CLINICAL CRITERIA AND TREATMENT OF SEGMENTAL VERSUS UPPER EXTREMITY REFLEX SYMPATHETIC DYSTROPHY

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The effectiveness of a multimodal treatment protocol in the long-term management of upper extremity reflex sympathetic dystrophy (RSD), as well as of isolated finger involvement, was analyzed. In the present series, 62 patients diagnosed with RSD were treated and followed for a mean of 22.2 + 1.5 months. The findings in the present study indicate that : 1) RSD occurs predominantly in females (female :male, 3 :1) ; 2) regional dystrophy is twice as common as segmental dystrophy ; 3) segmental dystrophy is most often associated with minor traumatic dystrophy, whereas regional dystrophy is more evenly distributed among the various clinical types ; 4) patients with regional dystrophy score their pain significantly higher ; and 5) segmental and regional dystrophy respond with equal satisfaction to the multimodal treatment regimen. In conclusion, the weight of the available evidence strongly suggests that RSD is a complex multifaceted disease entity which responds well when managed with a multimodal treatment program aimed at the various interacting components of the disorder. Furthermore, the finding that segmental dystrophy did not behave differently from the treatment protocol compared to extensive upper extremity RSD, suggests that the anatomic location of the syndrome may not significantly alter the course of the disease during treatment.

Keywords : RSD ; causalgia ; upper extremity ; clinical criteria of segmental vs upper extremity RSD.
Mots-clés : algodystrophie réflexe sympathique ; causalgie ; membre supérieur ; critères cliniques d'algodystrophie réflexe sympathique segmentaire ou du membre supérieur.

INTRODUCTION

Reflex Sympathetic Dystrophy (RSD) is a complex clinical entity for which various clinical types are now recognized. In the upper extremity, it presents as a modification of the normal pain response, usually as a complication of trauma to the nerves and/or muscles, surgery, such as carpal tunnel release, or it is caused by other factors, including primarily the overuse syndrome in which the disorder is attributed to extensive use of the hand and extremity, as in the case of pianists (4, 6, 15).

The course of RSD suggests that this syndrome may be an abnormally severe and prolonged manifestation of the normal physiologic sympathetic response to pain after injury (3, 5, 10). The prolongation of a normal sympathetic response disrupts homeostasis so that the otherwise adaptive response becomes pathologic. Although the sympathetic component of RSD is widely accepted, other recent data suggest that the early symptoms closely resemble those of an inflammatory reaction,

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findings which underscore the complexity of the disease and its presentations (19). Because the pathophysiology of the RSD syndrome remains obscure and lacks an appropriate animal model for its in-depth investigation, further refinements of the initial definition, such as sympathetically-maintained pain (SMP) and sympathetically-independent pain (SIP) have been attempted in an effort to delineate more accurately the abnormal pain alterations in response to trauma (16).

The great variety of treatment regimens used today to manage RSD appear to provide only temporary relief of symptoms in most cases. It is likely that this may be related not only to mostly unimodal therapeutic paradigms, but to the difficulties faced in diagnosis, as well as classification of the disease. In the present study, we assess the effectiveness of a multimodal treatment protocol in the long-term management of extensive upper extremity RSD, as well as isolated local finger involvement, according to the extent and clinical expression of the disease.

CLINICAL PRESENTATION AND CLASSIFICATION OF RSD

The excessive prolongation of the sympathetic response constitutes the basis of the major symptoms of RSD, including persistent pain, swelling, stiffness and discoloration of the extremity. Secondary symptoms include diffuse osteoporosis and pseudomotor and temperature changes, as well as vasomotor instability (3, 10).

