conferences were devoted to CRPS, subsequent conference publications did not provide any direction for treatment. Apparently, the experts in CRPS are still more concerned about the underlying mechanisms of CRPS and do not yet focus on intervention and management (Harden et al., 2001; Jänig and Stanton-Hicks, 1996). As long as there is so much uncertainty about the underlying mechanisms of CRPS and the role of various peripheral, central, and other perpetuating and contributing factors, it remains challenging to develop evidence-based guidelines for physical therapy or for any other discipline. The lack of specificity of the IASP criteria makes it even more difficult to determine any new treatment

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Box 1 Five-grade hierarchy of evidence (Moore et al., 1995).

Grade 1:	Strong evidence from at least one systematic review of multiple well-designed randomized controlled trials.
Grade 2:	Strong evidence from at least one properly designed randomized controlled trial of appropriate size.
Grade 3:	Evidence from well-designed trials without randomization, single group pre-post, cohort, time series or matched case-controlled studies.
Grade 4:	Evidence from well-designed non-experimental studies from more than one center or research group.
Grade 5:	Opinions of respected authorities, based on clinical evidence, descriptive studies or reports of expert committees.

approaches targeted at particular pain mechanisms (Bruehl et al., 1999; Galer et al., 1998; Harden et al., 1999).

In addition, it is difficult to compare various physical therapy studies as frequently, they do not describe which criteria were used in the determination of CRPS. Some studies use the IASP criteria, while others use Veldman's criteria developed in the Netherlands, or do not include any criteria (Veldman et al., 1993). The majority of studies failed to satisfy the IASP criteria and used vague sensory and autonomic criteria without including any motor features (Reinders et al., 2002; van de Beek et al., 2002). Differences were also found between the trials in inclusion/exclusion criteria, treatment methods, duration of treatments and trials, and measurement instruments (Perez et al., 2001). In summary, there are no randomized controlled studies evaluating physical therapy treatment regimens for CRPS. The American Physical Therapy Association suggests nevertheless that 80% of patients are expected to achieve the desired level of functioning in 3–36 visits (American Physical Therapy Association, 2001). Treatment of individual patients remains empiric and uses symptomatic techniques that may seem logical or that may have been proven to be effective in other conditions. Given the complexity of the syndrome, an interdisciplinary team approach is recommended (De la Calle-Reviriego 2000; Wilson, 1997, 1999).

Patient studies

In spite of interdisciplinary or multidisciplinary approaches, several multiple-case studies have suggested that up to 38% of patients with CRPS showed no improvement and continued to have persistent dysfunction (Patman et al., 1973; Subbarao and Stillwell, 1981; Wilder et al., 1992). In a study by Galer and colleagues, most patients described no overall improvement or worsening of symptoms over time (Galer et al 2000). Of patients referred to specialized health care centers, about 7% developed severe and unresponsive muscle contractions leading to severe incapacity (Schwartzman, 2000; van Hilten et al., 2000). Several case studies describe failed treatments for individuals with CRPS (Fox et al., 2001; Schmid et al., 2002). Zyluk analysed the reasons for poor treatment response of CRPS and concluded that poor outcomes were seen mainly in patients with duration of CRPS of more than 12 months, in patients with more advanced dysfunction, and in cases with coexisting nerve injuries or compression from the initial injury (Zyluk, 2002). The overall effectiveness of treatment remains difficult to determine based on the current literature, as illustrated by the following physical therapy case reports and studies (Forouzanfar et al., 2002).

Case reports

Menck and colleagues presented an interesting upper extremity trauma case study of a 38-year old woman diagnosed with upper extremity CRPS I after open reduction internal fixation surgery with Kirschner wires placed in several carpal and metacarpal bones (Menck et al., 2000). After 3 weeks of immobilization, several weeks of occupational therapy, and active and passive range of motion exercises, the patient underwent a second surgery to remove the Kirschner wires. The patient was referred to physical therapy, which she discontinued later because of pain after she accidentally hit her hand. Five months after the initial injury, the patient was diagnosed with CRPS I and referred again to physical therapy. While the patient received several physical therapy interventions to reduce pain and edema, the authors noted significant improvements particularly following thoracic spine mobilizations with a reduction of pain and edema, and improvements in skin color,

range of motion, and of course, thoracic spine mobility. The authors speculated that the improvements could be due to neurogenic stimulation to the sympathetic nervous system, relief of pressure to the sympathetic trunk, reduction of thoracic zygopophyseal referred pain, reflexive inhibition of muscle guarding, and possibly a placebo effect.

