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CERVICAL SPINAL CORD STIMULATOR MALFUNCTION SECONDARY TO LEAD FRACTURE

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Background: Spinal cord stimulation (SCS) is commonly used in the cervical spine to manage chronic intractable pain. However, complications can include lead displacement, lead migration, and lead fracture.

Case Report 1: The first case is of a 67-year-old woman who underwent spinal cord stimulator implantation in 2009 for the treatment of complex regional pain syndrome (CRPS). The device used was a Medtronic Restore system with an Octad 1×8 single lead array, and the battery was replaced in 2021. In December 2023, the patient began experiencing new-onset symptoms including dizziness, headaches, and balance disturbances. Due to these emerging neurological symptoms and the necessity for magnetic resonance imaging (MRI), the SCS system was explanted.

Case Report 2: The second case is of a 78-year-old woman who underwent spinal cord stimulator implantation in 2011 for the treatment of CRPS. The system used was a Medtronic RestoreUltra with an Octad 1×8 dual lead array. In 2020, the battery was replaced with a Medtronic Intellis pulse generator due to end-of-life.
In 2021, following a motor vehicle accident, the patient began experiencing electric shock-like sensations whenever the spinal cord stimulator was activated. A system interrogation was performed in 2022, which failed to resolve the issue.
Due to the persistent uncomfortable sensations and lack of therapeutic benefit, she requested removal of the system, which was explanted in May 2025. Post-explantation imaging revealed that the distal electrode of one lead remained in the cervical spine.

Conclusion: These two case reports highlight unusual presentations of cervical spinal cord stimulator lead fracture with or without loss of stimulation effectiveness. However, in the first case, despite the continued functionality of the device, the patient developed unexplained neurological symptoms and required MRI imaging. These symptoms improved following device removal, even though a portion of the electrode remained in place. In the second case, stimulation produced uncomfortable electrical sensation requiring electrical stimulation.
During the surgical procedure, post-explantation imaging revealed that the top electrode remained in the cervical spine, which in both cases was not identified until after explantation.

Key words: Spinal cord stimulation (SCS), side effects, penile pain, explantation of stimulator

BACKGROUND

Spinal cord stimulation (SCS), a neuromodulation technique, has been in use since 1967 for managing low back and lower extremity pain. It is also occasionally employed to treat painful cervical conditions, including post-laminectomy syndrome and complex regional pain syndrome (CRPS) types I and II. The frequency of SCS procedures has increased significantly in recent years, accompanied by a notable rise in associated

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healthcare costs (1). While the use of SCS has expanded with emerging indications and technological advancements, the utilization rates of other interventional pain management techniques have seen a marked decline, particularly following the COVID-19 pandemic (1-4).

Although SCS is generally regarded as an effective therapeutic modality, it is not without risks. Complications can arise from both the surgical implantation process and device-related malfunctions (5-15). Multiple reviews (5-12) have evaluated long-term complications associated with these devices. While general device-related complications have been well documented, reports specifically addressing electrode migration and lead fracture remain relatively scarce.

Hasoon et al (12), in a comprehensive review, examined lead migration, lead fracture, disconnection, and battery failure. They reported that lead fractures occur in up to 10% of cases, with an average incidence of 6%. These fractures are primarily attributed to mechanical stress from lead movement or bending, chronic inflammatory reactions, and biological interactions at the lead-tissue interface. In contrast to lead migration, lead fracture typically results in a complete separation or disruption of the electrode from the generator. This leads to an interruption in pulse transmission and a total loss of therapeutic stimulation to the targeted area.

Lead fractures carry significant clinical consequences for patients who depend on SCS therapy for pain relief. A compromised lead can diminish therapeutic effectiveness, resulting in suboptimal pain control and a reduced quality of life. Additionally, the presence of fractured or abandoned leads poses an increased risk of radiofrequency-induced heating during magnetic resonance imaging (MRI) examinations for most device manufacturers (7-17). Even newer SCS systems deemed MRI-conditional may still present elevated risks in cases involving potential lead fractures (18).

Given the clinical relevance of fractured or dislodged electrodes, we present two cases of cervical SCS malfunction due to lead fracture. Written informed consent was obtained from the patients for the presentation of these case reports. Both cases were performed by physicians other than the authors. Explantation was carried out by LM and MRS.

