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CEPHALAD MIGRATION OF SPINAL CORD STIMULATOR LEAD: A CASE REPORT

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Background: Since the introduction of neuromodulation, significant advances in technology and safety have been achieved. Despite these improvements, complications are frequently observed. Among these complications, lead migration has been reported as the most common, with significant cephalad displacement being among the rarest for this type.

Case Report: We present a case of a 69-year-old woman with chronic low back pain that experienced lead migration from T8 to T3 during the trial period, leading to an unsuccessful trial.

Conclusions: Although rare, drastic displacement in the cephalad direction of a spinal cord stimulator lead has been reported in the literature and warrants recognition. There are multiple potential etiologies that could explain this movement. There is a need to further study its mechanism, how the current methods for securing the lead perform, and developing better options for securing the device.

Key words: Neuromodulation, lead migration, spinal cord stimulator, case report

BACKGROUND

The current status of neuromodulation as an effective and safe modality to treat refractory chronic pain has been the outcome of decades of research, trials, and new technological advancements. Among the potential indications for an implant, we find postsurgical pain syndrome, peripheral neuropathy of extremities, complex regional pain syndrome, among others (1-3).

The permanent placement of the device is preceded by a trial period that is essential to identify whether the patient will respond to neuromodulation, and will help to plan the permanent surgical placement of the implant (4) (Table 1). Among the potential complications, lead migration has been identified as the more frequent. The rate at which this happens, has been reported to be between 0.7% and 78% depending on the study reviewed (5-7). Recent studies (4) state that up to 75% of these migrations occur in a caudal direction and, in most cases, the distance traveled by the lead is small, on an average of 1.3 cm, especially when cervical migration is present. The reason why the movement happens has been a topic of great debate and the most common culprits identified in the literature are mechanical stress on the lead, securing mechanism, or the anchoring devices. The potential consequences of the migration can impact patient outcomes as it could result in an unsuccessful trial, making it impossible to establish benefit from the therapy; and therefore, failing to receive a permanent implant that would otherwise be beneficial for the patient.

We present a case of cephalad migration of a trial lead from the T8 to the T3 level, representing a drastic movement. Such movements have been reported in the past (9-11), but its occurrence continues to be rare. After literature review, this report constitutes the second longest cephalad migration distance at the time of publication, which makes it worthy of further review.

CASE PRESENTATION

A 69-year-old woman with a past medical history of

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Table 1. Time table of event occurrence.

Patient started to develop symptoms of low back pain with bilateral radiculopathy.	2018
Underwent various types of conservative therapies without success (physical therapy, tricyclic antidepressants, SSRIs, short courses of opioids).	2019
Interventional procedures attempted (multiple lumbar medial branch blocks and lumbar epidural steroid injections).	2019-2020
Patient evaluated and cleared for SCS trial.	2020
SCS trial lead placement.	August 2020
Thoracic and lumbar x-ray was performed, which showed significant lead migration up to the T3 vertebral body. Lead repositioned to T8.	Postprocedure day #2
Trial leads removed showcasing an unsuccessful trial period.	Postprocedure day #7

Abbreviations: SSRIs, serotonin-specific reuptake inhibitors; SCS, spinal cord stimulator.

hypertension, type 2 diabetes mellitus, paroxysmal atrial fibrillation, and body mass index (BMI) of 23.7 kg/m2 presented to our clinic complaining of chronic low back pain with both axial and radiculopathic components that have been going on for approximately 2 years at the moment of the first evaluation (Table 1). During the next 7 months, she underwent a wide variety of treatment modalities, including physical therapy, tricyclic antidepressants, serotonin-specific reuptake inhibitors, short courses of opioids, and interventional techniques like multiple lumbar medial branch blocks and lumbar epidural steroid injections (Table 1). The patient was refractory to these therapies and continued to experience significant limitations in her activities of daily living in addition to worsening of symptoms. After appropriate preoperative workup, counseling, and psychological clearance, the patient was considered for a spinal cord stimulator (SCS) trial. Of note, imaging reviewed showed lumbarization of the S1 vertebra and levoconvex scoliosis of the lumbar spine, severe spinal canal stenosis at the L3-L4 level, and severe multilevel neuroforaminal narrowing, which explained her symptoms.