Several others have suggested that sympathetic dysfunction can be managed by applying specific movements and mobilizations to the thoracic spine and more specifically to the sympathetic chain and ganglia, however, there is again little evidence of such assumed specificity of spinal mobilizations. It is more likely that such maneuvers have a more general effect on the entire nervous system (Slater et al., 1994; Vicenzino et al., 1999). Menck and colleagues recommended to include an evaluation of thoracic spine mobility in patients with CRPS (Menck et al., 2000). Muramatsu and colleagues also reported satisfactory results with manipulative therapy in 15 out of 17 patients (Muramatsu et al., 1998). Hareau described the treatment parameters of 150 patients with CRPS (Hareau, 1996). Neither study included a control group. As with all case studies, while the findings may be interesting, thought provoking, and hopefully stimulating for future research, the reports are nevertheless anecdotal and it is not possible to draw any definitive conclusions. Lampen–Smith suggested that massage therapy could promote a reduction in pain and improvement of the local circulation and lymphatic flow (Lampen-Smith, 1997). Uher and colleagues compared a group of patients who received physical therapy emphasizing exercise with a group who received the same physical therapy with the addition of manual lymph drainage (Uher et al., 2000). No differences were found between the two groups. This study did not include a control group.

Randomized controlled studies

Lee and colleagues conducted a prospective randomized single blind trial of physical therapy and cognitive behavioral therapy for children and adolescents with CRPS (Lee et al., 2002). Patients were seen either once per week or three times per week in physical therapy combined with weekly sessions of cognitive behavioral therapy. Physical therapy treatments were individualized for each patient and included transcutaneous electrical nerve stimulation, progressive weight bearing, tactile desensitization, massage, and contrast baths. Although there were no noticeable differences between the two physical therapy groups, 89% of all patients reported excellent improvement in functional status. The lack of a control group and the design of the study combining two intervention techniques make it impossible to draw any conclusions regarding the efficacy of physical therapy alone.

A frequently cited prospective randomized controlled clinical study of patients with CRPS I of less than one year of duration, indicated that physical therapy was superior to occupational therapy (Oerlemans et al., 1999, 2000, 2002). Both physical and occupational therapy were superior to social work intervention. Interestingly, no significant differences were found for active range of motion of the shoulder, elbow, and forearm between physical therapy, occupational therapy, and social work. Range of motion of the wrist, fingers, and thumb improved significantly more with physical and occupational therapy, however, the improvements were not significant over a year after inclusion in the study. The authors suggested that physical and occupational therapy could facilitate a return to normal mobility in an early stage of recovery. The physical therapy program emphasized control over pain, avoidance of exacerbations of pain, close observations of responses to activity, and frequent exercise within these parameters. The authors recognized the difficulty with a single-blinded study design and acknowledged difficulty with controlling the internal validity of the study (Oerlemans et al., 1999, 2000, 2002). Nevertheless, this study is probably the best study to date supporting physical therapy intervention for patients with CRPS I of less than 1 year of duration. Another report from the same research group suggested that physical therapy intervention was also a cost effective treatment option (Severens et al., 1999).

Kemler and colleagues extrapolated predictors for successful use of physical therapy in patients with chronic CRPS I from a previous study of the efficacy of spinal cord stimulation (Kemler et al., 2000, 2001). In the original study, patients in both the experimental and control group received physical therapy. Given the study design, no conclusions can be drawn about the efficacy of physical therapy for patients with chronic CRPS I. The study did not include a control group. Instead, the authors attempted to identify the specific parameters of patient subgroups to predict outcomes, however, without a control group, there is little validity to this study (Kemler et al., 2001).

