The Clinical Journal of Pain
15:218–223 © 1999 Lippincott Williams & Wilkins, Inc., Philadelphia

Short- and Long-term Outcomes of Children with Complex Regional Pain Syndrome Type I Treated with Exercise Therapy

David D. Sherry, M.D., Carol A. Wallace, M.D., *Claudia Kelley, O.T., *Monica Kidder, P.T., and †Lyn Sapp, R.N.

*Departments of Pediatrics, *Rehabilitation, and †Nursing, University of Washington, Children's Hospital & Medical Center, Seattle, Washington, U.S.A.*

Abstract:

Objective: To report the initial and long-term outcome after an intensive exercise therapy program for childhood complex regional pain syndrome, type I (CRPS).

Design: Prospective follow-up.

Setting: A children's hospital.

Subjects: We followed 103 children (87 girls; mean age = 13.0 years) with CRPS. Forty-nine subjects were followed for more than 2 years (mean = 5 years 3 months).

Interventions: An intensive exercise program (most received a daily program of 4 hours of aerobic, functionally directed exercises, 1–2 hours of hydrotherapy, and desensitization). No medications or modalities were used. All had a screening psychological evaluation, and 79 (77%) were referred for psychological counseling.

Main Outcome Measures: Outcomes included pain, presence of physical dysfunction, or recurrent episodes of CRPS or other disproportional musculoskeletal pain.

Results: The mean duration of exercise therapy was 14 days, but over the past 2 years has decreased to 6 days. Ninety-five children (92%) initially became symptom free. Of those followed for more than 2 years, 43 (88%) were symptom free (15, or 31%, of these patients had had a reoccurrence), 5 (10%) were fully functional but had some continued pain, and 1 (2%) had functional limitations. The median time to recurrence was 2 months; 79% of the recurrences were during the first 6 months after treatment.

Conclusion: Intense exercise therapy is effective in initially treating childhood CRPS and is associated with low rate of long-term symptoms or dysfunction.

Key Words: Chronic regional pain syndrome, type I—Reflex sympathetic dystrophy—Exercise therapy—Physical therapy—Occupational therapy—Children—Outcome.

Complex regional pain syndrome, type I (CRPS; reflex neurovascular or sympathetic dystrophy), is a condition characterized by extreme limb pain associated with autonomic dysfunction.[1–3] Childhood disease differs significantly from that occurring in adults.[3–7] In childhood, the lower extremity is more commonly affected, whereas the upper limb is most common in adults and major trauma is much less of a precipitating event in childhood. Typically, in childhood, girls outnumber boys 3 to 1 and the typical age of onset is 9–15 years.[3,7–11] The etiology of childhood CRPS is unknown. However, most researchers agree that psychological stress and minor trauma play a significant role for most children.[3,8–11]

The treatment of CRPS has differed widely, with recommendations ranging from sympathetic blockade (medical or surgical) to psychotherapy.[12–15] Many of these treatment recommendations are based on adult CRPS. In children, we have found intensive physical and occupa-

Manuscript submitted August 4, 1998; revision received May 11, 1999; accepted for publication June 28, 1999.

Address correspondence and reprint requests to Dr. David D. Sherry, Rheumatology, CH-73, Children's Hospital & Medical Center, 4800 Sand Point Way, NE, Seattle, WA 98105, U.S.A. E-mail: dsherry@u.washington.edu

This work supported by the Barbara & David Kipper and the Chas. and Ruth Levy Foundation.

tional therapy (exercise therapy) sufficient to induce remission of symptoms in the vast majority.[3,8,16] The purpose of this paper is to describe our therapy program and report initial and long-term outcomes.

