Complex Regional Pain Syndrome and Dysautonomia Response to Cervical Spinal Cord Stimulation

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Introduction

Neurocardiovascular dysautonomia can result in postural orthostatic tachycardia syndrome (POTS) and disproportionally affects patient with Ehlers-Danlos Syndrome (EDS) and hypermobility spectrum disorders.[1] Pain in the upper extremities also disproportionally affects these populations and is commonly due to sympathetically maintained pain. Sparse literature characterizes the pain symptomatology and treatment for these conditions. Cervical spinal cord stimulation (SCS) for upper extremity complex regional pain syndrome (CRPS) is an established therapy for sympathetically maintained pain in the upper extremities refractory to conservative, comprehensive management.[2] SCS also can improve autonomic dysfunction-related orthostasis.[3]

In this study, patients with EDS, POTS and upper extremity CRPS were treated with cervical spinal cord stimulation over a three-year time period in an interdisciplinary pain medicine clinic. The aim of the study was to characterize patient experience and the myriad of dysautonomia and pain symptoms before and after cervical spinal cord stimulation.

Methods

After obtaining IRB approval, patients receiving cervical spinal cord stimulation for CRPS with a formal diagnosis of autonomic dysfunction and POTS were identified via billing records and review of the electronic health record (EHR). Written consent was obtained from all patients willing to participate in the study. Patients were excluded if age <18 years old or without formal dysautonomia diagnosis confirmed with testing. Via EHR review demographics, medical history, treatment approach and response to treatment were documented. Patients were contacted and surveyed on their experience with spinal cord stimulation therapy at the time of consent along with a Patient Global Impression of Change (PGIC) scale. All data was collected by the research team to limit treatment bias. Pre and post neuromodulation treatment symptoms were organized tabularly as were patient survey responses. Degree of pain reduction after stimulation treatment was evaluated as a percentage and presented as averages with standard error of the mean. Oswestry Disability Index and % disability were compared before and after spinal cord stimulation.

Results

Table 1. Patient Demographics (N=7)

Gender (%)	Female (100%); Male (0%)
Average age at time of implant (years)	36.3 ± 3.7
Ethnicity	Caucasian (85.7%) Other (14.3%
Average BMI (kg/m^2)	27.6 ± 7.0
Duration of chronic pain symptoms (years)	15.7 ± 7.9
Relevant Medical History (% with diagnosis)	Dysautonomia, Postural orthostatic tachycardia syndrome (POTS) (100%) Budapest criteria met for CRPS type 1 of upper extremities (100%) Hypermobility syndrome (100%) Ehlers-Danlos Syndrome (42.9%) Migraine (71.4%) Gastroparesis (28.6%) Mast Cell Activation syndrome (28.6%) Atypical facial pain (42.9%) Occipital Neuralgia (42.9%) Pelvic pain syndrome (42.9%) Small fiber neuropathy (14.3%) Cervical spine fusion (14.3%) Colectomy with ileostomy (14.3%) Low thoracic spinal cord stimulator for pelvic pain (14.3%) Inadequate relief with thoracic spinal stimulator trial for pelvic pain (14.3%)
Prior pain treatment	SNRI or TCA (100%) LDN (100%) Gabapentin or pregabalin (85.7%) Oral ketamine (100%) Buprenorphine (mcg) (42.9%) Stellate ganglion block (100%) PT/OT (100%) Pain psychology clearance (100%)
Autonomic dysfunction (POTS) regimen	Beta blocker (85.7%) Calcium channel blocker (85.7%) Fludrocortisone (42.9%) Midodrine (57.1%) Ivabradine (85.7%)