Reflex sympathetic dystrophy represents a complex, multifaceted disease with a plethora of symptoms which evolve and change with the progression of the disease over time. The course of its gradual evolution has been divided into three stages according to the evolution of the symptoms manifested (12). Initially, very soon after the injury, during stage I, vasodilatation produces hyperemia and oedema. This is the so-called "traumatic stage" which extends from the first to the third month and which is characterized by intermittent burning pain, swelling and lack of motion, as well as redness and sweating of the extremity. Bone demineralization begins in stage I and by the end of stage I vasoconstriction produces peripheral vasospasm. Within a couple of months, with the onset of stage II, the extremity begins to cool and the skin undergoes atrophy and becomes shiny. This is the dystrophic stage which begins from approximately the third month and lasts until about nine to twelve months. It is characterized by a marked stiffening of the joints which is related to the hardening of the swollen extremity, increased pain and a decrease in sweating and redness. Demineralization of the carpal bones is more evident, as is the peripheral vasospasm resulting from persistent vasoconstriction. Stage III or the atrophic stage begins around the ninth to twelfth month and may last for years. During this stage the extremity resembles a Volkmann's ischemic contracture. Pain tends to be somewhat intermittent at first and gradually worsens and peaks as the disease progresses. In stage III both the skin and subcutaneous tissue undergo atrophy. In addition the skin also becomes dry and cool, and the extremity is marked by an extreme stiffness.

Five clinical types of RSD are now recognized (12, 13). These include minor causalgia, minor traumatic dystrophy, shoulder-hand syndrome, major traumatic dystrophy, and major causalgia. *Minor causalgia* is generally attributed to cutaneous nerve injury, and as it tends to involve only the nerves of the wrist and hand, only a small region of the hand, usually 1 or 2 fingers, is affected. Injuries to the sensory branches of the radial, median and ulnar nerves, as well as digital and common digital nerves may act as causative factors for the development of minor causalgia. It is the least severe form of RSD and is associated with less pain, swelling, stiffness, discoloration and osteoporosis.

Minor traumatic dystrophy is the most common of the clinical types. Frequently this form of dystrophy is related to a definite injury, but one which is minor in severity, such as crushing of the hand, a fracture-dislocation, sprain or puncture wound. It presents with redness of the dorsum over the joints, mild palmar fasciitis and stiff digits, usually in a flexion contracture.

The *shoulder-hand syndrome* is characterized by pain and stiffness in the shoulder, with significant swelling of the hand and wrist. It is usually

related to an initial injury which tends to be proximal, such as injuries to the shoulder, sprains or fractures of the cervical spine and even the viscera, including myocardial infarction and stomach ulcer. The signs of shoulder-hand syndrome include a diffusely red, warm and dry extremity which exhibits palmar fasciitis. Limited or minor hand trauma may also predispose to the onset of shoulder-hand syndrome.

Major traumatic dystrophy has a more severe presentation of pain and symptoms, and although it is usually related to a major injury, such as a severe crush injury, Colles fracture, or severe wrist fracture-dislocation, it has also been associated with elective surgery, such as for carpal tunnel syndrome. Digits are usually in a flexion contracture, and wrist motion is very limited.

Major causalgia is characterized by the most severe pain, which is usually attributed to an injury of a major mixed nerve, such as the median nerve. Damage is usually proximal, and the extremity manifests a slight redness, sweating and coolness. Fingers tend to be in flexion contracture, and the extremity is very stiff. In general, pain and dysfunction are worse compared to the other forms of RSD.

PATIENTS AND TREATMENT

Diagnosis of RSD was done taking into consideration both the criteria established in the consensus report of an *ad hoc* committee of the American Association for Hand Surgery on the definition of RSD syndrome, as well as the criteria outlined by Kozin *et al.* (1, 11). Diagnostic criteria included persistent diffuse pain, the loss of hand function and autonomic dysfunction. Evidence for autonomic dysfunction was based on changes in skin and/or soft tissue blood flow, as reflected by increases or decreases in temperature, sweating, etc. Three-phase bone scans were performed as a supplemental diagnostic means for confirmation of RSD. Although the specificity and sensitivity of the method remain somewhat debatable in so far as information on the patient's angiogram (phase I) and blood pool (phase II), the findings from the third or delayed metabolic phase appear to be valuable in evaluating the patient (14, 9, 20). Specifically, criteria of altered scintigraphy were increased perfusion of the affected segment compared to the opposite hand in the first stage, increased uptake at the MCP, PIP and DIP joints in the second stage, or increased periarticular uptake in all joints of the affected segment in the third stage. The criteria for diagnosis for segmental versus regional dystrophy were similar, with the exception that the anatomic involvement was less than the entire hand for patients with segmental dystrophy, involving only a small segment of the hand or a single digit.

