

The movement disorder of reflex sympathetic dystrophy

Robert J. Schwartzman, MD, and James Kerrigan, MD

Article abstract—We present 43 patients with reflex sympathetic dystrophy (RSD) who manifested abnormalities of movement. The patients have focal dystonia, weakness, spasms, tremor, difficulty initiating movement, and increased tone and reflexes. These motor signs and symptoms may precede other manifestations of the illness by weeks or months. They most frequently, but not invariably, occur concomitantly with sudomotor or vasomotor changes and pain. Lioresal is effective in reducing spasms. Early in the course of RSD, the motor manifestation may be alleviated by intense sympathetic blockade or sympathectomy. In many patients, the movement disorder becomes independent of sympathetic innervation.

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Reflex sympathetic dystrophy (RSD) is characterized by severe burning pain, swelling, and vasomotor, sudomotor, dystrophic, and atrophic changes in the affected body parts.^{1,2} The accompanying motor abnormalities of dystonia, weakness, tremor, involuntary movements, and spasm have been described.³⁻⁸ These RSD-associated abnormalities of movement may follow minor trauma and relate in time and distribution to injury of the affected body part.³ Tremor at various frequencies has been documented in many of these patients.³⁻⁵ In 4 patients with focal dystonia, EMG evaluation revealed abnormal motor unit activity, overflow to contiguous muscle groups, as well as coactivation and synchronous bursts of motor unit activity in antagonist muscle groups.³ Spasms and irregular jerks of RSD-affected extremities have been noted to last for years. Sympathetic blockade was unsuccessful in relieving these abnormal movements.⁷ In the series of Jankovic and VanDerLinder,³ 15 of 23 patients with peripherally induced tremor and dystonia had possible predisposing factors for the development of these movement disorders. Nerve trauma or loss of peripheral afferent input may be the etiologic factor in some patients with orofacial dyskinesias, hemifacial spasm, torticollis, segmental myoclonus, painful moving fingers and toes, and involuntary amputation stump movements.⁹⁻¹⁵

We have noted that the motor manifestations of RSD may precede pain, be present in a "mirror distribution" on the contralateral side of the body, and appear suddenly. They occasionally occur in the absence of pain. These motor manifestations may variably be ameliorated or abolished with sympathetic blockade and may be a major factor in morbidity since they preclude aggressive physical therapy. We describe the clinical manifestations of dystonia, tremor, spasms, weakness,

and difficulty with initiation of movements in 43 patients with RSD.

Methods. All reported patients were from the Reflex Sympathetic Dystrophy Clinic at Jefferson Medical College. They were selected from the 1st 200 patients treated in the clinic.

A single examiner (R.J.S.) performed all initial physical and subsequent evaluations. Patients were first evaluated to rule out other neurologic conditions and, if included in this study, were staged according to the criteria recommended by Escobar.¹⁶ Stage I patients had a history of persistent pain with hyperpathia, hyperesthesia, or allodynia in the affected part, with at least 2 of the following physical findings: increased hair or nail growth, edema, livedo reticularis, temperature change, hyperhidrosis, or piloerection. Stage II patients had, in addition to the stage I criteria, dystrophic changes of soft tissue or nails or hair loss. Stage III patients had the features of stage I and II disease as well as atrophy of skin, soft tissue, muscle, and bone.

All patients in stages II and III of the illness were found to have some combination of weakness, spasm, tremor, increased tone, increased reflexes, difficulty in initiating movements, or dystonia. The 43 patients who form the basis of this report were selected because their motor symptoms and signs were major or were not associated with pain. Frequently, the patients were not fully aware of subtle aspects of dystonic posture or of their inability to initiate or sustain movements. All patients were hospitalized and underwent complete neurologic examinations daily. All patients had complement levels, ANA, rheumatoid factor, sedimentation rate, CBC, urinalysis, SMA-12, serum protein electrophoresis, immunoelectrophoresis, cryoglobulin determinations, and serum herpes virus titers. All patients had electromyographic and nerve conduction studies as well as myelography, CT, and MRI, when indicated, to evaluate the underlying basis of their RSD.

Results. The female-to-male ratio of our study group of 200 patients was 4.5:1. The age at onset of RSD symp-

From the Department of Neurology, Jefferson Medical College of Thomas Jefferson University, Philadelphia, PA.

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Address correspondence and reprint requests to Dr. Robert J. Schwartzman, Jefferson Medical College, Department of Neurology, 1025 Walnut Street, Room 511, Philadelphia, PA 19107.

