Pain Medicine Case Reports

ISSN 2768-5152

Volume 7, Number 3, pp. 117-120

Post-Spinal Cord Stimulator Implantation Effects on Normalization of Blood Glucose and Oxygen Saturation in Complex Regional Pain Syndrome: A Case Report

Tenzin Palkyi, BS[1], and Daltry Dott, MD[1,2]

Background: Spinal cord stimulation (SCS) has consistently been shown to improve quality of life and reduce pain in patients with complex regional pain syndrome (CRPS). Nevertheless, the extent of its potential benefits has yet to be completely elucidated.

Case Report: This case follows a patient who developed CRPS in her right wrist following a fall from her wheelchair. She experienced severe disruption to her quality of life. Multiple conservative treatment modalities failed to alleviate her symptoms. After successfully completing an SCS trial and receiving an implant, the patient's symptoms and quality of life improved significantly. Additionally, her blood glucose and oxygen saturation readings improved in the affected extremity after undergoing SCS.

Conclusion: Normalization of blood glucose and oxygen saturation levels is not a deeply studied effect from SCS treatment. More research is encouraged to understand the mechanisms under which these results arise and how they can benefit patients' outcomes.

Key words: Spinal cord stimulator, complex regional pain syndrome, causalgia, wrist pain, case report

BACKGROUND

Complex regional pain syndrome (CRPS), previously known as reflex sympathetic dystrophy and causalgia, is an overarching term characterized by acute or chronic regional pain and inflammation in the upper or lower extremities, typically following an injury to that limb. Three mechanisms regarding the development of CRPS are currently being explored: neuroplasticity, vasomotor function, and inflammatory pathways (1). Oftentimes, patients experience neural abnormalities and pain that is disproportionate to the severity of the original injury (2). Patients with CRPS can present with symptoms such as burning pain, sensitive skin, swelling and stiffness in affected joints, and limited mobility, among others (1).

There are 2 broad types of CRPS: type 1, where a neural lesion is not identified and type 2, when a neural injury can be identified. Although the pathophysiology of CRPS is still being researched, the current understanding of the condition attributes its development to multiple-factors, leading to its varied clinical presentations (3).

For a diagnosis of CRPS, a nuanced and rare condition, having an established framework to aid clinicians in diagnosing patients is critical. Currently, there are no definitive medical tests that can detect signs of or

From: [1]University of Texas Southwestern Medical Center, Dallas, TX; [2]University of Texas Southwestern Frisco Spine Clinic, Frisco, TX

Corresponding Author: Tenzin Palkyi, BS, BSA, E-mail: tenzin.palkyi@utsouthwestern.edu
Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.
Patient consent for publication: Consent obtained directly from patient(s).
Authors adhere to the CARE Guidelines for writing case reports and have provided the CARE Checklist to the journal editor.
Accepted: 2023-01-17, Published: 2023-05-31

diagnose CRPS, primarily because the development of the condition is varied across patients. The Budapest criteria, originally created in 2003, has been the main diagnostic resource that is currently used in practice. It importantly notes that CRPS is often a diagnosis of exclusion. The Budapest criteria greatly improved the diagnostic specificity of CRPS while maintaining high sensitivity compared to the previous International Association for the Study of Pain criteria (4). According to the Budapest criteria, a clinical diagnosis of CRPS would need to fulfill the 4 criteria detailed in Table 1 (5).

Once a diagnosis is reached, several therapies are used to treat CRPS, such as rehabilitation and physical therapy to maintain flexibility and blood flow, medications to alleviate symptoms such as inflammation, psychotherapy to help modulate the descending pathways, and procedures like sympathetic plexus blockade and spinal cord stimulation that target affected nerves to reduce pain (6). Further exploration of treatment modalities and appropriate stages of when to implement certain interventions is critical to providing the best patient care. For example, spinal cord stimulation (SCS) has been found to have evidence in treating components of CRPS, such as pain relief and quality of life. However, it is typically utilized later in the treatment regimen even though factors such as safety, efficacy, and cost point toward SCS having potential to be beneficial if incorporated earlier (7).

