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Dorsal Column Spinal Cord Stimulation for Sacral Radiculopathy Due to Sacroiliac Joint Fusion to Hardware: A Case Report

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Background: A complication of sacroiliac joint (SIJ) fusion is neuropathic pain due to intruding hardware.

Case Report: We present the novel management of a 57-year-old man who presented with S1 radiculopathy that began immediately after SIJ fusion, which had been performed 2 years prior. Physical exam and electromyography confirmed right S1 radiculopathy. Imaging confirmed hardware protrusion into the S1 neural foramen. The patient failed conservative management, and an outside tonic spinal cord stimulator trial (SCS) trial, but experienced 100% relief during the anesthetic phase of S1 transforaminal epidural steroid injections. A neurosurgical consult deemed the patient to be an inappropriate candidate for surgical revision due to the complete fusion of the hardware to bone. The patient successfully underwent a burst SCS trial with 100% relief as measured by the Numeric Rating Scale and increased his quality of sleep and activity with subsequent permanent implantation.

Conclusion: SCS utilizing burst stimulation can offer a unique treatment option for resultant neuropathic pain from SIJ fusion to hardware in the event that surgical revision is not recommended.

Key words: Spinal cord stimulator, scral radiculopathy, sacroiliac joint, failed back surgery syndrome, case report

BACKGROUND

As with all surgeries, back surgery complications can arise. Sacroiliac joint (SIJ) fusion, a procedure performed to address SIJ pain that is refractory to medical management, is used to achieve arthrodesis by grafting the sacrum and ilium together with implanted hardware (1). A complication rate of 18% to 21% has been estimated to occur in SIJ fusion procedures (2). A possible complication of SIJ fusion can occur when the implanted hardware abuts neural structures, resulting in neuropathic pain. An estimated 3.05% of SIJ fusion adverse events can be attributed to errors in hardware placement, which most commonly results in nerve root impingement (1).

Spinal cord stimulation (SCS) utilizes an implanted device within the epidural space to emit low levels of electricity near the spinal cord. This strategically administered energy attenuates pain via spinal and supraspinal neuromodulation. SCS interrupts ascending pain signals by suppressing neurons in the spinal cord's dorsal column, while simultaneously activating supraspinal descending inhibitory pathways, leading to pain alleviation (3).

The pulsed electricity can be administered with either tonic or novel waveforms, including burst or high frequency stimulation. Traditional SCS uses tonic stimulation, where electrical pulses are administered with a

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consistent amplitude, frequency, and pulse width. Burst stimulation delivers groups of 5 higher frequency, lower amplitude burst spikes separated by pulse-free intervals.

Burst stimulation has shown promising results toward reducing neuropathic pain more effectively than tonic stimulation, with a lower occurrence of paresthesia (4). High-frequency stimulation delivers stimuli with a frequency as high as 10 kHz. It offers benefits superior to conventional tonic stimulation, such as more effectively managing axial back pain and providing pain relief more frequently without paresthesia (5). Stimulation using novel waveforms is sometimes utilized in patients who fail to experience adequate pain relief with traditional or tonic stimulation (6).

Typically, planning for SCS includes a pain management consultation to determine appropriateness for therapy and psychological evaluation, followed by diagnostic imaging with magnetic resonance imaging. A stimulation trial is then performed, with temporary leads placed percutaneously and connected to an external energy source. The location of lead placement is typically decided by anatomic placement based on pain topography. The trial is used to determine if all pain locations are captured, commonly indicated by inducing paresthesia in the painful areas. The trial is also used to see if there is a resulting pain decrease or functionality increase. Permanent implantation is performed after the trial stimulation, where leads and an implantable pulse generator are placed. SCS is commonly indicated for intractable radicular pain secondary to failed back surgery syndrome (FBSS), treatment refractory complex regional pain syndrome, inoperable peripheral vascular disease, or refractory angina (3).

CASE PRESENTATION

We present the novel management of a 57-year-old man with a history of SIJ fusion who presented with right S1 radiculopathy secondary to fusion hardware misplacement. The radiculopathy began immediately after surgery was performed elsewhere 2 years prior to presentation. Physical exam and electromyography confirmed radiculopathy in the S1 dermatomal distribution. Computed tomography (Fig. 1) and magnetic resonance imaging (Fig. 2) confirmed protrusion of the SIJ fusion hardware into the S1 neural foramen.