Results

Nine sequential patients met criteria for inclusion from June 2020 through December 2023. All were reached via phone, and 7 of the 9 patients consented for the study at time of abstract and poster submission and are described in Table 1. Patients were all female gender with an average age of 36.3 ± 3.7 years, and moderate or severe disability on Oswestry Disability Index prior to implant. All 7 patients proceeded to implant after successful trial with leads being placed epidurally at C2 superiorly. All patients were responsive to stellate ganglion block prior to SCS, had trialed multiple medications, participated in physical and occupational therapy, and were evaluated for stimulation treatment by pain psychology. All patients had significantly widespread pain in addition to their upper extremity CRPS Type 1 and POTS diagnoses as summarized in Table 2 and all had a diagnosis of hypermobility. All leads were placed at C2; three patients received tonic stimulation and 4 received passive recharge sub perception burst. Stimulation treatment is summarized in Table 3. The average time of pain prior to implantation was 15.7 ± 7.9 years. After stimulation, average pain reduction was 64.3% ± 18.1% after 16.6 ± 9 months time since implant and is summarized in Figure 1. ODI and % disability pre and post implant are shown in Figure 2 and were not significantly changed. All patients described meaningful improvement in chronic pain and would recommend spinal cord stimulation to patients experiencing similar symptoms. Figure 3 describes the range of symptoms that were meaningfully improved and Figure 4 summarizes the respondent's PGIC scores, which were all 6 or greater.

Table 2. Description of Pain Locations

Patient 1	Neck, Thoracic, Left Leg, Head, Left Pelvis, Left Arm, Left Foot, Lumbar Spine, Right Arm, Left Shoulder, Right Leg, Right Foot
Patient 2	Thoracic, Thoracic Spine, Right Shoulder, Left Shoulder, Neck, Head, Left Arm, Left Hand, Abdominal, Cervical Spine, Right Hand, Right Arm, Right Foot
Patient 3	Left Leg, Right Leg, Right Arm, Left Arm, Abdominal, Thoracic, Left Pelvis, Right Pelvis, Left Foot, Right Foot, Right Shoulder, Left Shoulder, Head, Neck, Right Knee, Left Knee
Patient 4	Left Hand, Right Hand, Right Knee, Left Knee, Abdominal, Head, Neck, Right Shoulder, Left Shoulder, Thoracic, Left Arm, Right Arm, Left Elbow, Right Elbow, Left Leg, Left Pelvis
Patient 5	Head, Right Shoulder, Left Shoulder, Right Arm, Left Arm, Left Foot, Jaw, Right Pelvis, Left Pelvis, Neck, Thoracic, Thoracic Spine, Lumbar Spine
Patient 6	Head, Right Hand, Neck, Right Shoulder, Right Leg, Right Foot, Thoracic, Left Arm, Right Arm, Thoracic Spine, Lumbar Spine, Right Pelvis
Patient 7	Left Pelvis, Right Pelvis, Abdominal, Lumbar Spine, Head, Right Arm, Left Arm, Right Shoulder, Left Shoulder, Neck, Thoracic

Table 3. Cervical Spinal Cord Stimulation Treatment Descriptors

Device manufacturer	Abbott (57.1%) Medtronic (42.9%)
Lead type, configuration	Two cylindrical octrode leads (100%)
Cephalad tip of leads (vertebral level)	C2 (100%)
Time since implant (months)	16.6 +/- 9
Stimulation waveform	Subperception, passive recharge, burst (42.9%) Tonic (57.1%)
Infection, migration, lead fracture, explant, lead replacement, pulse generator replacement, hospitalizations	None
Reoperation	Lead revision (re-secured to fascia to ensure less lead motion with flexion and extension and more consistent paresthesia pattern) (14.3%)

Figure 1. Average Pain Relief After Trial to Time of Data Collection Post Implant