Table. Clinical features of RSD patients with movement disorder

Pt no.	Age	Sex	RSD stage	Limb (AH)	Duration Sx (yrs)	Precipitating factor	Dystonia	Tremor	Difficulty initiating movement	Spasms I	Deep tendon reflexes
1	47	M	I	Right upper	2	Post-op nerve injury	2	1	3	2	Slightly increased
2	23	F	III	Left lower	5	Trauma (leg)	3	1	3	2	Slightly increased
3	18	M	I	Right lower	5	Lumbar radiculopathy	1	1	1	2	Slightly increased
4	20	F	II	Right lower	4	Trauma (arm)	4	2	4	4	Greatly increased
5	28	F	I	Right upper	1.5	Trauma (arm)	4	0	4	4	Slightly increased
6	25	M	II	Left lower	3	Trauma (leg)	4	0	4	3	Slightly increased
7	52	F	II	Left lower	2	Lumbar radiculopathy	4	2	4	3	Slightly increased
8	36	F	II	Right lower	3	Lumbar radiculopathy	2	2	2	2	Slightly increased
9	23	F	II	Right upper	5	BPTI	2	3	3	3	Slightly increased
10	35	F	II	Left upper	7	IV cath placement	2	2	1	2	Greatly increased
11	70	F	I	Right lower	2	L5 radiculopathy	1	0	1	2	Slightly increased
12	42	F	I	Right upper	0.5	BPTI/neuroma	1	0	1	2	Slightly increased
13	19	F	III	Right lower	5	Trauma (ankle)	4	0	4	4	Slightly increased
14	41	F	II	Right lower	9	Foot fracture	1	0	2	1	Greatly increased
15	42	F	II	Left lower	18	Radiculopathy	1	1	1	1	Slightly increased
16	25	F	I	Left lower	2	Trauma (foot)	1	1	1	2	Moderately increased
17	43	F	I	Right lower	1	Post-op radiculopathy	2	1	1	3	Moderately increased
18	37	F	I	Right lower	4	Foot surgery neuroma	4	4	1	4	Slightly increased
19	29	F	I	Right lower	2	Trauma (ankle)	4	3	2	4	Moderately increased
20	27	F	I	Right lower	2	Trauma (ankle)	2	1	1	3	Slightly increased
21	33	F	III	Right upper	5	Hand fracture	4	4	4	2	Slightly increased
22	20	F	I	Right lower	8	Lumbar radiculopathy	1	1	1	1	Slightly increased
23	32	F	I	Right lower	4	Neuroma	2	1	1	1	Slightly increased
24	45	F	II	Right lower	4	Trauma (knee)	2	2	4	4	Slightly increased
25	29	F	I	Right upper	1	BPTI	4	0	4	3	Slightly increased
26	38	F	I	Left lower	4	Trauma (knee)	2	1	2	3	Slightly increased
27	18	F	I	Right lower	1	Trauma (ankle)	2	1	2	3	Slightly increased
28	25	F	I	Left lower	2	Trauma (knee)	2	0	2	2	Slightly increased
29	32	F	I	Right upper	3	BPTI	4	0	4	4	Moderately increased
30	26	F	I	Left upper	8	BPTI	4	4	3	4	Moderately increased
31	40	F	III	Right upper	6	BPTI	3	4	4	4	Slightly increased
32	10	F	I	Left lower	1	Trauma (leg)	1	0	1	1	Slightly increased
33	28	F	I	Right lower	4	Lumbar radiculopathy	2	2	2	2	Slightly increased
34	27	F	III	Right upper	6	BPTI	4	4	4	4	Greatly increased
35	23	M	II	Left upper	5	BPTI	4	3	4	4	Greatly increased
36	48	F	I	Right upper	3	BPTI	4	0	4	4	Slightly increased
37	20	F	I	Left lower	2	Trauma (foot)	3	2	2	3	Moderately increased
38	46	F	II	Right lower	3	Trauma (toe)	4	4	4	4	Moderately increased
39	10	M	I	Left lower	2	Trauma (leg)	1	0	1	1	Moderately increased
40	24	F	II	Right lower	5	Trauma (leg)	4	4	4	4	Moderately increased
41	55	M	II	Right upper	5	BPTI	3	2	1	1	Moderately increased
42	41	M	I	Left upper	2	Trauma (arm)	2	4	1	1	Moderately increased
43	35	F	III	Right upper	3	Trauma (arm)	1	2	3	2	Moderately increased

BPTI Brachial plexus traction injury.