In the present series, 62 patients were diagnosed with RSD. Nine of these patients are still undergoing treatment. Compatible with previous findings, the vast majority of our patients were females with a female-to-male ratio of 3 :1. Specifically, there were 46 females (74.2%) and 16 males (25.8%) with a mean age of 44.3 years (17-76 years) for females and 45.8 years (20-65 years) for males. The primary etiological factor associated with RSD was trauma (57.4%), followed by surgery (22.9%). In 19.7% of the patients, RSD was related to the overuse syndrome. There was a virtually equal distribution of the patients with regional dystrophy as a function of the stages. Of the patients with segmental dystrophy, 9 were in stage I, 6 in stage II and 4 in stage III.

A total of 19 patients had segmental dystrophy, while in 43 patients the disease was regional (table I). Specifically, segmental dystrophy included 5 single digits, 11 multidigits (usually 3 digits), and 3 patients with a small portion of the hand affected. The patients with regional dystrophy included 15 for hand, 13 for wrist, 8 from elbow-to-hand and 7 from shoulder-to-hand.

Table I. — Anatomic distribution of RSD among patients

Type	Location	N
Segmental	Part hand	3
	Single digit	5
	Multi digit	11
		19
Regional	Shoulder-hand	7
	Elbow-hand	8
	Wrist	13
	Hand	15
		43
Total		62

Although the specific treatment protocol was individualized according to the patient's needs, treatment involved a multimodal regimen aimed at interrupting

the abnormal sympathetic reflex arc, eliminating the initiating pain, and managing the loss of hand function. Management of the abnormal sympathetic reflex was achieved using stellate ganglion blocks, and the regional application of guanethidine, lidocaine and glucocorticoids. Specifically, stellate ganglion blocks were performed to interrupt the abnormal sympathetic reflex by blocking efferent impulses to the extremity. Thus, by preventing sympathetic activity in the extremity, the patient's skin became warmer and dryer, and returned to a normal color. Stellate blocks were administered by using either bupivacaine (15-20 ml of 0.25%) or lidocaine (20 ml of 1%). Three to 10 sessions were performed at 10- to 14-day intervals. Stellate blocks were used mainly for treating patients with shoulder-hand syndrome, although they were also applied for regional RSD located below the elbow. The stellate block was considered successful when a Horner's sign developed and warming of the affected hand was observed. Guanethidine or lidocaine were applied locally in order to decrease sympathetic vasoconstriction of peripheral vessels (7, 8). Like other sympatholytic drugs, or alpha- or beta- adrenergic receptor antagonists which are used for the same purpose, guanethidine acts by blocking catecholamine storage in sympathetic nerve terminals, so that sympathetic vasoconstriction of the peripheral vessels is reduced. A mixture of 10 mg guanethidine in 25 ml of normal saline was administered using Bier's double-tourniquet block technique. Lidocaine and corticosteroids were applied regionally (5 ml of 2% lidocaine in 15 ml of normal saline and 80 mg of prednisolone in 5 ml of normal saline) in order to prevent increased sympathetic stimulation from reaching the affected area by acting as a local nerve block (18).

In addition to eliminating the abnormal sympathetic response, the above methods also acted to relieve pain. Elimination of the factors causing pain, however, was primarily achieved by anti-inflammatory drugs, aspirin, and vasodilators which reduced swelling and stiffness. Calcitonin nasal spray (200 IU per day), which has been reported to significantly decrease pain and improve the range of motion, was also given to all patients (2). Warm gloves were used to reduce muscle spasm.

