EFLEX sympathetic dystrophy (RSD) is a neuropathic pain syndrome of unknown origin. The syndrome is now also referred to as complex regional pain syndrome, Type 1 (CRPS 1). It is characterized by motor symptoms, sensory symptoms (burning pain, allodynia, and hypesthesia), and symptoms of sympathetic disturbance (skin color changes, swelling, hyperhidrosis, and trophic changes in the skin and bone of the affected extremity). Because nearly all cases are precipitated by trauma, most scientists agree that nerve injury is involved in the pathogenesis of the syndrome and that this would cause secondary changes in the dorsal horn and/or pain maintaining sympathetic complications. Because the cause of RSD remains unknown, treatment is largely aimed at relieving the pain. Conventional pain treatments, however, appear ineffective in most cases of RSD.

Electrical spinal cord stimulation (SCS) has been used to treat pain since 1967. The findings in the first studies in which SCS was used to treat RSD were promising. Since 1987 we have used SCS for the treatment of pain in patients with RSD who do not respond to conventional treatments such as physical therapy, radiofrequency sympathetic nerve blocks, regional intravenous sympathetic blocks, and transcutaneous electrical nerve stimulation (TENS). To assess the clinical efficacy and possible adverse effects of SCS in reducing pain in patients with RSD we have retrospectively studied all 23 consecutive RSD patients treated in the Pain Management and Research Centre of the Maastricht University Hospital since 1991. The majority of patients with RSD reported improvement after implantation of an SCS system.

Object. The aim of the study was to assess retrospectively the clinical efficacy and possible adverse effects of electrical spinal cord stimulation (SCS) for the treatment of patients with reflex sympathetic dystrophy (RSD).

Methods. Twenty-three patients who suffered severe pain due to RSD were included in the study. The SCS system was implanted only after a positive 1-week test period. The visual analog scale (VAS) score for pain (1–10) was obtained in all patients prior to treatment, 1 month postimplantation, and at last follow up. At final follow-up examination, patients were asked to rate the effect of their treatment on the 7-point global perceived effect scale. Eighteen (78%) of 23 patients treated between 1991 and 1997 reported improvement during the test period. Permanent implantation of SCS system was not performed in the other five patients. Complications occurred in nine (50%) of 18 patients. The system was removed in three patients after implantation (17%). At the end of follow up (mean 32 months) 15 patients still had an implanted system. The mean pain score had decreased from 7.9 to 5.4 (p < 0.001). In the other eight patients the pain score had not changed significantly. In 13 patients (57%) in whom the SCS system was implanted, clinical status had much improved or improved; these cases were regarded as successful.

Conclusions. In this retrospective series, the majority of patients with RSD reported a subjective improvement after implantation of an SCS system.

KEY WORDS • reflex sympathetic dystrophy • complex regional pain syndrome • spinal cord stimulation
Test Stimulation

After an intravenous injection of cefuroxim (1500 mg), the patient was placed in the lateral position and a 5-cm vertical midline incision was made in the thoracic or lumbar spine, depending on the affected extremity. The epidural space was localized with a Tuohy needle. Using direct fluoroscopy, an SCS electrode (Pisces Quad lead, model 3487A; Medtronic, Minneapolis, MN) was advanced through the needle, connected to an external screen (model 3625; Medtronic), and positioned until the tip of the electrode was at the required level. After a testing period of 7 days, the temporary lead was removed. In patients who had the Quad lead implanted (before 1996), the lead was removed only if the test stimulation procedure was negative. During the testing period, patients were advised to perform all normal daily activities to get a good impression of the implant’s effect. To diminish the chance of infection, patients were not permitted to take a shower. The SCS system was implanted when during the testing period the patient reported a reduction in pain (50% decrease in original visual analog scale [VAS] score) that was estimated by the patient for the entire week of test stimulation, or if the patient reported “much improvement” on a 7-point global perceived effect (GPE) scale. The GPE categories include best ever, much improved, not improved/not worse, worse, much worse, and worst ever.