Dystonia	Spasms	Inability to initiate movements	Tremor
1 = Subtle.	0 = None.	0 = No movement.	0 = No tremor.
4 = Patient with no movement or only a flicker of movement.	4 = Severe.	4 = Normal movement.	4 = Severe.

toms ranged from 8 to 75 years. At the time of entry into the series, 108 patients were stage I, 62 stage II, and 30 stage III. A loose correlation between stage and the interval from the precipitating event to the development of RSD symptoms was noted. The RSD is more likely to be advanced for intervals of onset from initiating event greater than 30 months. Initial limb involvement was nearly equal between upper (106) and lower (94) extremity. Spread of sympathetic symptoms occurred in 82 patients. Patients were more likely to have spread of symptoms the longer they suffered with RSD. A specific precipitating event was found for every patient. Eighty-four patients (42%) were immobilized either by rigid cast, splinting, or booting prior to the development of RSD.

Thirty-six women and 7 men whose average age was 32 years (range, 10 to 70) were studied. RSD began in the upper extremity in 16 patients and in the lower extremity in 27. Soft tissue and nerve trauma was the initiating factor in 38 of these patients. In the upper extremity, peripheral nerve trauma or direct brachial plexus traction injury was the initiating event. In the lower extremity, ankle sprains, cartilage or ligamentous knee injuries, minor foot surgery, or disk disease precipitated the illness. Two patients had bone fractures, and in 2 others the illness began following lumbar disk surgery. The onset of pain was abrupt in 30% of patients, including those whose symptoms began in the postoperative period. The average duration of symptoms to time of evaluation was 3.5 years (1 month to 18



Figure 1. Adduction and flexion of the right arm with clenched fist (patient 5).

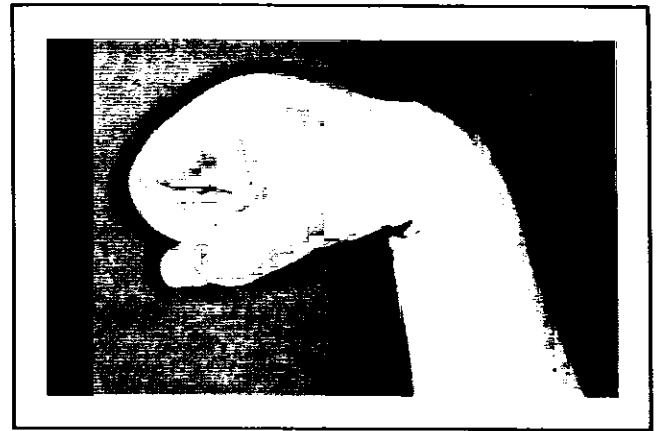


Figure 2. Flexion of the wrist and fingers. Patient unable to move the fingers (patient 25).

years). Twenty-four patients were in stage I disease, 13 in stage II, and 6 in stage III (table).

The most prevalent motor complaints, common to some degree in all of these patients, were weakness, spasms, and the inability or difficulty in initiating movements of the affected extremity (table). The most frequent description of the abnormality was, "My mind tells my hand to move, but it won't." Any generated movements were accomplished with intense effort that was frequently accompanied by the patient staring at the affected part. A perceptible lag time was noted prior to the 1st movement, which began as a small quivering of the fingers or toes. Associated or synergistic movements were noted in the opposite extremity in 5 patients. The movements initiated were not apractic, but all patients had difficulty completing them. This was most evident in the upper extremity, where patients would have difficulty opposing fingers or clenching the fist completely, but were able to demonstrate normal ideomotor, sympathetic, and ideational praxis. All patients were weak to some degree in an affected extremity. The most dramatic motor manifestation in these patients was a painful dystonic posture of the affected area. This was characterized most frequently in the upper extremity by adduction of the arm with flexion at the elbow, wrist, and fingers (figures 1 and 2). In the hand, the 3rd through 5th fingers were most frequently flexed and the thumb adducted and fistled. Seven patients with upper extremity dystonia also had severe dystonia of the trapezius and sternocleidomastoid muscles (figure 3B). One patient had extension of the wrist with flexion of the fingers and adduction of the thumb (figure 3, A and B). The most frequent posture observed in the lower extremity was internal rotation of the hip with plantar flexion and inversion of the foot (11 of 27 patients) (figure 4). Occasionally, 1 digit was forcibly flexed (figure 5). The dystonia of the foot and hand preceded involvement of the more proximal musculature. This dystonic posture was so severe in 2 patients that 1 dislocated her hip and the other cracked a plaster ankle cast. In 6 patients, the inverted plantar flexed posture of the lower extremity was noted in the affected extremity after the patient was pain free. In 2 patients, an inverted plantar flexed foot posture was noted in the unaffected lower extremity. In 3 patients, the characteristic dystonic upper extremity posture was noted in the unaffected upper extremity. In 5 patients, the dystonic posture appeared