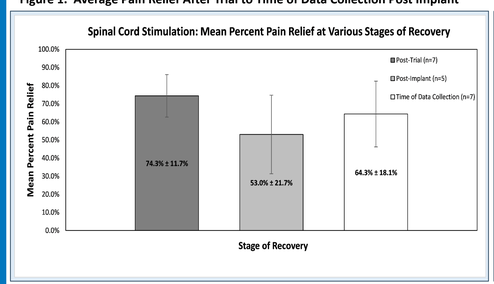


Figure 2. Mean ODI and % Disability Change Pre and Post Implant

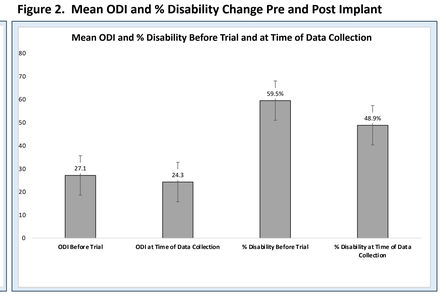
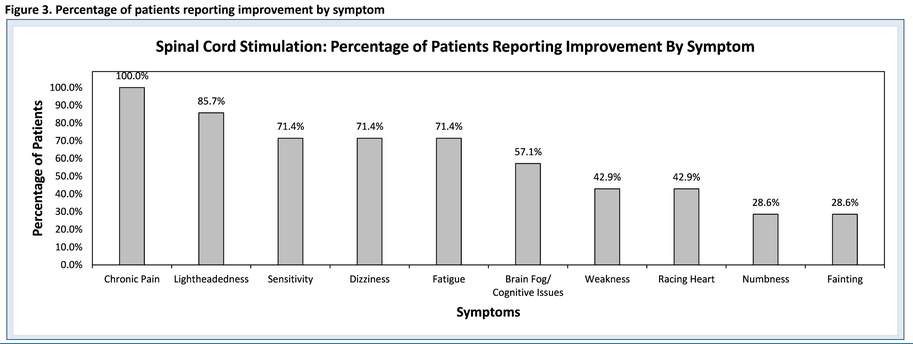
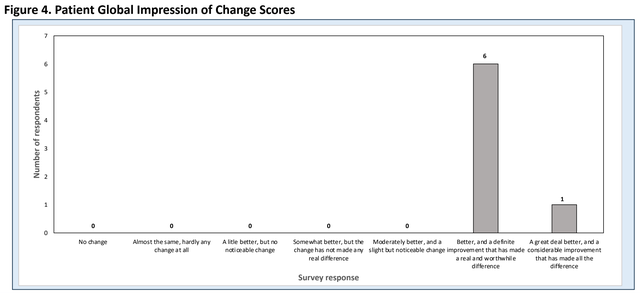


Figure 3. Percentage of patients reporting improvement by symptom



Results (continued)

Figure 4. Patient Global Impression of Change Scores



Discussion and Conclusions

Patients with POTS, CRPS, and hypermobility syndromes experience a multitude of unpleasant, disabling symptoms in addition to pain. This small but unique retrospective case-series study, characterizes the medical complexity of this population while illustrating the patient described benefits of cervical spinal cord stimulation when recommended by an interdisciplinary pain clinic. Limitations include the retrospective nature of the review which was offset by evaluating all patients at time of recruitment and consent. From this data, the surgical and treatment outcomes appear consistent with other patient populations.

Patient reported outcomes gathered in this study suggest meaningful reduction of symptoms and improvement of function and quality of life with a high level of patient satisfaction with the therapy. The novel observation of response in both pain and neurologic symptoms in this study suggests a common or intersecting pathway in the neurocircuity of neurocardiovascular dysautonomia and chronic pain with sympathetically maintained features and highlights the potential for spinal cord stimulation to modify pain and a myriad of non-pain symptoms in painful dysautonomia with sympathetically maintained pain.

One patient described at time of survey, a 30% relief of pain which was significantly less than all other patients. The same patient, however, reported a high PGIC, significant improvement in multiple debilitating symptoms, and a strong recommendation of the treatment for others. This suggests that % relief alone may underestimate the impact and patient perception of the benefits of neurostimulation thus supporting holistic, personalized evaluation of patient response to therapy over time. ODI did not significantly change pre and post implant, reflecting the limitations of ODI as a patient reported outcome in more widespread pain conditions as patients still identified significant benefit from spinal cord stimulation. The symptom improvements described in this study encompass many meaningful and relevant non-pain symptoms and align with published consensus.[4]

Future prospective study should elucidate via sham control effect size, optimal waveform, and durability of outcomes over time as well as the potential for autonomic disease modification.

References

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