In summary, there is a severe lack of research studies that substantiate the use of physical therapy for the treatment of patients with CRPS. In reviewing the physical therapy literature, it is

obvious that most interventions have been attempted without strong evidence, including transcutaneous electrical nerve stimulation (TENS), ultrasound, other electrotherapeutic modalities, biofeedback, splinting, massage, mobilizations, and exercise. Yet, many authors emphasized that physical therapy is one of the most important components of the treatment plan (Harden, 2000; Kemler et al., 2001; Lee and Kirchner, 2002; Rho et al., 2002; Stanton-Hicks et al., 1998; Viel et al., 1999; Weber et al., 2002). The American Physical Therapy Association suggested that physical therapy intervention can improve the function of 80% of patients in its consensus based Guide to Physical Therapy Practice (American Physical Therapy Association, 2001).

Clinical recommendations

Even though there is little or no scientific evidence of the efficacy of physical therapy intervention for patients with CRPS, there are several indications that physical therapy may nevertheless be helpful. Physical therapists focus on impairments, functional limitations, and disability (see Box 2) (American Physical Therapy Association, 2001). Physical therapy deals with movement dysfunction, which implies that potentially physical therapy should be a significant part of the treatment approach of patients with CRPS. Most patients with CRPS experience movement dysfunction and motor abnormalities, even though motor dysfunction is not included in the current diagnostic criteria for CRPS (Galer and Harden, 2001; Schwartzman and Kerrigan, 1990). The most common motor abnormalities include decreased range of motion, physiological tremors, decreased muscle strength, poor posture, and hemi-sensory neglect. Veldman and colleagues found that 95% of patients had weakness of the involved limb, 54% had muscular incoordination, and 49% had tremors (Veldman et al., 1993). Stutts suggested that many patients with CRPS present with dysfunctional postures and postulated that a significant number of these patients may be misdiagnosed with CRPS (Stutts et al., 2000). Rashiq and Galer reported that 65% of their patient sample had motor abnormalities (Rashiq and Galer, 1999). In a survey study of 242 patients with CRPS, 84% of the respondents reported having at least one neglect symptom, while 47% indicated they had both "cognitive" and "motor" neglect symptoms. Motor neglect constituted akinesia, bradykinesia, deficits in movement amplitude, and reduced frequency of movement; cognitive neglect implied that the patient had disowned the involved body part (Galer, 2000; Galer and Jensen, 1999). Researchers from Kiel University Hospital in Germany have quantified several motor abnormalities in patients with CRPS (Schattschneider et al., 2001; Wenzelburger et al., 2001). Interestingly, Verdugo and Ochoa found movement disorders only in persons with CRPS I and not in persons with CRPS II. They proposed that the movement disorders were "consistently of somatoform or malingered origin" as they were not able to demonstrate any neurological deficits and abnormalities (Verdugo and Ochoa, 2000). On the other hand, Ciccone and colleagues found no significant differences in psychological dysfunction between patients with CRPS and patients with chronic low back pain (Ciccone et al., 1997). Harden and colleagues have proposed revised criteria for CRPS that include changes in range of motion, motor dysfunction, and trophic changes (Harden et al., 1999).

There is general consensus that early physical therapy intervention is critical to avoid many of the complications associated with CRPS of longer duration, including immobilization and mechanical allodynia (Harden, 2000; Kemler et al., 2001; Lee and Kirchner, 2002; Rho et al., 2002; Stanton-Hicks et al., 1998). However, Scheele and colleagues remarked that there is no convincing clinical evidence in support of early intervention, partially due to patient selection bias. In studies of early intervention, it is practically inevitable that only patients with a mild form of CRPS will be included,

Box 2 Definitions of impairment, functional limitation and disability (American Physical Therapy Association, 2001).