prior to pain (2 in the upper extremity and 3 in the lower extremity). In general, the dystonia evolved gradually (6 months to 3 years) and could not be correlated with the severity of the other associated signs and symptoms of RSD. In 7 patients with dystonia, it appeared full-blown in 2 days, and in 2 it appeared overnight. The dystonia always spread ipsilaterally first. In 3 patients, it involved 3 extremities. Dystonia persisted in sleep in all patients in which it was noted.

A fine tremor was noted in the affected extremity of all patients who could move. This was most commonly a flexion-extension tremor of the fingers and was initiated by an attempt to move. It was seen at complete rest and was exacerbated by a maintained posture. The amplitude was several millimeters, and the velocity varied from 3 to 6 Hz. Three patients had unusual tremors. One was a large-amplitude flexion-extension tremor at the ankle that varied in amplitude, was not present in sleep, and the frequency of which was between 4 and 5 Hz. Two patients had large-amplitude intention tremors in the affected upper extremity. All tremors were diminished or abolished by successful sympathetic blockade and returned as the block abated. No abnormal movements were noted in the face, abdomen, or back in patients with RSD in these areas. Spasms were noted in all patients with the movement disorder of RSD. In 13 patients, spasms were occasionally noted in areas of the body that showed no objective evidence of RSD. Spasms were described in the face of 1 patient with RSD in the ipsilateral upper extremity. Two patients had spasms in abdominal muscles (RSD in 1 lower extremity). The spasms were described as intense, lasting for 10 to 15 seconds, and occurring intermittently throughout the day. Liorsesal in doses of 30 to 120 mg was partially effective in all patients and was very effective in 5 patients with spasms.

Six patients with ipsilateral upper extremity RSD had intermittent dysphasia and difficulties with initiating swallowing. The reflexes were hyperactive in the affected extremities of all patients regardless of whether they suffered the movement disorder, unless there was an underlying segmental radiculopathy. The great majority of the patients with the motor manifestations of RSD (90%) have noted at least a brief decrease in these



Figure 3. (A) Extension of the wrist with adduction and tight flexion of the fingers (patient 29). (B) Dystonia of the right trapezius and sternocleidomastoid muscles. Hyperextension of the wrist with adduction of the thumb and severe flexion of the fingers. The patient was unable to move the extremity (patient 29).

symptoms and signs following sympathetic blockade.^{17,18} Longer relief has been obtained with sufentanil (morphine) sympathetic blocks to the affected ganglia or chain.¹⁹ Sympathectomy in an extremity that has been successfully blocked gives the best long-term result. Beta blockade, steroids, calcium channel blockade, phenoxybenzamine, tricyclics, and non-narcotic analgesics were invariably ineffective. Benzodiazepines have been effective in relieving the spasms in 20% of patients, but have not altered the other motor manifestations of the illness. Lioresal in doses of 90 to 120 mg/d has been extremely effective in relieving the dystonia in 2 patients and has been the most effective drug in relief of spasms in the others. These 2 patients had generalized dystonia and were unable to walk or use utensils. Lioresal at doses of 120 mg/d allowed them to perform normal activities of daily living, although they still manifested bilateral plantar flexion and inversion of the feet and slight dystonic hand postures. In those patients who had relief of RSD following sympathetic blockade and subsequent sympathectomy in the lower extremity, a great majority still demonstrated subtle dystonia. This is manifest by plantar flexion and inversion of the foot in the absence of pain. A severely affected upper extremity may return to normal following successful sympathetic blockade. The usual small-amplitude high-frequency movements of the fingers and toes on attempted movement, noted initially, gradually abated with increasing sympathetic blockade. In patients who have the painless onset of these motor manifestations in a previously unaffected extremity, difficulty with initiation of movement and slowness of rapid alternating movements are the most frequent complaints.

Discussion. Dystonia, weakness, inability to initiate movement, increased tone, spasms of somatic musculature, and postural and intention tremor are the primary manifestations of motor involvement in our



Figure 4. Bilateral plantar flexion and inversion of the feet (patient 40).