The loss of hand function was managed following Watson's hand rehabilitation by using both "scrub" and "carry" exercises (21). Night splints were used to return the hand to a normal resting position and relieve pain during motion. Reconstructive procedures were performed as required. Patients were followed from 7 to 47 months with an average of 22.2 $\pm$ 1.5 months.

RESULTS AND DISCUSSION

Of the 5 clinical types of RSD identified, 21% of our patients (13) had minor causalgia, 38.7% (24) had minor traumatic dystrophy, 9.7% (6) had shoulder-hand syndrome, 25.8% (16) had major traumatic dystrophy, and 4.8% (3) had major causalgia. Treatment was initiated approximately 4 months after the onset of pain for patients with segmental dystrophy, and approximately 7 months after the onset of pain for patients with regional dystrophy. Interestingly, the pain experienced by the patients was scored significantly higher in the patients with regional dystrophy compared to patients with segmental dystrophy (5.6 ± 0.3 vs 4.1 ± 0.5, respectively ; $p < 0.01$, Student's t-test).

Minor causalgia (associated with cutaneous nerve injury, involving nerves of hand or wrist, affecting one or two fingers or a small hand region, causing less pain, swelling, stiffness, discoloration and osteoporosis) : of the 13 patients (21.0% of the total series) with minor causalgia, all were females with ages ranging from 17 to 65 years (mean age : 34.7 ± 4.6 years). Although minor causalgia usually affects a couple of fingers or a small hand region, only 2 patients (15.4%) had segmental dystrophy, while 11 (84.6%) had regional dystrophy, affecting the entire hand. Minor causalgia was predominantly related to overuse syndrome (61.5%), and more rarely was a complication of trauma (23.1%) or surgery (15.4%). Pain was endured for an average of 5.5 ± 1.3 months before the initiation of treatment and was scored 4.3 ± 0.5 on a pain scale of 0 to 10 by the patients. The majority of those patients who completed treatment demonstrated excellent results (66.7%) while 25% had very good results and only 8.3% had fair results (table II).

Minor traumatic dystrophy (most common, involving one or a few fingers, the initial trauma being a crush, a fracture-dislocation, a sprain, or a puncture wound, with red dorsum over joints, mild palmar fasciitis, stiff digits and flexion contracture) : 24 patients (38.7%) with this form of dystrophy, which also tends to involve a smaller

Table II. — Etiology and results according to clinical type of RSD (Number of patients)

Type	Etiology			Results			
	Trauma	Surgery	Overuse* Syndrome	Excellent	Very Good	Good	Fair
Minor causalgia	3	2	8	8	3	—	1
Minor traumatic dystrophy	13	7	4	4	5	—	1
Shoulder-hand syndrome	3	3	—	1	2	—	4
Major traumatic dystrophy	13	2	—	9	2	1	4
Major causalgia	3	—	—	2	1	—	—

* One patient had RSD associated with an etiological factor not listed above.

anatomical region, were treated. There were 18 females (75%) and 6 males (25%) with ages ranging from 18 to 62 years (mean age : 44.1 ± 2.7 years). In this group, the majority of patients had segmental dystrophy (17 or 70.8%), compared to regional dystrophy (7 or 29.2%). The primary etiological factor for these patients was trauma (54.2%) followed by surgery (29.2%). Only 4 patients (16.7%) expressed the disorder as a result of overuse. Pain which was scored 4.2 ± 0.5 by the patients, was endured 4.9 ± 0.9 months before treatment was sought and initiated. Excellent results following treatment were obtained in 70% (14) of these patients, while 25% and 5% had very good and fair results respectively.

Shoulder-hand syndrome (pain, stiffness in the shoulder, swelling hand, wrist and arm proximal initial trauma — shoulder, neck, rib cage, viscera —, diffuse redness, warm and dry skin) : three females and three males, 20 to 65 years of age (mean 49.2 ± 7.1 years), were treated for shoulder-hand syndrome. By definition, all of these patients (6) had regional RSD. Presentation of the shoulder-hand syndrome was related equally to trauma (3) and surgery (3).