The patient had failed comprehensive conservative management, including physical therapy, chiropractic care, and pharmacotherapy. He experienced 100% relief during the anesthetic phase of multiple S1 transforaminal epidural steroid injections, but had no long-term relief. The patient had failed an outside tonic SCS trial, reporting that during that trial he never experienced appropriate capture of his lower extremity pain. Because the SIJ fusion hardware was placed approximately 2 years prior to presentation, the hardware had time to fully fuse with bone.

Given this complete fusion, a neurosurgery consult recommended against surgical revision due to the significant likelihood of morbidity with any hardware removal. No specific patient comorbidity caused the patient to be deemed as a poor surgical candidate. The patient successfully underwent a dorsal column SCS trial using burst stimulation with almost 100% relief on the Numeric Rating Scale and increased his quality of sleep and activity with subsequent permanent implantation (Fig. 3).

Following 8 weeks of successful pain relief with the permanently implanted device, the patient's pain relief began to decrease. Reprogramming and follow-up imaging did not reveal any significant migration that might have led to his loss of pain relief, indicating that lead misplacement was not to blame. With each reprogramming attempt the patient reported pain relief, but he began requesting more and more frequent reprogramming. The patient was instructed to take a "stimulation holiday" in order to attempt to regain pain relief, but during this period he ultimately decided to pursue additional opinions regarding SIJ screw removal. He was offered, but declined, alternative options, including exchanging the implanted pulse generator.

DISCUSSION

This case report details a novel solution employed to manage neuropathy caused by SIJ fusion hardware impinging on the S1 neural foramen. In this case, a neurosurgery consult deemed the patient inappropriate for surgical revision due to full hardware fusion to bone, requiring an alternative to be pursued. Utilizing SCS to treat this patient's pain can be considered a noteworthy and inventive solution. This case depicts the first documented use of successfully employing SCS to alleviate neuropathic pain caused by SIJ fusion hardware abutting neural structures.

The current literature describes prior episodes of nerve root impingement following SIJ fusion confirmed by computed tomography. In these cases, the problem was resolved by either retracting the implants to the neural foramen edge or entirely removing the hard-

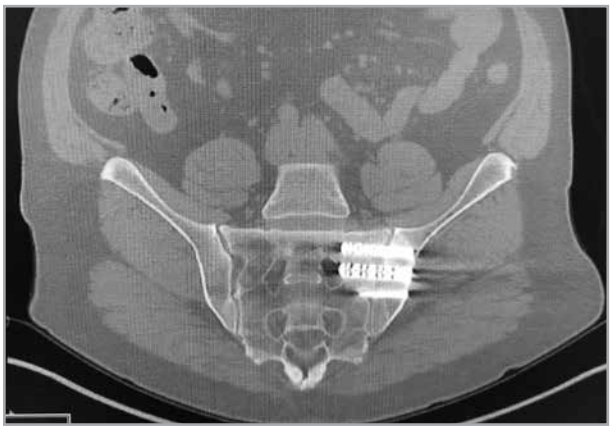

Fig. 1. Coronal computed tomography image indicating SIJ fusion hardware impinging into the S1 neural foramen.

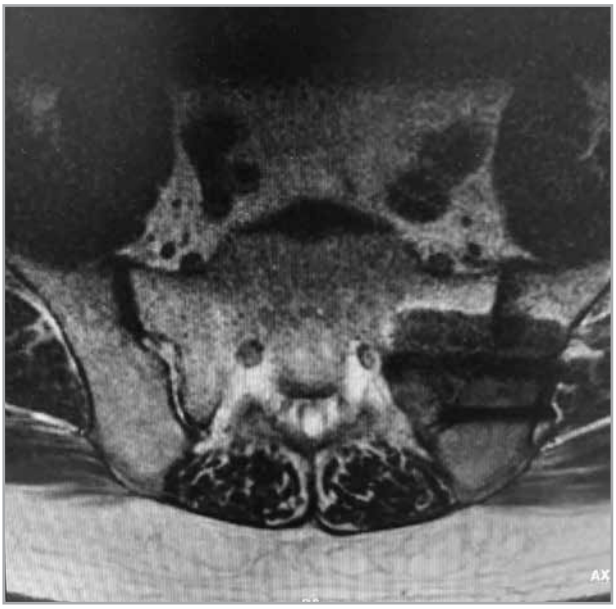

Fig. 2. Axial magnetic resonance image indicating SIJ fusion hardware impinging into the S1 neural foramen.

