Case Report

Pain Relief in CRPS-II after Spinal Cord and Motor Cortex Simultaneous Dual Stimulation

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We describe a case of a 30-year-old woman who suffered a traumatic injury of the right brachial plexus, developing severe complex regional pain syndrome type II (CRPS-II). After clinical treatment failure, spinal cord stimulation (SCS) was indicated with initial positive pain control. However, after 2 years her pain progressively returned to almost baseline intensity before SCS. Additional motor cortex electrode implant was then proposed as a rescue therapy and connected to the same pulse generator. This method allowed simultaneous stimulation of the motor cortex and SCS in cycling mode with independent stimulation parameters in each site. At 2 years follow-up, the patient reported sustained improvement in pain with dual stimulation, reduction of painful crises, and improvement in quality of life. The encouraging results in this case suggests that this can be an option as add-on therapy over SCS as a possible rescue therapy in the management of CRPS-II. However, comparative studies must be performed in order to determine the effectiveness of this therapy.

Key words: Chronic neuropathic pain, Complex regional pain syndrome Type II, brachial plexus injury, motor cortex stimulation, spinal cord stimulation

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Complex regional pain syndrome (CRPS) is a severely disabling, uncommon form of chronic pain of unknown pathophysiology; it is characterized by prolonged or excessive pain and mild or dramatic changes in skin color, temperature, and/or swelling in the affected area (1). There are 2 similar forms of clinical presentation, called CRPS type I and CRPS type II (CRPS-II) respectively, both with the same symptoms and treatments. CRPS-II (previously named causalgia) is the term used for patients with confirmed nerve injuries. Individuals without confirmation of nerve injury are classified as having CRPS type I (previously called reflex sympathetic dystrophy syndrome) (1). Though most patients with CRPS may respond to clinical treatment with medications, physical therapy, and rehabilitation, there are cases considered refractory (2). For this population, neuromodulation often represents an important therapeutic option. To date, the most commonly used and effective neuromodulation to treat those patients is spinal cord stimulation (SCS) (3). SCS is currently the gold standard for refractory cases of CRPS. However, in clinical practice, there are cases that SCS's effect fades with time as reported by Kemler et al (4).

The purpose of this report is to summarize the case of a patient with a traumatic brachial plexus lesion suffering from CRPS-II, who achieved satisfactory pain control with SCS, but who subsequently developed tolerance and sensitization, thus requiring an additional neuromodulation strategy. Based on the encouraging experience of pain relief in CRPS after motor cortex stimulation (MCS) (5,6), a cortical electrode was implanted for simultaneous MCS and SCS through the same pulse generator in a cycling stimulation fashion. Treatment was indicated due to unsatisfactory evolution and based on our previous reported experience, in which we found that MCS is not only able to improve pain but also sensory and motor symptoms of severe CRPS (5).

Case Description

The patient is a 30-year-old, right-handed woman who suffered a gunshot wound resulting in a partial right brachial plexus injury and humerus fracture. Besides partial paralysis, severe pain started right after she was discharged from the hospital; it was present as a continuous burning and throbbing sensation, felt mostly in the right forearm and hand. The pain was severe and permanent, making sleep very difficult. It soon progressed to untreatable neuropathic pain with intense chronic pain syndrome on the lateral side of the right arm. There was associated decreased muscle strength with restricted range of motion of the shoulder in all directions. Electromyography of the right arm evidenced neuropathy in the right axillary nerve, with severe degeneration of motor fibers and signs of further degeneration in activity.

One month after her injury she had humerus reduction surgery and osteosynthesis and underwent a minimally invasive lung surgery to remove a projectile fragment that was causing hemoptysis. Until that moment, she had been treated with opioids and tricyclic antidepressants (methadone 30 mg/d, amitriptyline 50 mg/d). Multidisciplinary rehabilitation and physical therapy (PT) were also added to her treatment. Despite this, pain relief was not satisfactorily achieved. She had permanent high pain scores: visual analog scale for pain (VAS) of 10/10 and an SF-36 v2 (SF-36 v2TM Health Survey Scoring Demonstration) of 85. In addition to her continuous pain, allodynia, edema, changes in skin blood flow, and abnormal sudomotor activity and total anesthesia in both her arm and hand were present and notorious.