Pain received a relatively high score in these patients (7.3 ± 0.3), which was significantly greater than for patients with minor causalgia and minor traumatic dystrophy ($p < 0.05$ by ANOVA, followed by Fisher's PLSD). Although the number of patients in this group is considerably smaller than in the previous, the results tended not to be as dramatic. All of these patients were treated with stellate blocks which produced excellent results in 25% and very good or good results in 50% and 25% of the patients, respectively.

Major traumatic dystrophy (increased pain and symptoms, usually flexion contracture of the digits, limited wrist motion, frequent carpal tunnel syndrome, major initial trauma — crush, Colles' fracture. severe wrist fracture-dislocation) : there were 10 females and 6 males (62.5% and 37.5%, respectively) with ages ranging from 26 to 76 years (mean 50.4 ± 3.6 years) who were treated for major traumatic dystrophy. All 16 patients in this group had regional dystrophy. Trauma was the cause for 86.7% of the cases, while 13.3% were associated with surgery. Pain, which was endured an average of 8.3 ± 1.6 months, was scored high by the patients (6.3 ± 0.4). Of the patients who completed the multimodal treatment protocol, 69.2% (9) had excellent results, 15.3% (2) had very good results and 7.7% (1) had good and fair results.

Major causalgia (extreme pain, associated with major mixed nerve injury — median nerve —, damage usually to the proximal part, slight redness, sweating, coolness, flexion contracture of fingers, and extreme stiffness) : three patients, two females and one male, with major causalgia were treated. Ages ranged from 39 to 60 years (mean age : 53 ± 7 years). Two of the patients had regional dystrophy, while one had isolated finger involvement. Trauma was the etiological factor in all cases, and pain was scored 6.3 ± 2.6. The results were excellent in two patients and very good in one.

DISCUSSION

The differences in the etiological factors between segmental and regional dystrophy approached statistical significance ($p < 0.07$), with regional dystrophy being more often associated with the overuse syndrome (26.8%) compared to segmental (5%) (table III) The differences between patients with segmental versus regional RSD in the various clinical types of the disease do not appear to reflect the outcome following treatment. The majority of patients with segmental or regional RSD exhibited excellent results following therapy (68.8% and 63.9%, respectively).

Table III. — Etiology and results for segmental vs regional RSD

	Segmental	Regional
Etiology		
Trauma	60.0%	56.1%
Surgery	35.0%	17.1%
Overuse syndrome	5.0%	26.8%
Results		
Excellent	68.8%	63.9%
Very good	25.0%	25.0%
Good	—	5.6%
Fair	6.2%	5.5%

The most notable contrast between the two anatomically-defined forms concerned the clinical types observed ($p = 0.0001$, chi-square test). Specifically, the majority of patients with segmental RSD had minor traumatic dystrophy (17 or 85%), while the patients with regional dystrophy were more evenly distributed among the different clinical types (fig. 1). This may be related in part to the differences in pain scoring attributed to the patients, with regional dystrophy being associated with significantly more pain, as noted earlier.

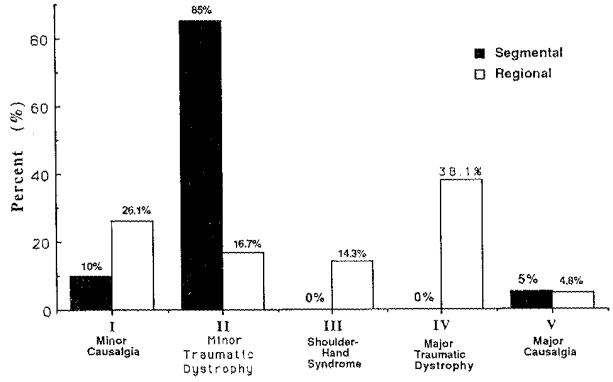

Fig. 1. — Distribution of the clinical types for isolated finger involvement (segmental) versus extensive upper extremity (regional) RSD.