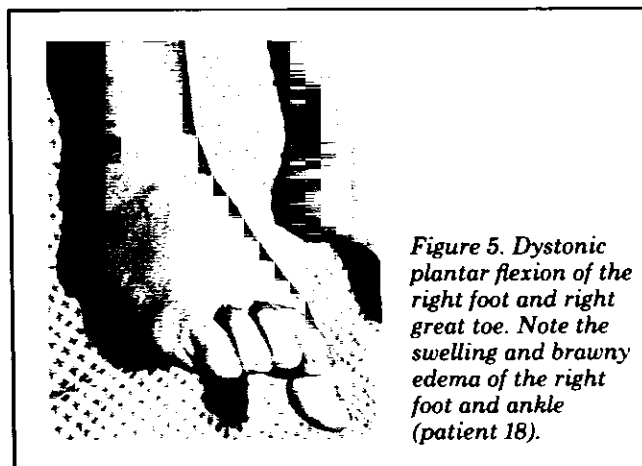


Figure 5. Dystonic plantar flexion of the right foot and right great toe. Note the swelling and brawny edema of the right foot and ankle (patient 18).

patients with RSD. These motor manifestations have been noted previously but, due to their association with severe pain, swelling, and sudomotor and vasomotor symptoms, have not been accorded the prominence they warrant in the RSD symptom complex.^{17,18}

The motor manifestations of RSD may precede other manifestations by weeks or months. No specific pattern or initiating or concomitant factors could be identified. They occurred slightly more frequently in the lower extremities regardless of the stage of RSD in which they were noted. Most often these motor manifestations occurred concomitantly with sudomotor, vasomotor and the pain of stage I and II disease. They are always present in stage III disease, but are hard to differentiate from the other severe signs and symptoms of the disease. Early in the course of RSD, the motor manifestations may be alleviated by intense sympathetic blockade or sympathectomy, but after several months, or in stage III disease, they seem to escape sympathetic modulation or control and are permanent.

The physiologic and pharmacologic effects of catecholamines on skeletal muscle contraction, neuromuscular transmission, anterior horn cell depolarization, and spinal cord reflexes are complex and dose dependent.²⁰⁻²³ However, other influences on the anterior horn cell may be primary or act concomitantly with this sympathetic innervation to cause the motor manifesta-

tions of RSD. Recent neuroanatomic, neurophysiologic, and neuropharmacologic reports have demonstrated a profound effect of the undecapeptide substance P (SP) and related peptides on sensory and motor neuron function.²⁴⁻²⁷ Hökfelt et al²⁴ and Ljungdahl et al²⁸ have demonstrated SP containing "C" afferents in the skin, prevertebral sympathetic and dorsal root ganglia, and dorsal, ventral, and intermediolateral columns of the spinal cord. The application of these peptides to motor neurons in spinal cord preparations results in prolonged depolarization.^{29,30} They are many times more potent than excitatory amino acids or acetylcholine.²⁹ The depolarization of motor neurons occurs after a long latent period, is long lasting, and has a prolonged after-discharge.^{29,30} It is blocked in the rat spinal cord by the GABA derivative baclofen.³¹ SP may act as a neuromodulator in the spinal cord that may be released in concert with a faster acting neurotransmitter to modulate the excitability of neurons in its environment.³⁰ The central effects of intrathecal instillation of SP are to enhance the motor response to noxious or nociceptive stimuli.^{32,33}

Beacham and Perl³⁴ described a reflex that links the somatic and sympathetic nervous systems. They demonstrated that dorsal root afferent volleys carried by myelinated and unmyelinated fibers initiate discharge of preganglionic sympathetic fibers at both the entry and adjacent spinal levels.³⁴ Thus, a clear neuroanatomic network exists for the linkage of painful as well as nonpainful sensory information to discharge sympathetic fibers intrinsic to the spinal cord and the prevertebral ganglia.³⁵ This sympathetic innervation has profound effects on the muscle spindle, primary "C" fiber afferents, and the muscle itself.³⁶ The tremor, difficulty with initiation of movement, and increase in reflexes and muscle tone may be directly related to hyperactivity of the sympathetic nervous system in RSD. We suggest that the interaction between SP and the sympathetic nervous system directly initiates the intense and prolonged depolarization of anterior horn cells that may underlie the dystonia of RSD.³⁶⁻³⁸

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