CASE REPORTS

Case Report 1

A 67-year-old woman patient, who had been under long-term management for multiple pain conditions, was being treated with a cervical spinal cord stimulator in conjunction with cervical facet joint interventions and stellate ganglion blocks. The spinal cord stimulator was originally implanted in 2009 for the treatment of CRPS. The system consisted of a Medtronic Restore device with an Octad 1×8 lead array. The battery was replaced in 2021. The device was presumed to be functioning normally until April 2025.

However, beginning in December 2023, the patient began experiencing new-onset symptoms including dizziness, headaches, and balance disturbances. She was evaluated by her neurologist, who recommended MRI of the brain and cervical spine. Despite the presumed continued function of the SCS system, the emergence of neurological symptoms and the system's lack of MRI conditionality led to a decision to proceed with explantation.

In April 2025, the patient was taken to the operating room for device removal. Following standard preparation and placement in the prone position, removal of the leads and battery was undertaken under monitored anesthesia care (MAC) with local anesthetic infiltration. The procedure began with an incision over the battery site, which allowed for explantation of the battery and disconnection from the leads.

A second incision was made just below the 12th rib, paramedial to the 12th vertebral body, where the anchors were dissected. An additional incision was performed paravertebrally at the T3 level, where dissection was carried out and the anchors were successfully removed without complication. Following anchor removal, the lead was extracted without difficulty.

However, post-operative x-ray imaging revealed that the top electrode remained in the epidural space (Figs. 1 and 2). The disconnection of the electrode was not identified prior t explanation. Medtronic technical services were contacted and identified this as an abandoned lead. They advised that surgical intervention would be required for its removal. Nevertheless, they confirmed that an MRI of the brain could be performed safely, provided the retained portion of the electrode did not lie within the MRI coil field.

Case Report 2

A 78-year-old woman with a history of chronic pain conditions was managed with a cervical spinal cord stimulator, cervical epidural steroid injections, and oral analgesics. The spinal cord stimulator, initially implanted

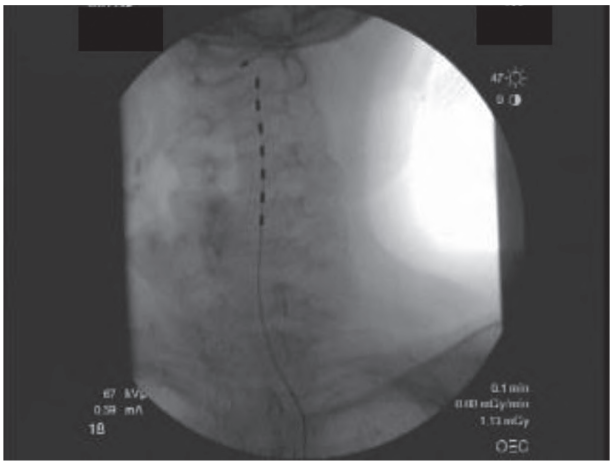

Fig. 1. Fluoroscopic image prior to explantation with lead fracture.

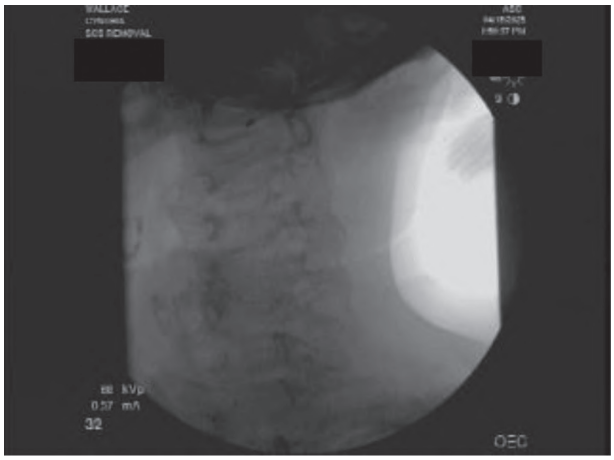

Fig. 2. Fluoroscopic image after removal of lead with retained electrode.

in 2011 for CRPS, consisted of a Medtronic RestoreUltra system with an Octad 1×8 dual lead array. The battery was replaced in 2020, and the system was presumed functional until the patient was involved in a motor vehicle accident in 2021.

Following the accident, she began experiencing discomfort, inadequate pain relief, and electric shock-like sensations whenever the stimulator was activated. A system interrogation in 2022 by Medtronic clinical support concluded that no corrective intervention could be offered. Due to persistent symptoms and lack of therapeutic benefit, the patient opted for device explantation.