Spinal cord stimulation was indicated since medical therapies had failed to manage her pain on their own. An implantable system, Lamitrode 3240 with 4 contacts and one Eon Mini 3788 Impulse generator (Saint Jude Medical, Plano, Texas) with a 16-channel, multi-program system, using one lead with eight contacts, was implanted in the lower abdomen. The system allowed stimulation programs to be delivered as either a single stimulation or multiple stimulation programs. The stimulator aimed to deliver electrical pulses to the dorsal aspect of the cervical spinal cord. SCS together with medical treatment achieved a 40% partial improvement of pain in VAS (from 10 without stimulation to 6 with stimulation). Before SCS treatment the patient was not able to move her arm or hand; after SCS she began to progressively move her hand. The pain decreased to a certain extent immediately after the surgery, but returned almost to baseline soon after and remained at that level. Aggravating the picture, 2 months after SCS the patient suffered trauma in the right scapular region, had worsening pain, had added burning sensation and significant paresthesia in the forearm and right hand. The doses of drugs and electrical stimulation were increased in order to alleviate her pain. A year after the incident, the patient was readmitted with respiratory insufficiency and bradycardia due to opioid intoxication, secondary to an overdose. She was in a pain crisis due to the battery exhaustion of the pulse generator. After clinical stabilization, the pulse generator was exchanged.

Regrettably at that moment there was still no satisfactory result in pain control (from 10 to 8 in VAS) even with significant doses of methadone (80 mg/d), tramadol (300 mg/d), and venlafaxine (150 mg/d) and reprogramming the SCS parameters. Worsening the picture, adverse effects such as constipation, excessive thirst, nausea, vomiting, and anxiety were observed. At this time the system impedance was within the normal range (403 Ω). We tried a wide range of stimulation parameters in order to optimize pain control but no significant improvement was achieved (frequency of 10-130Hz, 60-200μs PW; 5.0μA-13μA amplitude).

Motor cortex stimulation was proposed as "add-on therapy" for her chronic and refractory neuropathic pain (Fig. 1A). Surgery was performed with the patient under mild sedation according to the technique described elsewhere (7,8). Intraoperative stimulation showed immediate pain relief with stimulation in contacts -1+2 at 50 Hz; 90μs; 10.3 mA, that corresponded to 80% of the motor threshold. Impedance in pole 1 was 837 Ω and in pole 2 of 792 Ω. After the surgery, the MCS electrode was connected to the same generator for SCS (Eon Mini 3788 Impulse generator [Saint Jude Medical, Plano, TX]) with cycling independent stimulation (Figs. 1B and 1C). Therapeutic medication dose adjustments included methadone 60 mg/d, and venlafaxine 150 mg/d and both electrodes turned on. The patient reported 62.5% improvement in pain (from VAS 8/10 to 3/10) and reduction in the number of painful episodes. Also there was a 42% improvement in quality of life scores (from 85 to 121 in SF-36 v2) with dual stimulation.

Two years following implantation of MCS using dual stimulation, the patient reported only isolated episodes of pain, improvement in muscle mass, improvement in arm and hand coloration, improvement in discriminative tactile sensation, and sustained alleviation of pain for at least one year (Fig. 2).

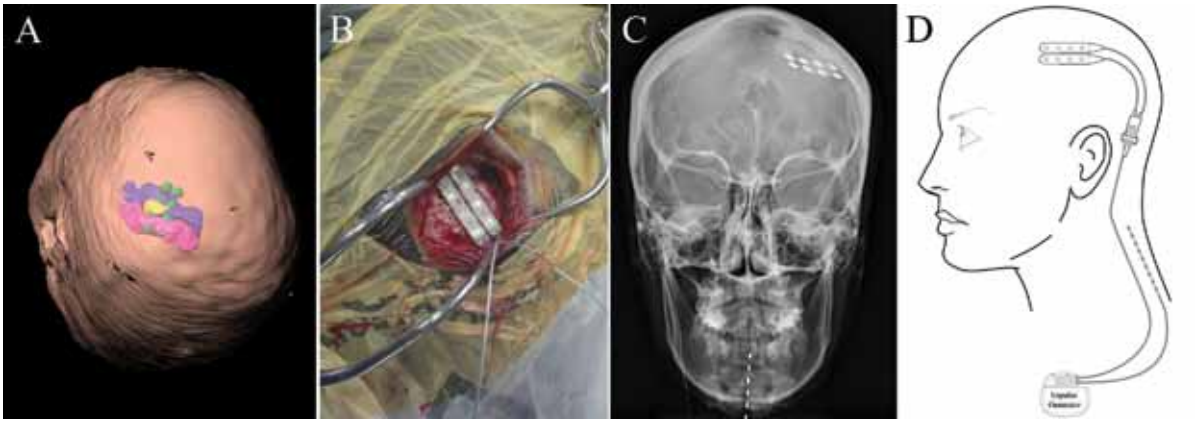

Fig. 1. *(A) Epidural implantation of 2 paddle electrodes side-by-side (8 contacts) over the motor cortex after navigation-guided craniotomy and intraoperative transdural bipolar electrical stimulation. (B) Plain radiography of the skull and cervical spine showing spinal cord stimulation linear electrode and motor cortex stimulation electrodes placed. (D) Illustration of simultaneous spinal cord and motor cortex stimulation, using cycling stimulation and connected to a sole impulse generator.*