SCS involves stimulating electrodes within the epidural space; once activated, they can reduce the perceived pain sensation by delivering an electrical current to the dorsal column of the spinal cord. If an SCS trial is successful, then a power source for the electrodes can be subcutaneously implanted for longer-term use (8). Postulated mechanisms to explain this are the “gate-control theory, modulating neuronal hyperexcitability, and neurotransmitter concentration” (9). Moreover, cerebrospinal fluid protein levels are also positively affected by SCS, demonstrating that the effect of SCS treatment can stretch into the realm of immune function and neuroplasticity. Review papers have reached similar conclusions that SCS is an appropriate treatment for the pain levels and quality of life of patients with CRPS, although neither psychological nor functional improvement results were conclusive (6,9). Currently, though, there is no literature that focuses on how blood glucose or oxygen saturation readings can be affected by CRPS and SCS implantation. The following case supports the use of SCS to ameliorate CRPS symptoms and normalize abnormal blood glucose and oxygen saturation levels in the limb affected by CRPS.

CASE PRESENTATION

Informed consent was obtained from the patient for submission of the case report. Institutional Review Board approval was not required per institutional policy.

A 53-year-old, right-handed woman with a past medical history of fibromyalgia, hypertension, diabetes mellitus (DM), asthma, and Hashimoto thyroiditis presented in November 2020 with right wrist pain that began after falling from her wheelchair in March 2020.

She described the pain as stabbing, shooting, and throbbing, with radiation to the forearm, rated 6-7/10 on the Numeric Rating Scale. The pain was located on the lateral and dorsal aspects of her wrist and forearm. Nothing alleviated her pain, whereas touching the area and moving her right arm worsened the pain. The patient’s quality of life was severely negatively affected as she could not use her right hand for any daily tasks and had to learn how to use her left hand instead. Other reported symptoms included swelling in the right medial wrist; allodynia of the anterolateral forearm, hand, and wrist; skin color changes; and temperature changes in the injured area. Additionally, the patient noted that her fasting blood sugar taken by finger prick

Table 1. Budapest diagnotic criteria for CRPS.

4 requirements to meet a diagnosis of CRPS under the Budapest Criteria:

- **Ongoing pain disproportionate to the inciting event**
- **1 symptom in 3 or more of the following classes**
- **1 sign in 2 or more of the following classes**
- **No other diagnoses that can fit the signs and symptoms**

Category	Signs/Symptoms
Sensory	Hyperaesthesia, allodynia (to light touch and/or deep pressure, or joint movement), or hyperalgesia (to pinprick)
Vasomotor	Temperature asymmetry, skin color changes, or skin color symmetry
Sudomotor/Edema	Edema, changes in sweating patterns, or sweating asymmetry
Motor/Trophic	Reduced range of motion, motor dysfunction (weakness, tremor, dystonia), or trophic changes (hair, nail, skin)

was increasing in the right upper extremity, on average, 50 - 70 points higher than her left upper extremity, and her oxygen saturations taken by pulse oximetry were approximately 30% different between the left and right upper extremities (Tables 2,3).

Imaging of her right hand was reviewed which identified diffuse marrow edema concerning for osteonecrosis or pathologic fracture, and soft tissue edema suspicious for a ruptured ganglion cyst located along the volar margin of the ulnar styloid. She had been evaluated by a hand surgeon who did not think that these issues were accounting for her presenting symptoms. After all other diagnoses were ruled out, the patient was diagnosed with CRPS, type 1.

She tried and failed multiple conservative treatment options over the course of one year, including medications from multiple classes such as anticonvulsants, muscle relaxants, nonsteroidal anti-inflammatory drugs, and antidepressants; an interdisciplinary pain program; physical therapy; a home exercise program; and multiple right stellate ganglion blocks.

Imaging of her cervical spine and a psychiatric evaluation were obtained for preoperative workup in preparation for a spinal cord stimulator trial. After a successful trial in November 2021 with lead placement at the C2 vertebral body resulted in significant amelioration of her symptoms, she underwent SCS implant in December 2021. Since the implant, the patient has had excellent improvement in skin discoloration, motor function, and pain level. The difference in blood glucose between the patient's right and left upper extremities after finger prick decreased as well, ranging about 20-50 points instead of the previous 50-70 points. She also had improvement in her pulse oximeter readings without discrepancies between the 2 extremities.

Table 2. Blood glucose readings prior to spinal cord stimulator implantation.

	Left (unaffected extremity)	Right (affected extremity)
Reading 1	109	182
Reading 2	139	245
Reading 3	97	123

Table 3. Oxygen saturations taken by pulse oximetry prior to spinal cord stimulation.