In August 2020, the patient was taken for SCS trial lead placement with a paresthesia-free system (Nevro Corp., Redwood City, CA) (Table 1). During the uneventful procedure, access was obtained with ease at the T12-L1 level using a right and left paramedian approach with Touhy needles and loss of resistance syringes, then 2 leads were guided up to the T8 and the midway point of the T9 vertebra. Appropriate placement was confirmed with fluoroscopy (Fig. 1). We then proceeded to remove the Touhy needles under live fluoroscopy with special attention to confirm no change in the lead position. After confirmation, and acknowledging the patient's history of allergic reactions to adhesives, the leads were securely taped to the skin. Tension-relieving loops were created and paper tape was used to secure the loops to the skin. Subsequently, we applied multiple Tegaderm adhesives (3M Corporation, Maplewood, MN) directly over the loops and Medipore tape (3M Corporation, Maplewood, MN) was used on top to provide further security. As previously mentioned, no firm adhesive tape (StayFIX, Merit Medical, South Jordan, UT) was used due to our patient's allergy history. The patient was then taken back to the preprocedural area and was discharged home after meeting appropriate criteria.

During a follow-up with the patient, 2 days after the trial, she endorsed no relief from the stimulation. After discussion with the patient, lead migration was suspected and she was advised to return to the hospital for confirmation of proper lead position. A thoracic and lumbar x-ray was performed, which showed significant lead migration up to the T3 vertebral body (Fig. 2, Table 1). After discussing potential risks and benefits with the patient and acknowledging the significant lead migration, she was taken back to the procedure suite and the leads were pulled back until the top of the left lead was at the top of T8 and the right lead was at the top of T9 (Fig. 3). We decided to extend the duration of the trial for an additional 4 days, with a total trial duration of 7 days. The trial leads were then removed successfully at the end of this period (Table 1). Upon interrogation, the patient reported < 50% improvement of the pain; therefore, the trial was considered unsuccessful.

During the next 3 years of her interactions with our clinic, she underwent a second trial with a paresthesia-producing SCS system (SPRINT, SPR Therapeutics, Cleveland, OH), which was also unsuccessful. She then decided to proceed with the surgical procedure and underwent a staged T10-to-pelvis posterior spinal fusion and L5-S1 anterior fusion. She continues to deal with chronic back pain secondary to hardware-related problems requiring a revision procedure in 2023.

DISCUSSION

Despite the fact that accounts and studies of lead migration are predominantly described in the context of permanent device implantation, reports of lead movement in the cephalad direction during trial can be found. With that said, at the moment of this publication, our case represents the second longest distance traveled.

It is well established that hardware-related complications are reported to be the most common complication. Among these, lead migration is the main cause for SCS revision (8,12). Lead movement is especially prevalent when the trial is performed, this is because, in most cases, there is no formal anchoring system sutured. Moreover, there is no consensus on the best way to secure the device. This is well documented by Mullins et al (4) in their 2023 observational study where 50% of leads experienced significant migration, while Jenkinson et al (7) reported more concerning numbers of 78%. We recognize that the vast majority of these cases represent caudad lead migration 75% to 80% (4), but cephalad migration of the lead could result in serious consequences. For example, there have been reports of vascular structures punctured by the lead with subsequent development of epidural hematoma (5). We also ponder how many of these migration episodes are missed due to lack of follow-up x-rays, making the previous numbers conservative. In our opinion, this warrants extra caution and exhaustive discussion of optimal securing techniques to limit these types of lead movement to the minimum.

In regards to the specific causes for lead migration, the literature suggests that etiology is likely multifactorial. To provide some structure to the discussion, we will organize them into patient-related, procedural, and postprocedural factors. For patient-related factors, our case's relatively low BMI, with less soft tissue between the skin and epidural space, led to the lead being less tethered within the soft tissues. In addition, the levoconvex scoliosis in her lumbar region could have played a role, the follow-up x-ray revealed that the external leads had lateralized to the right side along the curvature of the scoliotic portion of her thoracic spine (Table 1). Furthermore, the lumbarized S1 vertebra potentially increased the mobility of her lumbar spine adding yet another point of motion.

Among the procedure-related factors, insufficient anchoring of the lead could have played a role. Surgically implanted leads, which are anchored to the dura as well as to the deep fascia, appear to have lower migration rates than percutaneously implanted leads, suggesting that lack of sufficient anchoring makes a lead more prone to migration (12). This is more prominent in the case of trials, where, in many cases, no anchoring via sutures is performed. In addition, due to an adhesive allergy, no StayFIX securing dressing was used. It is possible that if the loops were trapped underneath

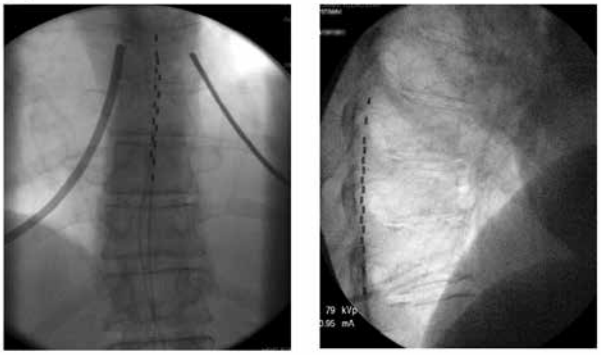

Fig. 1. Initial placement of SCS trial leads with the superior lead at T8 and inferior lead at T9. SCS, spinal cord stimulator.