MATERIALS AND METHODS

Subjects

From July 1984 through February 1997, 107 patients were diagnosed with CRPS and fulfilled the diagnostic criteria of the International Association for the Study of Pain.[2] All were referred by their physicians to either the pediatric rheumatology or pediatric reflex neurovascular dystrophy clinic and evaluated by one of the authors (D.D.S.). Children with pain without color, temperature, or perspiration changes were excluded, as were those with fibromyalgia. Affect was subjectively assessed by the physicians and therapists; congruent affect was defined as the patients displaying overt pain behaviors such as wincing, grimacing, or crying when reporting severe pain; the absence of such pain behaviors and maintaining a cheerful affect and unworried affect while reporting severe pain (greater than 7 out of 10) was defined as an incongruent affect.[1-3] One hundred three participated in our exercise therapy program and are included in this report. Long-term prospective follow-up, defined as longer than 2 years, was available for 49 patients. These 49 patients were identified by the research nurse and contacted as outlined below; they were not presently being cared for in our clinic.

Medical history and physical characteristics of the 103 patients were prospectively and retrospectively gathered (Table 1). Most were severely disabled; 12 were bedridden or confined to a wheelchair, 50 were nonambulatory without crutches, 21 were able to do only limited activities, and only 20 were able to perform most activities. Most (76%) had allodynia and most (79%) had an incongruent, cheerful affect when reporting severe pain. However, 17 patients had a congruent affect and 5 had marked pain behaviors (crying and screaming with movement or touching the symptomatic limb). All had signs of autonomic dysfunction (cyanosis, decreased skin temperature, or edema).

Almost all the children had had normal radiographs of the painful site prior to being seen. Bone scintigraphy had been obtained in 57 patients and demonstrated decreased uptake in the affected region in 31 (54%), increased uptake in 11 (19%), and were normal in the remainder. Prior treatments were legion and are shown in Table 2.

Measures

Pain was assessed by self-report on a 0–10-point scale, both verbally and with a 10-cm visual analog scale (VAS). Dysfunction was ascertained by both self-report and observation of the subject's ability to perform age- and limb-appropriate activities such as participation in physical education, dressing one's self, endurance walking, or ability to open a car door.

Medical therapy

No medication was administered except for, occasionally, acetaminophen for headache. Patients on narcotics or anticonvulsants were tapered off their medication; steroids, antidepressants, nonsteroidal antiinflammatory drugs, muscle relaxants, and phenoxybenzamine all were immediately discontinued without adverse problems noted.

Psychological evaluation

A comprehensive psychological assessment, previously described,[8,17] was obtained in all patients. Briefly, this

TABLE 1. *Clinical characteristics of 103 children with complex regional pain syndrome, type I*

male (%)	87 (84)
ale (%)	16 (16)
edian age in years (range)	12.7
7–21.2)	
edian duration of symptoms in months (range)	2.0
1–108)	
story of trauma	
None (%)	47 (46)
Mild (%)	43 (42)
Severe (%)	13 (13)
ver extremity involved (%)	83 (81)
per extremity involved (%)	11 (11)
per and lower extremities involved (%)	9 (9)
lteral involvement (%)	17 (17)
ltiple, not symmetrical, sites involved (%)	16 (16)
odynia (%)	78 (76)
onomic dysfunction (%)	103 (100)

TABLE 2. *Prior treatments administered for complex regional pain syndrome, type I, before initiation of exercise therapy*

Treatment	No. patients
Brace or splint	32
Cast	20
TENS	11
Chiropractic treatments	7
Massage	3
Acupuncture	2
Opioid pain medications	25
Steroids	10
Antidepressants	7
Anticonvulsants	1
Muscle relaxants	6
Phenoxybenzamine	2
Xylocaine injection	2
Sympathetic blocks	8
Epidural morphine	1
Exploratory surgery	1

TENS, transcutaneous electrical nerve stimulation.

included standardized questionnaires assessing the family and marriage dynamics, depression, symptom inventory, and an interview. Results are reported as either referred or not referred for psychotherapy.