	Left (unaffected extremity)	Right (affected extremity)
Reading 1	98%	68%

DISCUSSION

As a multifactorial condition, CRPS affects both a patients' physical and mental well-being. The prognosis for CRPS is variable, with some patients having spontaneous remission and others having irreversible issues (9). Long-term consequences include anxiety and depression, permanent strength loss, reduced movement, muscular atrophy, contractures, osteoporosis, and high levels of chronic pain. Without proper interventions, CRPS can negatively affect quality of life (10). Since there are no singular curative treatments for CRPS, it is important to prioritize pain relief and affected limb mobility when considering a multidisciplinary approach (1).

Although there are no findings in the current literature that ascertain the effects of CRPS on blood glucose and oxygen saturation levels, this patient observed a larger difference in both glucose and oxygen readings when comparing her affected (right arm) and unaffected limb (left arm following her injury). These levels were considerably reduced once she underwent an SCS implantation.

A limitation with this patient is that there are limited documented readings before and after SCS implantation because the abnormal values were not regularly documented in the patient's medical record. Conditions that may lead to alterations of glucose measurements include the patient's right arm dominance, unilateral arm exercise, and perfusion effects (11,12). Additional data points from this patient, as well as future patients with upper extremity CRPS and DM, could strengthen the observations from this case report. Further research needs to be conducted in patients with DM as well as in those with CRPS to study how blood glucose and oxygen saturations are affected in limbs and to find out if interventions help to normalize these values, thus possibly improving long-term prognoses and risks.

CONCLUSION

SCS has been an effective treatment for CRPS pain, quality of life, and other symptoms, as supported by previous literature. As demonstrated by this case, SCS may also have vasomotor effects that can normalize oxygen saturations and blood glucose measurements that may be affected with untreated CRPS. Given the complex pathophysiology of CRPS, additional research is necessary in this field to further elucidate the mechanisms under which these results were observed and if SCS is a viable option to help normalize these values and potentially prevent or reduce the long-term effects of CRPS.

REFERENCES

1. Marinus J, Moseley GL, Birklein F, et al. Clinical features and pathophysiology of complex regional pain syndrome. *Lancet Neurol* 2011; 10:637-648.
2. Bruehl, S. Complex regional pain syndrome. *BMJ* 2015; 351:h2730.
3. Stanton-Hicks M, Jänig W, Hassenbusch S, et al. Reflex sympathetic dystrophy: changing concepts and taxonomy. *Pain* 1995; 63:127.
4. Harden RN, Bruehl S, Perez RS, et al. Validation of proposed diagnostic criteria (the "Budapest Criteria") for Complex Regional Pain Syndrome. *Pain* 2010; 150:268-274.
5. Crock LW, Baldridge MT. A role for the microbiota in complex regional pain syndrome? *Neurobiol Pain* 2020; 8:100054.
6. Shim H, Rose J, Halle S, Shekane P. Complex regional pain syndrome: A narrative review for the practicing clinician. *Br J Anaesth* 2019; 123:424-433
7. Taylor RS, Buyten JV, Buchser E. Spinal cord stimulation for complex regional pain syndrome: A systematic review of the clinical and cost-effectiveness literature and assessment of prognostic factors. *Eur J Pain* 2006; 10:91-101.
8. Turner JA, Loeser JD, Deyo RA, Sanders SB. Spinal cord stimulation for patients with failed back surgery syndrome or complex regional pain syndrome: A systematic review of effectiveness and complications. *Pain* 2004; 108:137-147.
9. Taylor SS, Noor N, Urits I, et al. Complex regional pain syndrome: A comprehensive review. *Pain Ther* 2021; 10:875-892.
10. Duong S, Bravo D, Todd KJ, Finlayson RJ, Tran Q. Treatment of complex regional pain syndrome: An updated systematic review and narrative synthesis. *Can J Anaesth* 2018; 65:658-684.
11. Liu X, Shah SA, Eid TJ, et al. Differences in glucose levels between left and right arm. *J. Diabetes Sci Technol* 2019; 13:794-795.
12. Kawakatsu S, Lui X, Tran B, et al. Differences in glucose readings between right arm and left arm using continuous glucose monitor. *J. Diabetes Sci Technol* 2022; 16:1183-1189.