Implantation of the SCS System

In patients treated before 1996, the lead remained in situ after a positive test period. In patients treated after 1996, the Quad lead was implanted as described previously in the Test Stimulation section. After the lead was positioned, patients received a sedative and a pulse generator (Itrel 2 or 3, model 7424 or 7425; Medtronic) was implanted in the subcutaneous tissue in the left lower anterior abdominal wall, and it was connected to the electrode by a tunneled extension lead (model 7495-51 or 7495-66; Medtronic). After closing the skin, the pulse generator was activated and adjusted using a console programmer (model 7432; Medtronic). Initial stimulation was started at a rate of 85 Hz and a pulse width of 210 usec. Patients in whom the Itrel 2 system was planted were able to switch between a fixed high and low amplitude, using a magnet (model 7452; Medtronic), whereas patients in whom the Itrel 3 system had been implanted could control the stimulation intensity by adjusting the amplitude from 0 to 10 V with a patient programmer (model 7434-NL; Medtronic). Postimplantation, patients remained in the hospital for 24 hours, during which they received two doses of cefuroxim (750 mg) intravenously. The following day an x-ray film was obtained. When no change in the position of the electrode was evident on the x-ray film, the patient was discharged. Further adjustments in programming could be made on an outpatient basis. Postimplantation no restrictions were placed on patient activities. Only extreme body movements may be harmful to the system, and these disabled patients are not likely to make such movements.

Patient Assessments

Using the VAS, patients rated their daily average pain at the last outpatient visit prior to implantation (baseline pain score) and at 1 month postimplantation. Complications were recorded throughout treatment and follow-up period. At the end of the follow-up period, patients were contacted by mail and asked to rate their GPE in comparison with pretreatment scores. If the patients indicated their condition was better, “improved,” treatment was defined as a “success.” Anything less than a score of “improved” was defined as “failure.” At the end of the follow-up period, patients were again asked to rate their pain by using the VAS at three fixed time points per day for 4 consecutive days. The average of these samples was calculated.5

Statistical Analysis

Statistical analysis was performed using the t-test for paired samples or the Wilcoxon signed rank sum test, as appropriate. A probability value of less than 0.05 was considered statistically significant.

Results

Baseline Data

Twenty-three patients with RSD underwent implantation of a (temporary) lead for SCS. In 13 patients RSD affected the leg and in 10 it affected the arm. There were eight men and 15 women. The mean age was 39 years (range 24–54 years); the mean duration of RSD was 44 months (range 9–179 months). The RSD was precipita-
Spinal cord stimulation in reflex sympathetic dystrophy

Test Stimulation

Eighteen (78%) of 23 patients reported improvement during test stimulation. The other five patients noted no effect in spite of adequate paresthesia in the affected area (Cases 18 and 19) or more pain (Cases 5, 7, and 23); these patients did not receive permanent implantations. During the test stimulation period three complications were recorded. In one patient (Case 5) the trial period was complicated by a defective temporary lead. In another patient the lead shifted from C-6 to C-7 (Case 12). A new temporary lead was placed in both cases; however, it was effective in the latter patient only. One other patient suffered a subcutaneous hematoma (Case 7).

Pain Relief at 1-Month Follow Up

One week after removal of the temporary lead, the 18 patients who had responded positively to the test stimulated by trauma in 14 patients, by surgery in seven, and by infection and an intravenous infusion cannula in the last two patients. Prior to implantation, all patients had been treated with nonsteroidal antiinflammatory drugs, opioids, antidepressants, anticonvulsants, and adrenergic blocking drugs by stellate ganglion blocks or lumbar sympathetic blocks. Twenty patients had undergone physical therapy, 16 patients had undergone TENS, and 22 patients had undergone other treatments (intravenous mannitol infusion, 50% dimethyl sulfoxide application)4,16 without lasting success. Demographic, treatment, and outcome data for the patients are summarized in Table 2.


**TABLE 2**

*Treatment and outcome data in 23 patients with RSD who underwent treatment with SCS*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Duration of RSD (mos)</th>
<th>Location</th>
<th>SB</th>
<th>TENS</th>
<th>PT</th>
<th>Manitol</th>
<th>DMSO</th>
<th>Test SCS Failure</th>
<th>Fail-ure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27, F</td>
<td>54</td>
<td>lt leg</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>42, M</td>
<td>40</td>
<td>lt arm</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>34, F</td>
<td>27</td>
<td>lt leg</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>26, F</td>
<td>15</td>
<td>lt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>45, F</td>
<td>49</td>
<td>lt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>37, F</td>
<td>23</td>
<td>rt arm</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7</td>
<td>45, F</td>
<td>20</td>
<td>lt leg</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>37, F</td>
<td>179</td>
<td>rt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>50, F</td>
<td>26</td>
<td>lt leg</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>10</td>
<td>43, M</td>
<td>29</td>
<td>lt leg</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11</td>
<td>49, M</td>
<td>40</td>
<td>rt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>12</td>
<td>45, M</td>
<td>65</td>
<td>lt leg</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>13</td>
<td>29, M</td>
<td>32</td>
<td>lt leg</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>14</td>
<td>27, F</td>
<td>50</td>
<td>lt leg</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>15</td>
<td>54, F</td>
<td>16</td>
<td>lt leg</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>16</td>
<td>50, M</td>
<td>43</td>
<td>rt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>17</td>
<td>32, F</td>
<td>9</td>
<td>rt leg</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>18</td>
<td>48, F</td>
<td>21</td>
<td>lt leg</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>19</td>
<td>50, F</td>
<td>54</td>
<td>lt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>20</td>
<td>28, F</td>
<td>99</td>
<td>rt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>21</td>
<td>24, M</td>
<td>32</td>
<td>rt leg</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>22</td>
<td>32, M</td>
<td>31</td>
<td>lt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>23</td>
<td>50, F</td>
<td>55</td>
<td>rt arm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* PT = physical therapy; SB = sympathetic block.