An impairment is defined as "the loss or abnormality of anatomical, physiological, mental, or psychological structure or function."
A functional limitation is defined as "the restriction of the ability to perform a physical action, task, or activity in an efficient, typically expected, or competent manner at the level of the whole person."
A disability is "the inability to perform or a limitation in the performance of actions, tasks, and activities usually expected in specific social roles that are customary for the individual or expected for the person's status in a specific sociocultural context and physical environment."

given the gradual development of the severity of the syndrome (Scheele et al., 2002). Because of the lack of definitive studies, any guidelines for physical therapy intervention are somewhat speculative (Thacker and Gifford, 2002).

Irrespective of the medical diagnosis, chronic pain patients' beliefs and expectations about pain and their futures are strongly correlated with their behaviors, their attitude toward physical therapy intervention, their attendance, their compliance with exercise programs, and their willingness to explore new avenues (Hellstrom et al., 2000; Jensen et al., 1999; Turk and Okifuji, 1999). Stanton-Hicks and colleagues expressed that a prerequisite for any CRPS therapy program is the development of a therapeutic relationship (Stanton-Hicks et al., 1998). With an established therapeutic relationship, physical therapists can incorporate methods that will improve patients' self-efficacy by down regulating the positive feedback loop that exists when chronic pain result in secondary symptoms (Bandura et al., 1987, 1988). Many patients with chronic pain develop kinesiophobia or fear-avoidance (Crombez et al., 1999; Vlaeyen and Crombez, 1999; Vlaeyen and Linton, 2000). Physical therapy plays an important role in overcoming kinesiophobia and facilitating active movement. Aggressive mobilizations and strengthening programs should be avoided as they may contribute to the development and maintenance of kinesiophobia. The interaction between pain severity, pain-related fear and kinesiophobia is critical for understanding the complexity of persons with chronic pain syndromes, including CRPS. There is even evidence that pain-related fear can be more disabling than pain itself (Crombez et al., 1999). Individualizing the physical program is important as patients present with different impairments and functional limitations. At the same time it is important to realize that patients with chronic pain conditions have different patterns of experiencing and adapting to their pain conditions (Eccleston et al., 2001; Turk and Rudy, 1988). Through systematic interventions, the degree of pain-related fear and pain catastrophizing can be reduced (Vlaeyen et al., 2002).

Several authors emphasized that early in the treatment program, physical therapists should evaluate patients for the presence of active myofascial trigger points (MTrPs) (Allen et al., 1999; Harden, 2000; Imamura et al., 1997; Rashiq and Galer, 1999; Stanton-Hicks et al., 1998). Again, Rashiq and Galer asserted that the treatment of myofascial pain syndrome (MPS) in patients with CRPS should precede any other interventions (Rashiq and Galer, 1999). Treatment of MTrPs cannot only improve range of motion, it can also reduce local and referred pain complaints by direct inactivation of MTrPs, through correction of the mechanical factors that produced it, or through improvement in the underlying medical disorders that predispose to the development or maintenance of the MTrP (Gerwin and Dommerholt, 2002).

Physical therapy should include gentle range of motion exercises within patients' tolerance levels. Splint therapy that results in immobilization of the involved is generally contraindicated, except in those cases where stabilization of a fracture is necessary. In select cases, dynamic splinting may be used. Frequently, desensitization exercises or pharmacologic interventions are indicated prior to any active mobilizations. Gradually increasing range of motion, strength and flexibility are important parameters to eventually improve or restore functionality. Aquatic physical therapy may be useful to stimulate weight bearing for patients with lower extremity CRPS. Posture correction may be necessary (Stutts et al., 2000). Wu and colleagues compared the effects of qigong on patients with CRPS I and found that 91% of qigong patients reported analgesia compared to 36% of control patients at the end of the study protocol consisting of six 40 min qigong sessions over 3 weeks, with reevaluation at 6 and 10 weeks (Wu et al., 1999). Electrotherapeutic modalities, such as TENS, have been used, but there is no consensus regarding their efficacy. Electrotherapy may in fact cause more symptoms in patients with mechanical allodynia through stimulation of large myelinated A_fibers (Thacker and Gifford, 2002).