Exercise therapy

The therapy philosophy was to reestablish normal use of the affected limb as quickly as possible. Our program stressed function almost exclusively through aerobic exercise training rather than progressive resistive exercises. No modalities such as transcutaneous electrical nerve stimulation (TENS) or biofeedback were used. Therapeutic activities for the lower extremity included jumping activities, running up and down stairs, various bilateral coordination movements (such as mini-trampoline, skiing, jumps, and jumping jacks), and relevant age-appropriate physical education simulated activities and sport drills. Upper extremity exercises concentrated on weight bearing, functional activities (such as wall washing and handwriting), and coordination drills. Hydrotherapy was administered in a pool and focused on specific limb exercises and general aqua aerobic training.

Patients with allodynia underwent desensitization with towel rubbing, hand massage, textured fabric rubs, and contrast baths (2°C and 38°C). Street clothing and sports shoes were required regardless of allodynia (i.e., those with foot allodynia wore socks and laced-up shoes).

The duration of exercise therapy was 5–6 hours daily for most. Four hours were divided by occupational and physical therapy and 1–2 hours consisted of hydrotherapy in a heated (34°C) swimming pool. All patients also had evening and weekend home exercise programs that would take from 45 minutes to 3 hours to perform. In some patients, scheduling this amount of exercise therapy was delayed, so an intense home exercise program was prescribed. These patients met with the occupational and physical therapist for an hour and were shown exactly what to do. If the patient was able to do this program and resolve their pain before a longer, full program could commence, then the longer program was canceled and the patient was followed in the usual fashion (see below).

Compliance with doing the exercises with the therapists was not a problem for the vast majority. Most of these patients were highly motivated and eager to please. All patients were encouraged to improve the quality of their body movement and speed to accomplish various tasks. Distraction was used to divert their focus from pain (such as playing catch while jumping on the mini-trampoline or playing computer or board games while weight bearing on one leg).

Because of insurance changes over the years, the majority of patients treated in the 1980s were inpatients and the majority of those treated in the 1990s were outpatients.

Follow-up

Patients were followed in the clinic for 6–8 months after completion of the exercise program. Long-term data were obtained from a structured phone questionnaire administered by a nurse (L.S.) not aquainted with the family.

Data were analyzed by using the relevant statistic including Fisher's exact test, chi-square, and nonpaired t test to scan initially for possible relations between 50 variables and recurrent disease and treatment failures. Correction for multiple variables was not done because this was meant to be a broad search; a p value of less than 0.05 was used to identify variables of interest. Computations were performed by using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, U.S.A.).

RESULTS

Exercise therapy was administered to 60 patients on an inpatient basis, to 31 patients on an outpatient basis, and to 12 patients as a home program after an initial day of instruction.

Complete resolution of pain and full function were observed in 95 patients (92%). Initial VAS and verbal pain scores were available for 74 patients and follow-up scores for 84 patients. Initially, the mean score, with 100 indicating the worst pain, was 76; the mean score of those who were in complete remission was 1 ($n = 77$); the mean score of those not in remission was 58 ($n = 7$). The pain in the 8 patients in remission with pain scores who reported scores of 3–20 had complicating conditions such as tendonitis, patella femoral syndrome, or mechanical pain. The mean duration of therapy was 14 days (range = 1–90 days); however, over the past 2 years the mean duration has decreased to 6 days (range = 1–25 days). Predictors of those who did not respond completely to the therapy program were receiving outpatient therapy rather than inpatient therapy ($p = 0.014$, Fisher's exact test, two tailed), receiving fewer days of therapy (7 vs. 19 days; $p = 0.003$, t test, two tailed), shorter duration of symptoms (2 vs. 8 months; $p = 0.35$, t test, two-tailed), and scoring higher on the achievement orientation subscore of the Family Environment Scale (7.2 vs. 5.4; $p = 0.015$, t test, two-tailed).