Pain Relief at Final Follow-Up Examination

The follow-up period lasted for a mean duration of 32 months (range 6–79 months). In the group of patients who underwent implantation of the SCS system the mean pain score at the end of the follow-up period was 5.4 (15 patients; range 1–8.4), which was a significant reduction from baseline (7.9, p = 0.001). At the end of follow-up review, eight of the 23 patients did not have an implanted SCS system (for reasons to be presented); these patients reported a mean pain score of 6.8 (range 2.3–9.3), which was not a significant reduction from baseline (7.3). Figure 1 shows the mean pre- and posttreatment pain scores for the 15 patients with and the eight patients without the SCS system.

Device-Related Complications

Nine (50%) of 18 patients suffered complications after implantation of the permanent SCS system (Table 3). Most complications were technically related to the device, and all of these complications required that the patient undergo reoperation. In four cases the system was removed. In two cases this was due to major complications (infected pulse-generator pocket 1 month postimplantation in one patient and an infected lead wound 8 months postimplantation in another). When infection had resolved, a new system was implanted in the patient with the infected pulse-generator pocket. Because the patient with the infected lead wound did not notice any worsening of the pain after the system was removed, no attempt was made to implant a new system. In the other two cases implants were removed because of lack of effect (at 12 and 20 months postimplantation). Overall, in three patients (17%) the system was removed definitively.

Global Perceived Effect

Graphic reproduction of the GPE scores is shown in Fig. 2. In the 15 patients with an implanted SCS sys-
tem, eight patients indicated a score of “much improved,” five patients indicated “improved,” and two patients indicated a score of “worse.” Therefore, outcome was regarded as successful in 13 patients. Four of these 13 patients had scores indicating their clinical status was “improved” or “much improved,” although their VAS pain score had either worsened or scarcely improved (< 1 on VAS). Two patients had scores indicating their GPE was “worse,” although their pain score had improved.

In the group of patients without a SCS system, two patients indicated a GPE score of “worst ever,” whereas three patients had scores indicating their GPE was “much worse” and one patient whose score indicated that the GPE was “not improved/not worse.” Remarkably, two patients’ scores demonstrated their GPE to be “much improved” and “improved,” respectively.

The success of the SCS system at the end of follow up was not significantly related to age, sex, duration of illness, affected extremity, affected side, or baseline pain score.

Discussion

Although SCS has been used to treat patients with severe chronic pain since 1967,13 only three studies on its clinical efficacy for the treatment of RSD have been reported.1,6,11 In addition to their methodological shortcomings (sample size, lack of pain scores, patient selection, retrospective analyses), these studies are particularly difficult to interpret because they present data on only successfully treated patients. We have therefore retrospectively studied all patients with RSD who underwent treatment with SCS in our hospital since 1991. To minimize bias, special effort was made to document every consecutive patient intentionally treated with SCS. Pain scores were recorded prospectively, and assessment of GPE was performed retrospectively.

Outcome and Significance

Test stimulation was successful in 18 (78%) of the 23 patients, which is in accordance with reported data.1 In three of these 18 patients in whom a SCS system was implanted, the effect waned over time and the system was removed. At the end of the follow-up period 15 of 23 patients had retained their implanted SCS systems. When success at the end of follow up is defined as a minimum GPE status of “improved,” 13 (57%) of 23 patients showed clinical improvement, which is similar to results achieved by Barolat, et al.1 Comparison with the other two studies6,11 is difficult because they do not describe patient selection.