Conclusions

Considering the number of unanswered questions, it should come as no surprise that there is a profound lack of clinical studies that support the efficacy of physical therapy interventions. In this sense, the physical therapy management of patients with CRPS mimics most other conditions, for which physical therapy interventions remain empiric and symptom-based. There is much to be done in basic research and in the clinical applications. In the mean time, physical therapy appears to be a useful adjunctive therapy approach for patients with CRPS, particularly within an interdisciplinary setting. Physical therapy should include at least gentle range of motion exercises, inactivation of myofascial trigger points, desensitization interventions, aquatic physical therapy, posture training, and movement retraining.

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References

Allen, G., Galer, B.S., Schwartz, L., 1999. Epidemiology of complex regional pain syndrome: a retrospective chart review of 134 patients. Pain 80 (3), 539–544.

American Physical Therapy Association, 2001. Guide to physical therapy practice, 2nd Edition. Physical Therapy 81, 9–744.

Bandura, A., Cioffi, D., Taylor, C.B., et al., 1988. Perceived self-efficacy in coping with cognitive stressors and opioid activation. Journal of Personal and Social Psychology 55 (3), 479–488.

Bandura, A., O'Leary, A., Taylor, C.B., et al., 1987. Perceived self-efficacy and pain control: opioid and nonopioid mechanisms. Journal of Personal and Social Psychology 53 (3), 563–571.

Bruehl, S., Harden, R.N., Galer, B.S., et al., 1999. External validation of IASP diagnostic criteria for complex regional pain syndrome and proposed research diagnostic criteria. International Association for the Study of Pain. Pain 81 (1–2), 147–154.

Ciccone, D.S., Bandilla, E.B., Wu, W., 1997. Psychological dysfunction in patients with reflex sympathetic dystrophy. Pain 71 (3), 323–333.

Crombez, G., Vlaeyen, J.W., Heuts, P.H., et al., 1999. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. Pain 80 (1–2), 329–339.

De la Calle-Reviriego, J.L., 2000. Sindrome de dolor regional complejo: la necesidad de un planteamiento multidisciplinar. Revista de Neurologia 30 (6), 555–561.

Eccleston, C., Crombez, G., Aldrich, S., et al., 2001. Worry and chronic pain patients: a description and analysis of individual differences. European Journal of Pain 5 (3), 309–318.

Forouzanfar, T., Koke, A.J., van Kleef, M., et al., 2002. Treatment of complex regional pain syndrome type I. European Journal of Pain 6 (2), 105–122.

Fox, I.M., Domsky, R., Frank, M.J., 2001. Complex regional pain syndrome: a report of two cases recalcitrant to usual treatment protocols. Journal of Foot and Ankle Surgery 40 (4), 232–235.

Galer, B.S., 2000. Hemisensory impairment in patients with complex regional pain syndrome. Pain 84 (1), 113.

Galer, B.S., Bruehl, S., Harden, R.N., 1998. IASP diagnostic criteria for complex regional pain syndrome: a preliminary empirical validation study. International association for the study of pain. Clinical Journal of Pain 14 (1), 48–54.

Galer, B.S., Harden, R.N., 2001. Motor abnormalities in CRPS: a neglected but key component. In: Harden, R.N., Baron, R., Jänig, W. (Eds.), Complex Regional Pain Syndrome, Vol. 22. IASP Press, Seattle, pp. 135–140.

Galer, B.S., Henderson, J., Perander, J., et al., 2000. Course of symptoms and quality of life measurement in complex regional pain syndrome: a pilot survey. Journal of Pain and Symptom Management 20 (4), 286–292.

Galer, B.S., Jensen, M., 1999. Neglect-like symptoms in complex regional pain syndrome: results of a self-administered survey. Journal of Pain and Symptom Management 18 (3), 213–217.

Gatchel, R.J., McGeary, D., 2002. Cochrane collaboration-based reviews of health-care interventions: Are they unequivocal and valid scientifically, or simply nihilistic? Spine Journal 2, 315.

Gerwin, R.D., Dommerholt, J., 2002. Treatment of myofascial pain syndromes. In: Weiner, R. (Ed.), Pain Management; A Practical Guide for Clinicians. CRC Press, Boca Raton, pp. 235–249.