The long-term outcome for 49 of these 103 patients is displayed on Table 3. After a mean follow-up of 5 years 3 months, 43 patients (88%) had no symptoms of CRPS. Fifteen (31%) had had recurrent episodes of disproportional pain (with or without symptoms of autonomic dysfunction) that resolved with reinstitution of an exercise program. One child (2%) was still dysfunctional with CRPS pain, and 5 (10%) had persistent mild pain but were fully functional. The median time between remission of the first episode of CRPS and the start of the second episode was 2 months (range = 2 weeks to 4 years). The second episode occurred

TABLE 3. *Telephone reported outcome of 49 patients with complex regional pain syndrome, type I, followed for 2 or more years*

	Duration of Follow-up					
Years of follow-up	2–3	3–4	4–5	5–6	6–7	7+
Completely well	4	10	6	5	6	4
Had recurrence, presently well	0	4	1	1	0	2
Some pain, fully functional	0	2	0	0	3	0
Pain causing dysfunction	0	0	0	1	0	0

within the first 6 months after initial resolution in 79% of these patients. Predictors of recurrent episodes included previous suicide attempts ($p = 0.026$, Fisher's exact test, two-tailed), history of an eating disorder ($p = 0.028$, Fisher's exact test, two tailed), reporting less pain initially (50 vs. 77 mm on a 100-mm VAS; $p = 0.021$, t test, two-tailed), and scoring higher on the Brief Symptom Inventory subsets of depression and paranoid ideation (ps = 0.037 and 0.048, respectively, t test, two-tailed).

Psychological evaluation resulted in 79 families (77%) being referred for psychotherapy. Recurring psychological themes included nonverbalization or nonrecognition of feelings, parental enmeshment with child, difficulty individuating from extremely close families, or the presence of unsupportive, uncohesive families. The quality and duration of psychotherapy were not measured.

DISCUSSION

Children with CRPS differ significantly from adults with CRPS in both the manifestations of the illness and the response to treatment.[3] Adults with CRPS seem to be more resistant to treatment,[6,15,18] which may be due to intrinsic differences between childhood and adult CRPS. Adults more frequently have significant trauma preceding their CRPS and more upper extremity involvement, and, perhaps, it is less of a psychopathophysiologic phenomenon.[19–23]

Treating children with multiple modalities and medications has not met with as great success. Wilder et al. treated 70 children with a program of graduated physical therapy, TENS, psychotherapy, antidepressants, and sympathetic blockade, and 38 (54%) reported residual pain or dysfunction.[12] Stanton et al. reported resolution of pain in 25 of 36 children (69%) treated with hospitalization, twice daily physical therapy, TENS, biofeedback, behavior modification, psychotherapy, analgesics, antiinflammatory drugs, local injection, and sympathetic blocks.[7]

Our results are significantly better than those and agree with results obtained by others who emphasized exercise therapy.[3,9,10] There are several specific aspects of our program that are noteworthy. We overtly recognize that the pain is real and significant by outlining a model for sympathetically mediated pain amplification. This is reassuring because the incongruent affect associated with the pain is frequently interpreted by family, peers, and previous health care providers as malingering. Discussing psychological stress as a potential cause is paramount because this allows the parents to express their concern about the role stress plays in their child's pain. Quite often, previously unrevealed emotional stressful events are disclosed.[8,17] However, other, nonpsychological factors such as injury or illness may play a role, and in 23% of our patients we found no compelling reason to recommend psychotherapy.

The more important aspects of the exercise therapy include the one-to-one therapist–patient interaction, the prolonged duration of therapy, the focus on function, and acknowledging but disregarding pain. Parents were not allowed to be present during the therapy session because they can unintentionally undermine the authority of the therapist and distract the patient. Frequently, when the parent returned to pick up the patient, function deteriorated and pain complaints escalated.

The mechanism for improvement is unknown. One could speculate that this amount of exercising may produce endorphins and other pain-related mediators that may work through mechanoreceptors, hormonal shifts, overriding the nociceptors, increased blood flow, or other negative feedback loops that may be peripheral or central.