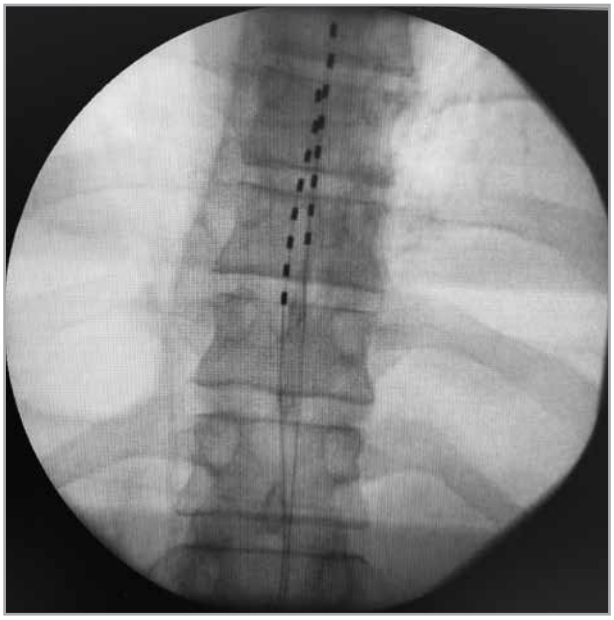

Fig. 3. Fluoroscopy indicating lead placement status post permanent implantation of a spinal cord stimulator.

ware, with replacement utilizing smaller equipment. Surgical repair and/or revision of these previous cases led to complete recovery with no future sequela (7,8). However, in this case, the neurosurgery consult decided to avoid surgical revision because the hardware had already solidly fused to the bone, causing a high likelihood of postoperative morbidity.

As the most common clinical indication for SCS therapy in the United States (3), strong evidence exists for utilizing SCS in the treatment of FBSS. FBSS is defined as back pain that persists after surgical intervention or pain that appears in the same topographical location after surgery has been performed for alleviation of spinal pain (9). The patient in this case presentation experienced pain in the S1 dermatomal distribution after protrusion of SIJ fusion hardware, resulting in neural impingement. No precedent was set by previous similar cases, but the already proven efficacy of SCS in the management of FBSS, the dermatomal coverage of such SCS placement, as well as previous failed conservative management and minimal relief with less invasive treatment options, contributed to the utility of SCS in this particular case.

Burst stimulation was specifically utilized during the second SCS trial due to existing evidence suggesting the superiority of novel waveform patterns such as burst over tonic stimulation in treating neuropathic pain, particularly as a "salvage therapy" option when failing treatment with tonic stimulation (4). The successful response of the patient's pain to the second trial of SCS highlights the value and clinical utility of this treatment.

Novel SCS waveform trials should be considered by pain management physicians who encounter future similar cases where tonic stimulation fails to provide adequate pain relief. However, habituation must also be considered in patients undergoing SCS to manage severe pain. Habituation, or diminishing response to repeated therapy over time, is commonly seen after long-term

SCS treatment lasting more than 2 years. In this case the patient appeared to develop very rapid habituation; we ruled out reasons for his lack of pain relief such as lead migration. Some literature indicates that briefly pausing SCS therapy for a defined time period might help attenuate this issue (10), but habituation is still currently a challenging problem to manage and limits the long-term efficacy of SCS. Ongoing study regarding this challenging problem surely remains a high priority in the field of neuromodulation.

Additionally, despite the patient being deemed an excellent candidate in terms of indication and previous failed conservative measures of pain management, and being psychiatrically cleared for SCS, this patient had underlying depression and anxiety that was untreated, psychiatric barriers that likely hindered his long-term response to SCS. These psychiatric barriers included excessive pain focus, untreated depression and anxiety, and poor coping mechanisms, all of which have been connected to poor SCS outcomes (11). This fact highlights the utility of SCS as a treatment option for similar future cases in patients who either do not have these psychiatric barriers, or who receive appropriate psychiatric intervention pre-, during, and post-SCS.

CONCLUSION

SI joint fusion hardware can abut neural structures resulting in neuropathic pain. If this hardware is fused solidly to bone, revision is typically not recommended, possibly leaving patients with severe, intractable pain. Recognition of this clinical entity is important for pain management physicians. Following comprehensive evaluation and exhaustion of conservative management, this patient ultimately responded well to dorsal column SCS, with subsequent rapid development of habituation leading to SIJ screw removal.

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