In May 2025, under MAC and local infiltration, the patient underwent explantation. After standard positioning and preparation, the battery was removed through a right flank incision, and the leads were disconnected. A second incision in the posterior midthoracic region allowed for dissection and removal of the anchors, followed by successful lead extraction.

Postoperative imaging, however, revealed that the distal electrode tip of one lead remained in the cervical epidural space (Figs. 3-5). This was deemed an abandoned lead. Although surgical removal is the definitive treatment, technical support advised that an MRI of the brain could still be performed as long as the retained fragment lies outside the imaging coil field.

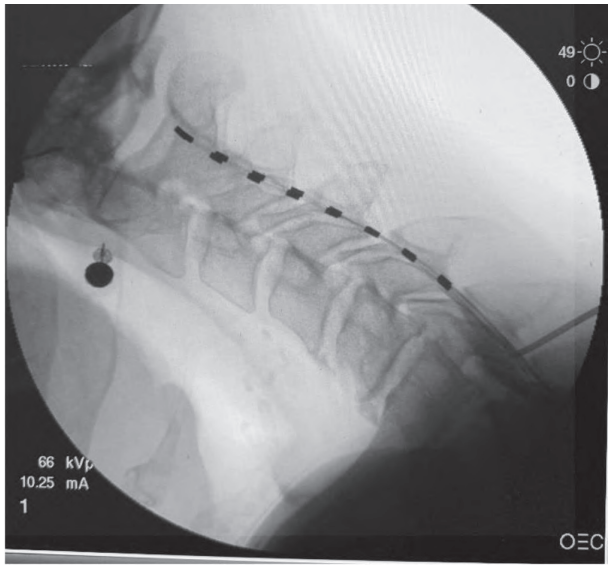

Fig. 3. Fluoroscopic image prior to explantation.

DISCUSSION

SCS is a neuromodulation technique that involves the placement of electrical leads into the epidural space, including the cervical spine. Numerous device-related complications have been documented in the literature (1-15). Among these, lead fracture is a relatively rare but significant complication.

Lead fractures have been associated with reduced therapeutic efficacy and increased risk of radiofrequency-induced heating during MRI in cases involving broken or abandoned leads in most commercially available systems. Additionally, retained or fractured leads and electrodes may provoke neurological symptoms by irritating the spinal cord.

The incidence of lead fractures has been reported in up to 6% of patients, according to a comprehensive

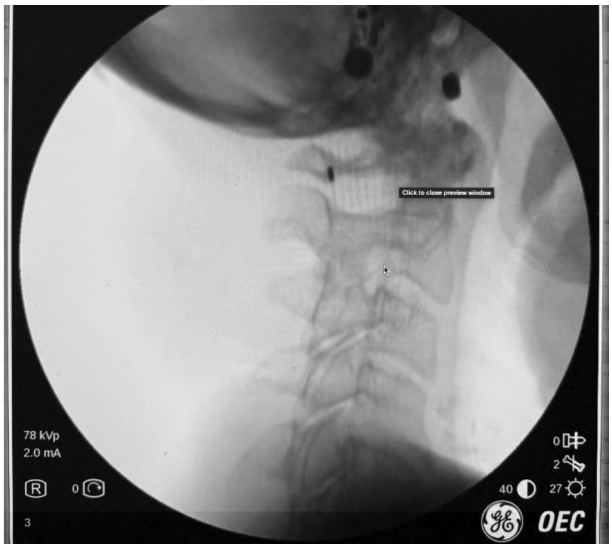

Fig. 4. Fluoroscopic lateral image after explantation with retained electrode.

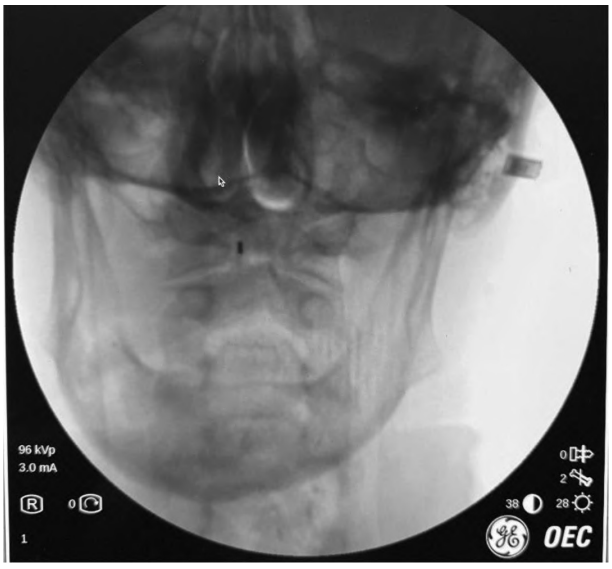

Fig. 5. Fluoroscopic PA view with retained electrode post explantation.