In the successful SCS group, the mean 1-month postimplantation pain score had decreased from 7.9 to 4.2; at the end of the follow-up period (mean 32 months), however, this score had declined to 5.4. Whether this increase in pain scores reflects a short-term placebo effect or is mediated by diminished effect of the SCS system caused by spinal “resetting” or epidural fibrosis around the lead remains unknown.

In comparing pretreatment with postimplant stimulation, the patient’s perception depends on specific treatment but is heavily influenced by the natural course of the disease as well. This rationale suggests why two patients in whom implant failure resulted in removal indicated their clinical status was “improved” and “much improved.” On the other hand, it implies that some successfully treated patients might have improved without implantation of an SCS system. Four patients made “improved” or “much improved” recoveries, although their pain had worsened or had scarcely improved (< 1 on VAS). Clinical status in two other patients was “worse,” although their pain had improved. The observation that the GPE and pain scores do not completely correlate underscores the need to conduct a prospective study when evaluating SCS in a variable disorder such as RSD.14

Although functional status was not recorded prospectively in the present study, some data may be of interest. Pretreatment, two patients were wheelchair dependent, and two others could walk with the aid of crutches. Posttreatment, these four patients are walking without aid. Three patients who were unable to use their hand pre-
Spinal cord stimulation in reflex sympathetic dystrophy

treatment have regained its use. They are able, for example, to drive a car. Thus, the SCS system provided functional improvement in four (31%) of 13 patients with an affected leg and in three (30%) of 10 patients with an affected arm.

Methodological Considerations

In a study that evaluates the efficacy of SCS for the treatment of RSD several problems are encountered. First, because no objective measures are known with which to diagnose RSD, diagnosis is based on clinical criteria. All patients in this study fulfilled the International Association for the Study of Pain criteria for CRPS 1. All suffered severe pain, which was reflected by VAS pain scores of at least 6. Second, assessment of the efficacy of SCS cannot be truly performed in a “blinded” fashion because of the paresthesia that accompanies stimulation in patients with RSD. Nevertheless, results of this retrospective study should be seen in light of the fact that no control group has been used. Third, to assess the results of SCS on the level of pain, we are always dependent on subjective measures, which make it difficult to differentiate between effect and placebo. We tried to meet this problem by questioning all patients in whom SCS was attempted, not only those in whom SCS was a success.

One important feature of this study is the complete documentation of those patients nonsuccessfully treated. We believe that this is crucial for the evaluation of an expensive, demanding therapy used to treat a nonlife-threatening disorder. Until now studies have neglected to provide data on these failed cases.1,6,11 We found that the pretreatment degree of pain remained unchanged in patients who did not profit from SCS (eight patients), during a mean follow-up period of 32 months. This is an important observation, which suggests that whatever the outcome, SCS does not negatively affect the course of RSD.

Treatment Complications

Nine (39%) of the 23 patients suffered complications. In two patients the SCS system had to be removed due to a complication (9%). Based on findings from larger studies it is known that complications of various character necessitate removal of the system in 5 to 15% of cases.7,9 Technical defects are a substantial part of SCS management problems. In this study five (22%) of 23 patients suffered technical defects. Two of these defects (puls-generator failure, pulse-generator disconnection) might be considered random events, whereas the risk of the lead shifting and breaking in vivo seems to be inherent in the treatment itself; there is a reported incidence of these defects in 3 to 5% of cases.3,7 Although complications affect treatment results, cause patient discomfort, and generate costs, they rarely cause permanent neurological deficits.3,7,9 For this reason, the relatively high complication rate of SCS should not be an obstacle in treatment consideration but must be well communicated to the future patient.

Conclusions

The findings in our study suggest that SCS is effective in the treatment of a majority of patients with RSD, although the incidence of complications is substantial. To prove unequivocally the clinical and cost-effectiveness of SCS for the treatment of patients with RSD, a randomized, prospective study is required, one that includes effective parameters such as pain scores, functional assessments, and quality of life measures. Currently we are conducting such a study.

Acknowledgments

We would like to thank Mrs. Christophe and Mrs. Groeneweg for their assistance.

References

14. Veldman PM, Goris RJ: Multiple reflex sympathetic dystrophy: which patients are at risk for developing a recurrence of reflex dystrophy in the same or another limb? Pain 64:463–466, 1996

Manuscript received April 24, 1998. Accepted in final form August 19, 1998. Address reprint requests to: Marius A. Kemler, M.D., Department of Surgery, Maastricht University Hospital, P.O. Box 5800, 6202 AZ Maastricht, The Netherlands. email: mkeml@shee.azm.nl.