Harden, R.N., 2000. A clinical approach to complex regional pain syndrome. Clinical Journal of Pain 16 (2 Suppl), S26–32.

Harden, R.N., Baron, R., Jänig, W., 2001. Complex Regional Pain Syndrome. IASP Press, Seattle.

Harden, R.N., Bruehl, S., Galer, B.S., et al., 1999. Complex regional pain syndrome: are the IASP diagnostic criteria valid and sufficiently comprehensive? Pain 83 (2), 211–219.

Hareau, J., 1996. What makes treatment for reflex sympathetic dystrophy successful? Journal of Hand Therapy 9 (4), 367–370.

Hellstrom, C., Jansson, B., Carlsson, S.G., 2000. Perceived future in chronic pain: the relationship between outlook on future and empirically derived psychological patient profiles. European Journal of Pain 4 (3), 283–290.

Imamura, S.T., Lin, T.Y., Teixeira, M.J., et al., 1997. The importance of myofascial pain syndrome in reflex sympathetic dystrophy or complex regional pain syndrome. In: Fischer, A.A. (Ed.), Myofascial Pain; Update in Diagnosis and Treatment, Vol. 8. W.B. Saunders Company, Philadelphia, pp. 207–211.

Jänig, W., Stanton-Hicks, M. (Eds.). 1996. Reflex Sympathetic Dystrophy: A Reappraisal. Progress in Pain Research and Management. IASP Press, Seattle.

Jensen, M.P., Romano, J.M., Turner, J.A., et al., 1999. Patient beliefs predict patient functioning: further support for a cognitive-behavioural model of chronic pain. Pain 81 (1-2), 95–104.

Kemler, M.A., Barendse, G.A., van Kleef, M., et al., 2000. Spinal cord stimulation in patients with chronic reflex sympathetic dystrophy. New England Journal of Medicine 343 (9), 618–624.

Kemler, M.A., Rijks, C.P., de Vet, H.C., 2001. Which patients with chronic reflex sympathetic dystrophy are most likely to benefit from physical therapy? Journal of Manipulative and Physiological Therapeutics 24 (4), 272–278.

Lampen-Smith, R.A., 1997. Complex regional pain syndrome I (RSD) and the physiotherapeutic intervention. New Zealand Journal of Physiotherapy 4, 19–23.

Lee, B.H., Scharff, L., Sethna, N.F., et al., 2002. Physical therapy and cognitive-behavioral treatment for complex regional pain syndromes. Journal of Pediatrics 141 (1), 135–140.

Lee, K.J., Kirchner, J.S., 2002. Complex regional pain syndrome and chronic pain management in the lower extremity. Foot and Ankle Clinics 7 (2), 409–419.

Menck, J.Y., Requejo, S.M., Kulig, K., 2000. Thoracic spine dysfunction in upper extremity complex regional pain syndrome type I. Journal of Orthopedic and Sports Physical Therapy 30 (7), 401–409.

Moore, A., McQuay, H., Gray, J.A.M., 1995. Evidence-based everything. Bandolier 1 (12), 1.

Moore, A., Petty, N., 2001. Evidence-based practice—getting a grip and finding a balance. Manual Therapy 6 (4), 195–196.

Muramatsu, K., Kawai, S., Akino, T., et al., 1998. Treatment of chronic regional pain syndrome using manipulation therapy and regional anesthesia. Journal of Trauma 44 (1), 189–192.

Oerlemans, H.M., Oostendorp, R.A., de Boo, T., et al., 1999. Pain and reduced mobility in complex regional pain syndrome I: outcome of a prospective randomised controlled clinical trial of adjuvant physical therapy versus occupational therapy. Pain 83 (1), 77–83.

Oerlemans, H.M., Oostendorp, R.A., de Boo, T., et al., 2000. Adjuvant physical therapy versus occupational therapy in patients with reflex sympathetic dystrophy/complex regional pain syndrome type I. Archives of Physical Medicine and Rehabilitation 81 (1), 49–56.