We did not use modalities such as TENS, ultrasound, or pain medications.[12,15] Likewise, we have not found it necessary to offer sympathetic blocks, sympathectomy, corticosteroids or other medications. Many of our patients had received such therapies without benefit, although we realize they would not have been referred if they had responded. Our underlying philosophy is that, in the long run, these patients need to be able to control pain and dysfunction, should it recur, through a home exercise program without requiring professional attention. Thus, ultimate control is placed into the hands of the patient. This, in itself, may help the long-term outcome.[24]

Admission to the hospital facilitates the administration of this intensive therapy schedule.[3,7] It provides the multidisciplinary team an opportunity to witness family interactions and observe the patient outside of the family setting. Some patients will experience increased pain, especially at night

after a strenuous day, which is difficult for the parents to manage effectively at home. In the hospital, the staff can adequately document the symptoms and signs, encourage physical activity, and lessen secondary gain.

In the past 3–4 years, we have been treating more patients as outpatients or with home programs because of financial and managed-care constraints. We can admit only the most overtly dysfunctional or those who fail an outpatient program. The long-term effect of this change in our program is not yet clear, but we have reduced the average amount of exercise therapy delivered. As indicated by our data, fewer days of therapy and outpatient status may be indicators of not fully responding to exercise therapy.

We found no striking predictors of recurrent disease. Three mild indicators were prior suicide attempts, a history of anorexia nervosa or bulimia, and reporting less pain. The first two may bespeak underlying psychological distress, but other indicators of distress were not related to recurrent disease such as physical or sexual abuse, clinical depression, school problems, or family dysfunction on most of the individual subscores of the psychological battery. Although obtaining or not obtaining psychological help did not predict recurrent disease, we have no way to account for the quality and extent of help each person received. Therefore, these data are too preliminary to state with any confidence the failure of psychotherapy to prevent reoccurrence.

We do not know why reporting less pain initially may be related to future reoccurrence, although it is our impression that children with the most pain and dysfunction are easier to treat. Establishing functional goals and tangible improvement is easier to realize. There may also be differences in the effect of exercising more painful limbs on endorphins or other biologically significant molecules involved in the pain of CRPS.

The role of the psychological evaluation itself, in addition to later psychotherapy, on the outcome is hard to assess. Some families have embraced the fact that significant emotional stress is present and that they have played a role in this illness. However, most families were resistant to psychotherapy, so attending a few psychotherapy sessions probably did not alter the family functioning over time. This finding and the rapidity of functional improvement lead us to believe that the exercise therapy is paramount. Controlled prospective studies are needed to clarify this belief.

Our study is limited by the fact most of the long-term follow-up patients were treated as inpatients. Further studies are needed to see whether those treated as outpatients do as well.

CONCLUSIONS

Ninety-two percent of 103 children with CRPS treated with an intense exercise therapy program resolved all symptoms and regained full function. The long-term outcome of 49 children was excellent, with 88% fully functional without pain after a mean of more than 5 years. Recurrent episodes occurred in 31% and developed in most within the first 6 months; most resolved with self-initiation of their exercise program.

Acknowledgments: We thank Charles H. Spencer, M.D., for his helpful critique of this manuscript and Amber Stinson for her technical assistance.