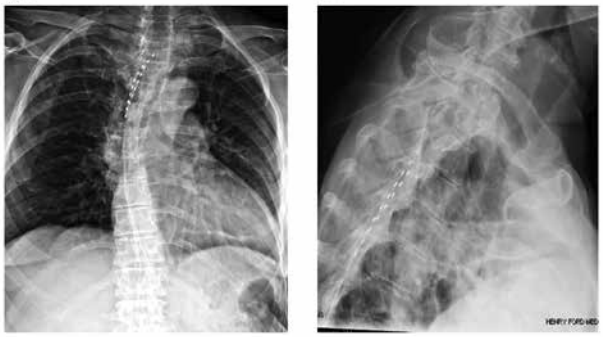

Fig. 2. Follow-up AP and lateral x-ray at postprocedure day #2. Showing significant lead migration to the T3 vertebral body. AP, anteroposterior.

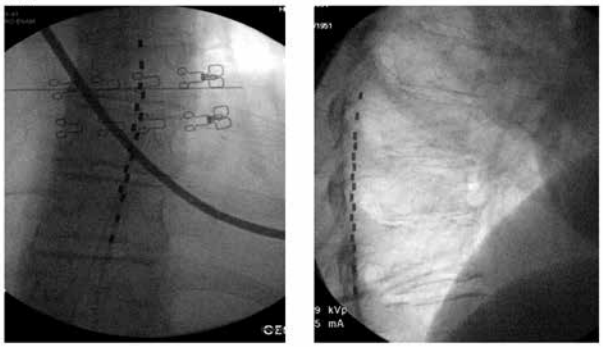

Fig. 3. Fluoroscopic images showing lead reposition to the T8 and T9 level.

the nonadhesive part of Tegaderm, the distal part of the leads could have crossed between the skin and the adhesive part such that they were fixed at this point, making deeper movement into the epidural space the path of least resistance. To add to that, it is understood that the epidural space has negative pressure that may have facilitated the movement aided by the airtight seal created by Tegaderm (13). The mechanism behind the "hanging drop" technique used to confirm access to the epidural space supports this possibility (14). It has also been reported in the literature that postprocedural patient activity, including bending and rotational movements, are an important factor affecting lead migration (4,16). Furthermore, in our case, the lack of additional layers of protective tape due to adhesive allergy may had played a role.

As our final point, we want to emphasize the fact that there is no universally approved lead-securing technique during the trial, especially for patients with adhesive allergies. The practice in our clinic is to use the StayFIX securing device, which has proven to be reliable in our experience but there is no formal data documenting the rate of migration with their use. Furthermore, we were not able to use it because of patient-related factors. Other well-documented techniques include the use of tape, silk sutures, and the combination of suturing with anchoring devices. Interestingly, Osborne et al (15) documented in their study that securing with tape was associated with significantly lesser chance of lead migration compared to suture and tape. With that said, this technique has been associated with higher chance of cephalad migration. On the other hand, Mullins et al (4) documented higher incidence (86%) of significant lead migration with mechanical anchors compared to 44% with sutures alone, with a higher incidence of caudad migration. This could mean that fixation of the lead to the skin can be a source of traction.

We deem this presentation and discussion relevant because the consequences of lead migration can be detrimental to the patient's outcome. As exposed previously, the risk of epidural hematoma exists, and failure of the trial period will prevent the permanent placement of a device that otherwise could have been helpful. We believe that the anchoring device selection should be an integral part of the preprocedural planning and patient-related factors should be used to determine the most appropriate option. Furthermore, it is in our best interest to develop a strategy that will mitigate significant cephalad and caudad migration in addition to formally studying how securing devices like StayFIX perform compared to other options.

CONCLUSIONS

Lead migration remains the most common complication of SCS implantation, leading to a loss of therapeutic stimulation (8). Even though caudad migration appears to be more prominent, significant cephalad migration has been reported in the past and could lead to significant adverse events. Our patient was unique in that the cephalad lead migration was extensive, which is rarely encountered and documented. Multiple factors may have contributed, including a low BMI, levoconvex scoliosis of the lumbar spine, a lumbarized S1 vertebra, and/or the use of Tegaderm and tape as opposed to an external adhesive fixation tape. This report has the additional purpose of raising awareness of this potential complication and reinforcing the need to further study the mechanisms behind lead migration, how the current methods for securing the lead perform, and developing more options for securing the lead in all types of patients such that the incidences of migration are reduced.

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