Oerlemans, H.M., Oostendorp, R.A., Severens, J.L., et al., 2002. Gunstig effect van adjuvante fysiotherapie en in mindere mate van ergotherapie vergeleken met maatschappelijk werk bij posttraumatische dystrophie van één bovenste extremiteit: een gerandomiseerd gecontroleerd klinisch onderzoek. Nederlands Tijdschrift voor Geneeskunde 146 (19), 895–902.

Patman, R.D., Thompson, J.E., Persson, A.V., 1973. Management of post-traumatic pain syndromes: report of 113 cases. Annals of Surgery 177 (6), 780–787.

Perez, R.S, Kwakkel, G., Zuurmond, W.W., et al., 2001. Treatment of reflex sympathetic dystrophy (CRPS type 1): a research synthesis of 21 randomized clinical trials. Journal of Pain and Symptom Management 21 (6), 511–526.

Rashiq, S., Galer, B.S., 1999. Proximal myofascial dysfunction in complex regional pain syndrome: a retrospective prevalence study. Clinical Journal of Pain 15 (2), 151–153.

Reinders, M.F., Geertzen, J.H., Dijkstra, P.U., 2002. Complex regional pain syndrome type I: use of the International Association for the Study of Pain diagnostic criteria defined in 1994. Clinical Journal of Pain 18 (4), 207–215.

Rho, R.H., Brewer, R.P., Lamer, T.J., et al., 2002. Complex regional pain syndrome. Mayo Clinic Proceedings 77 (2), 174–180.

Schattschneider, J., Wenzelburger, R., Deuschl, G., et al., 2001. Kinematic analysis of the upper extremity in CRPS. In: Harden, Baron, R.N., Jänig, R. (Eds.), Complex Regional Pain Syndrome, Vol. 22. IASP Press, Seattle, pp. 119–127.

Scheele, P., Oerlemans, H.M., Verbeek, A.L., et al., 2002. Posttraumatische dystrofie: vraagtekens bij het nut van een vroege aanpak. Nederlands Tijdschrift voor Geneeskunde 146 (30), 1402–1406.

Schmid, C., Tjan, T.D., Scheld, H.H., 2002. Severe complex regional pain syndrome type II after radial artery harvesting. Annals of Thoracic Surgery 74 (4), 1250–1251.

Schwartzman, R.J., 2000. New treatments for reflex sympathetic dystrophy. New England Journal of Medicine 343 (9), 654–656.

Schwartzman, R.J., Kerrigan, J., 1990. The movement disorder of reflex sympathetic dystrophy. Neurology 40 (1), 57–61.

Severens, J.L., Oerlemans, H.M., Weegels, A.J., et al., 1999. Cost-effectiveness analysis of adjuvant physical or occupational therapy for patients with reflex sympathetic dystrophy. Archives of Physical Medicine and Rehabilitation 80 (9), 1038–1043.

Slater, H., Butler, D.S., Shacklock, M.O., 1994. The dynamic central nervous system: examination and assessment using tension tests. In: Boyling, J.D., Palastanga, N. (Eds.), Grieve's Modern Manual Therapy. Churchill Livingstone, Edinburgh.

Stanton-Hicks, M., Baron, R., Boas, R., et al., 1998. Complex regional pain syndromes: guidelines for therapy. Clinical Journal of Pain 14 (2), 155–166.

Stutts, J.T., Kasdan, M.L., Hickey, S.E., et al., 2000. Reflex sympathetic dystrophy: misdiagnosis in patients with dysfunctional postures of the upper extremity. Journal of Hand Surgery [Am] 25 (6), 1152–1156.

Subbarao, J., Stillwell, G.K., 1981. Reflex sympathetic dystrophy syndrome of the upper extremity: analysis of total outcome of management of 125 cases. Archives of Physical Medicine and Rehabilitation 62 (11), 549–554.

Thacker, M., Gifford, L., 2002. A review of physiotherapy management of complex regional pain syndrome. In: Gifford, L. (Ed.), Topical Issues in Pain, Vol. 3. CNS Press, Falmouth, pp. 119–141.