In summary, the findings of the present study suggest the following : 1) compatible with previous studies, RSD occurs overwhelmingly in females (3 :1) ; 2) regional dystrophy is twice as common as segmental dystrophy ; 3) segmental dystrophy is most often associated with minor traumatic dystrophy, whereas regional dystrophy is more evenly distributed among the various clinical types ; 4) patients with regional dystrophy score their pain significantly higher ; and 5) segmental and regional dystrophy respond with equal satisfaction to the multimodal treatment regimen. Overall, the weight of our evidence suggests that RSD is a complex multifaceted disease entity which responds well when managed with a multimodal treatment program aimed at the various interacting components of the disorder (21). Although segmental RSD did not appear to behave differently with the treatment protocol, the recognition and documentation of a more localized form of RSD may allow for its earlier diagnosis and treatment, and thus improve the chances for a successful outcome.

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SAMENVATTING

P. N. SOUCACOS, L. A. DIZNITSAS, A. E. BERIS, K. N. MALIZOS, T. A. XENAKIS, G. S. PAPADOPOULOS. Klinische criteria en behandeling van segmentaire versus bovenste lidmaat reflex sympatische dystrofie.

De efficaciteit van een multimodaal behandelingsprotocol in het beleid van zowel bovenste lidmaat als vinger dystrofie werd geanalyseerd. In deze reeks werden 62 patiënten behandeld en gevolgd voor 22.2 ± 1.5 maand. De bevindingen zijn de volgende : 1) RSD treft vln vrouwen (3 :1) ; 2) regionale RSD is tweemaal zo frequent als segmentaire ; 3) segmentaire RSD ziet men vln na mineure traumata terwijl men regionale RSD meer gelijk gespreid vindt over de verschillende vormen van RSD ; 4) regionale RSD scoort hoger op de pijnschaal ; 5) beide vormen beantwoorden gelijkmatig op de multimodale behandeling. RSD is een complexe aandoening met verschillende facetten die beantwoordt aan een behandeling die ingrijpt op verschillende componenten van de aandoening. Segmentaire RSD verschilt weinig van de regionale RSD en dit wijst erop dat de anatomische localisatie het verloop van de aandoening niet significant beïnvloedt tijdens de behandeling.

RÉSUMÉ

P. N. SOUCACOS, L. A. DIZNITSAS, A. E. BERIS, K. N. MALIZOS, T. A. XENAKIS, G. S. PAPADOPOULOS. Critères cliniques et traitement des formes segmentaires et complètes de l'algodystrophie réflexe sympathique du membre supérieur.

L'efficacité d'un protocole de traitement multimodal de prise en charge à long terme de l'algodystrophie réflexe sympathique touchant l'ensemble du membre supérieur ou un doigt isolé a été analysée. La série comporte 62 patients traitée, suivis pendant une durée moyenne de 22,2 ± 1,5 mois. Les observations de l'étude sont les suivantes : (1) l'algodystrophie touche plus volontiers les femmes (rapport femmes/hommes : 3.1) ; (2) la forme régionale est 2 fois plus fréquente que la forme segmentaire ; (3) la forme segmentaire est plus souvent associée à une algodystrophie mineure traumatique, tandis que la forme régionale se manifeste de manière égale selon les différents types cliniques ; (4) les patients présentant une algodystrophie régionale souffrent de douleurs plus intenses ; (5) les formes segmentaires et régionales répondent de manière équivalente au protocole de traitement multimodal. En conclusion, l'algodystrophie réflexe sympathique est une affection complexe, dont les présentations cliniques sont variées, mais répondant bien au traitement multimodal dirigé contre les différentes facettes interactives de l'affection. En outre, la constatation que la forme segmentaire répond de manière équivalente au traitement par rapport à la forme extensive suggère que la localisation anatomique du syndrome n'influence pas de manière significative l'évolution sous traitement de l'affection.