review. Several case reports have illustrated various complications related to lead fracture. For example, Yin and Gungor (13) described a case of spinal cord stimulator malfunction due to lead fracture in the lumbar spine. Similarly, Padalia et al (14) reported lead migration with transection adjacent to the foramen magnum. In their case, MRI-conditional cervical spinal cord stimulator leads migrated cephalad, and the distal portion of the lead appeared transected. Although the device was revised and the lead replaced, the distal transected tip was left in the epidural space near the foramen magnum to avoid potential surgical complications.

Martin et al (15) reported a dislodged spinal cord stimulator electrode that became embedded in the ligamentum flavum. During access of the T11/12 interlaminar space using the loss-of-resistance technique, the lead failed to advance past the needle tip. Upon withdrawal, it was discovered that the first electrode had detached. Fluoroscopic imaging confirmed that the electrode had lodged in the ligamentum flavum. After consultation with the device manufacturer's medical director, the decision was made to leave the electrode in place and proceed with placing a single lead. The patient was followed for 2 weeks, and no long-term outcomes were reported.

Accurate diagnosis of lead fracture is essential for appropriate clinical management. Diagnosis should be guided by the patient's symptomatology and evidence of reduced pain relief. In Case 1, the spinal cord stimulator was still functioning, and there was no loss of pain control. However, the primary concern was the need to perform MRI of the brain and cervical spine—an issue complicated by the system's lack of MRI compatibility. Fluoroscopic imaging prior to explantation failed to detect any dislocation or fracture of the electrode, which was only identified intraoperatively during surgical removal.

This case is particularly unusual in that the patient did not present with typical signs of lead malfunction, such as decreased pain relief. Instead, she developed new neurological symptoms, including dizziness and balance disturbances. Interestingly, her symptoms improved significantly—approximately 70%—following explantation of the SCS system, despite a retained electrode fragment in the epidural space. Given the degree of improvement, the patient declined further surgical intervention to remove the residual lead.

The underlying mechanism of her symptoms remains unclear but may involve irritation of the dura mater or spinal cord by the displaced electrode. The precise timing of the lead dislocation is also unknown. However, it appears that mechanical irritation from the lead may have triggered her symptoms, which were resolved substantially once the stimulator system was removed.

This case underscores the importance of considering complications beyond therapeutic failure when evalu-

ating lead fractures or dislodgements. While modern MRI-conditional SCS systems may reduce the risk of complications during imaging, challenges still exist due to variability in device types and conditionality status (19). Additionally, explantation can be particularly complex in older devices, especially those using paddle leads. Although our patient had a percutaneous lead, Kim et al (20) described similar removal challenges with a cylindrical S-series paddle lead.

In the second case, the spinal cord stimulator was malfunctioning. Preoperative fluoroscopic imaging did not reveal any dislocation or fracture of the electrode; however, a retained distal electrode fragment was identified intraoperatively during explantation. Due to the risks associated with further surgery, the patient declined additional intervention to remove the residual lead.

CONCLUSION

We report two cases of cervical spinal cord stimulator (SCS) system malfunction, originally implanted in 2009 and 2011.

In the first case, the patient experienced unexplained symptoms despite the device appearing to function normally. No specific incident was identified, but the patient reported dizziness and balance disturbances that persisted until device explantation. A lead fracture was discovered only after the explant, and the patient subsequently experienced marked improvement in symptoms.

In the second case, the patient was involved in a motor vehicle accident and began experiencing inadequate pain relief accompanied by unpleasant electric shock-like sensations. As with the first case, lead fractures were not identified until after the system was removed.

These cases highlight the need to consider factors beyond a simple loss of therapeutic effect, such as potential nerve root or spinal cord irritation. Timely recognition and removal of malfunctioning components, particularly retained leads in the epidural space, may be critical to symptom resolution.

Author Contributions

The article was designed by LM and MRS.

All authors contributed to the preparation of this article, reviewed and approved the content with the final version.

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