Turk, D.C., Okifuji, A., 1999. Assessment of patients' reporting of pain: an integrated perspective. Lancet 353 (9166), 1784–1788.

Turk, D.C., Rudy, T.E., 1988. Toward an empirically derived taxonomy of chronic pain patients: integration of psychological assessment data. Journal of Consulting and Clinical Psychology 56 (2), 233–238.

Uher, E.M., Vacariu, G., Schneider, B., et al., 2000. Manuelle Lymphdrainage im Vergleich zur Physiotherapie bei Complex Regional Pain Syndrom Typ I. Randomisierte kontrollierte Therapievergleichsstudie. Wiener Klinische Wochenschrift 112 (3), 133–137.

van de Beek, W.J., Schwartzman, R.J., van Nes, S.I., et al., 2002. Diagnostic criteria used in studies of reflex sympathetic dystrophy. Neurology 58 (4), 522–526.

van Hilten, B.J., van de Beek, W.J., Hoff, J.I., et al., 2000. Intrathecal baclofen for the treatment of dystonia in patients with reflex sympathetic dystrophy. New England Journal of Medicine 343 (9), 625–630.

Veldman, P.H., Reynen, H.M., Arntz, I.E., et al., 1993. Signs and symptoms of reflex sympathetic dystrophy: prospective study of 829 patients. Lancet 342 (8878), 1012–1016.

Verdugo, R.J., Ochoa, J.L., 2000. Abnormal movements in complex regional pain syndrome: assessment of their nature. Muscle Nerve 23 (2), 198–205.

Vicenzino, B., Cartwright, T., Collins, D., et al., 1999. An investigation of stress and pain perception during manual therapy in asymptomatic subjects. European Journal of Pain 3 (1), 13–18.

Viel, E., Ripart, J., Pelissier, J., et al., 1999. Management of reflex sympathetic dystrophy. Annales de Medecine Interne 150 (3), 205–210.

Vlaeyen, J.W., Crombez, G., 1999. Fear of movement/(re)injury, avoidance and pain disability in chronic low back pain patients. Manual Therapy 4 (4), 187–195.

Vlaeyen, J.W., De Jong, J.R., Onghena, P., et al., 2002. Can pain-related fear be reduced? The application of cognitive-behavioural exposure in vivo. Pain Research Management 7 (3), 144–153.

Vlaeyen, J.W., Linton, S.J., 2000. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 85 (3), 317–332.

Weber, M., Neundorfer, B., Birklein, F., 2002. Morbus Sudeck—Pathophysiologie und Therapie eines komplexen Schmerzsyndroms. Deutsche Medizinische Wochenschrift 127 (8), 384–389.

Wenzelburger, R., Schattschneider, J., Wasner, G., et al., 2001. Grip force coordination in CRPS. In: Harden, R.N., Baron, R., Jänig, W. (Eds.), Complex Regional Pain Syndrome, Vol. 22. IASP Press, Seattle, pp. 129–134.

Wilder, R.T., Berde, C.B., Wolohan, M., et al., 1992. Reflex sympathetic dystrophy in children. Clinical characteristics and follow-up of seventy patients. Journal of Bone and Joint Surgery [Am] 74 (6), 910–919.

Wilson, P.R., 1997. Post-traumatic upper extremity reflex sympathetic dystrophy. Clinical course, staging, and classification of clinical forms. Hand Clinics. 13 (3), 367–372.

Wilson, P.R., 1999. Complex regional pain syndrome—reflex sympathetic dystrophy. Current Treatment Options in Neurology 1 (5), 466–472.

Wu, W.H., Bandilla, E., Ciccone, D.S., et al., 1999. Effects of qigong on late-stage complex regional pain syndrome. Alternative Therapies in Health and Medicine 5 (1), 45–54.

Zyluk, A., 2002. The reasons for poor response to treatment of posttraumatic reflex sympathetic dystrophy. Acta Orthopedica Belgica 68 (Suppl.), 139–143.

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