REFERENCES

1. Mitchell SW, Morehouse GR, Keen WW. *Gunshot wounds and other injuries of nerves*. New York: J.B. Lippincott, 1864.
2. Merskey H, Bogduk N. *Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms*. Second Edition. Seattle: IASP Press, 1994:40–2.
3. Bernstein BH, Singsen BH, Kent JT, et al. Reflex neurovascular dystrophy in childhood. *J Pediatr* 1978;93:211–5.
4. Veldman PHJM, Reynen HM, Arntz IE, et al. Signs and symptoms of reflex sympathetic dystrophy: prospective study of 829 patients. *Lancet* 1993;342:1012–6.
5. Kozin F, McCarty DJ, Sims J, et al. The reflex sympathetic dystrophy syndrome. I. Clinical and histologic studies: evidence for bilaterality, response to corticosteroids and articular involvement. *Am J Med* 1976;60321–31.
6. Kozin F, Ryan LM, Carerra GF, et al. The reflex sympathetic dystrophy syndrome (RSDS). III. Scintigraphic studies, further evidence for the therapeutic efficacy of systemic corticosteroids, and proposed diagnostic criteria. *Am J Med* 1981;70:23–30.
7. Stanton RP, Malcolm JR, Wesdock KA, et al. Reflex sympathetic dystrophy in children: an orthopedic perspective. *Orthopedics* 1993;16: 773–9.
8. Sherry DD, Weisman R. Psychological aspects of childhood reflex neurovascular dystrophy. *Pediatr* 1988;81:572–8.
9. Silber TJ, Majd M. Reflex sympathetic dystrophy syndrome in children and adolescents. *Am J Dis Child* 1988;142:1325–30.
10. Ruggeri SB, Athreya BH, Doughty R, et al. Reflex sympathetic dystrophy in children. *Clin Orthop* 1982;163:225–30.
11. Ashwal S, Tomasi L. Neumann M, et al. Reflex sympathetic dystrophy syndrome in children. *Pediatr Neurol* 1988;4:38–42.
12. Wilder RT, Berde CB, Wolohan M, et al. Reflex sympathetic dystrophy in children. Clinical characteristics and follow-up of seventy patients. *J Bone Joint Surg [Am]* 1992;74:910–9.
13. Gainer MJ. Somatization of dissociated traumatic memories in a case of reflex sympathetic dystrophy. *Am J Clin Hypn* 1993;36:124–31.
14. Olcott C IV, Eltherington LG, Wilcosky BR, et al. Reflex sympathetic dystrophy—the surgeon's role in management. *J Vasc Surg* 1991; 14:488–95.
15. Schutzer SF, Gossling HR. The treatment of reflex sympathetic dystrophy syndrome. *J Bone Joint Surg [Am]* 1984;66:625–9.
16. Wotring K, Mehn J, Stengem C. Evaluation and treatment of the pediatric reflex neurovascular dystrophy patient [abstract]. *Arthrit Rheum* 1985;28(suppl):S143.
17. Sherry DD, McGuire T, Mellins E, et al. Psychosomatic musculoskeletal pain in childhood: clinical and psychological analyses of 100 children. *Pediatrics* 1991;88:1093–9.
18. Schwarzman RJ, McLellan TL. Reflex sympathetic dystrophy. A review. *Arch Neurol* 1987;44:555–61.
19. Bruehl S, Carlson CR. Predisposing psychological factors in the development of reflex sympathetic dystrophy. A review of the empirical evidence. *Clin J Pain* 1992;8:287–99.
20. Van Houdenhove B. Vasquez G, Onghena P, et al. Etiopathogenesis of reflex sympathetic dystrophy: a review and biopsychosocial hypothesis. *Clin J Pain* 1992;8:300–6.

21. Oyen WJG, Arntz IE, Claessens RAMJ, et al. Reflex sympathetic dystrophy of the hand: an excessive inflammatory response? *Pain* 1993;55:151–7.
22. Thimineur MA, Saberski L. Complex regional pain syndrome type I (RSD) or peripheral mononeuropathy? A discussion of three cases. *Clin J Pain* 1996;12:145–50.
23. Galer BS, Butler S, Jensen MP. Case reports and hypothesis: a neglect-like syndrome may be responsible for the motor disturbance in reflex sympathetic dystrophy (complex regional pain syndrome–1). *J Pain Sympt Manage* 1995;10:385–92.
24. Buckelew SP, Huyser B, Hewett JE, et al. Self-efficacy predicting outcome among fibromyalgia subjects. *Arthrit Care Res* 1996;9:97–104.