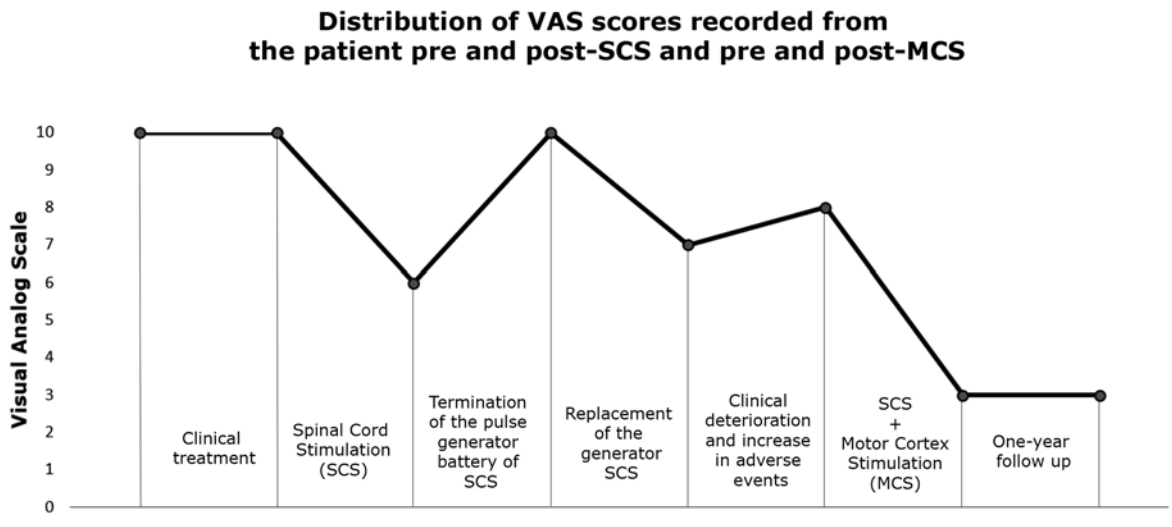

Fig. 2. VAS scores during the follow up period from the pre-SCS base line, post-SCS period and SCS+MCS period.

Discussion

Spinal cord stimulation is approved for the treatment of chronic pain of neuropathic origin and has shown optimal responses (9); however, it has been reported that its effects may decrease over time. In the case of CRPS-I, Kemler et al (4) performed a randomized trial in a 2:1 ratio in which 36 patients with CRPS-I were allocated to receive SCS and PT and 18 patients to receive PT only. Twenty-four patients received permanent spinal cord stimulator SCS with PT after successful test stimulation; the remaining 12 patients did not receive a permanent stimulator. The trial reported that at 5 years post-treatment, SCS with PT produced results similar to those following PT only for pain relief and that there is a diminishing effectiveness of SCS over time. What is also interesting about this trial is that despite such a situation, 95% of patients with an implant would re-

peat the treatment for the same result (3,4,9).

In 1988, Namba and Nishimoto (10) proposed stimulation of descending motor pathways in a model of trigeminal neuropathic pain. Three years later Tsubokawa et al (11,12) introduced motor cortex stimulation in patients with deafferentation pain secondary to central nervous system lesions, observing an improvement in pain. Stimulation of the primary motor cortex is a proposed treatment for intractable deafferentation pain secondary in various neuropathic pain syndromes including brachial plexus avulsion. Also CRPS patients have been treated by MCS with encouraging results (5,6). MCS may affect pain perception indirectly via neuronal networks synapsing on pain-modulating areas, with many interacting mechanisms involved: activating PAG neurons and consequently the opioid receptors (13,14), resulting in long-term changes in the modulation of neurotransmitter levels (15), but the mechanism underlying the effects of MCS is not known (16). Results from experimental models of MCS have proposed that the effect of MCS can be topographical according to corticotopy (17,18). Also, other structures of the brain are activated during effective stimulation of the motor cortex (19). Recently, inflammatory changes were observed at distant sites such as the spinal cord after MCS (20). Such proposed mechanisms can be related to good results in pain control and functional recovery of patients with very severe CRPS (5,6). However, MCS is often proposed as a last resort for patients with post-stroke or post-traumatic neuropathic pain and in trigeminal deafferentation pain, but its results are still a matter of controversy and no controlled study has proven the efficacy of MCS in a blind fashion.

Conclusion

We report a case of a patient with intractable CRPS-II who had the benefit of pain relief after SCS that faded away in the long-term. The same patient had her pain controlled after subsequent rescue MCS, utilizing the same SCS pulse generator for cycling stimulation. This approach provided pain control without transient or lasting side effects and maintained pain relief during a 2-year follow-up period. The result of this case suggests that a combination of SCS and MCS may be an alternative for patients who present with long-term loss of effect after successful SCS in chronic treatment-resistant pain related to CRPS-II.

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