Case Report

Thoracic Nerve Root Entrapment by Intrathecal Catheter Coiling: Case Report and Review of the Literature

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Background: Intrathecal catheter placement has long-term therapeutic benefits in the management of chronic, intractable pain. Despite the diverse clinical applicability and rising prevalence of implantable drug delivery systems in pain medicine, the spectrum of complications associated with intrathecal catheterization remains largely understudied and underreported in the literature.

Objective: To report a case of thoracic nerve root entrapment resulting from intrathecal catheter migration.

Study Design: Case report.

Setting: Inpatient hospital service.

Results/Case Report: A 60-year-old man status post implanted intrathecal (IT) catheter for intractable low back pain secondary to failed back surgery syndrome returned to the operating room for removal of IT pump trial catheter after experiencing relapse of preoperative pain and pump occlusion. Initial attempt at ambulatory removal of the catheter was aborted after the patient reported acute onset of lower extremity radiculopathic pain during the extraction. Noncontrast computed tomography (CT) subsequently revealed that the catheter had ascended and coiled around the T10 nerve root. The patient was taken back to the operating room for removal of the catheter under fluoroscopic guidance, with possible laminectomy for direct visualization. Removal was ultimately achieved with slow continuous tension, with complete resolution of the patient's new radicular symptoms.

Limitations: This report describes a single case report.

Conclusion: This case demonstrates that any existing loops in the intrathecal catheter during initial implantation should be immediately re-addressed, as they can precipitate nerve root entrapment and irritation. Reduction of the loop or extrication of the catheter should be attempted under continuous fluoroscopic guidance to prevent further neurosurgical morbidity.

Key words: Implantable drug delivery system, intrathecal, catheter migration, postoperative complications, looping, fluoroscopy

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Intrathecal drug delivery systems (IDDS) have been used since the early 1980s for advanced pain therapy in patients with chronic pain associated with cancer or nonmalignant etiology. IDDS deliver therapeutic agents at a programmable, continuous infusion rate to the subarachnoid space, allowing for lower doses of analgesics, increased efficacy, and reduction of potential systemic side effects. The development of

externally programmable, battery-powered pumps has allowed for noninvasive dose changes, further decreasing the risks associated with frequent aspiration and injection of therapeutic solutions (1). However, several complications associated with IDDS placement and management have been described, including neurologic compromise from either compressive intradural or extradural spinal hematoma, low pressure headaches and spontaneous intracranial subdural hemorrhage from persistent cerebrospinal fluid (CSF) leak, infection, catheter tip granulomas, catheter fracturing, and migration (2).

We report the case of a patient who underwent placement of a trial intrathecal catheter that was complicated by protracted urinary retention and persistent back pain, which culminated in pump occlusion and attempted removal. Ambulatory removal of the tunneled trial catheter produced new radicular neuropathic symptoms that unmasked coiling of the intrathecal catheter around the T10 nerve root, requiring a return to the operating room for extraction and potential surgical intervention.

Case Report

Case History

A 60-year-old gentleman with intractable chronic axial low back pain secondary to failed back surgery syndrome (FBSS) presented to the pain management clinic at the authors' institution for an IDDS trial. His past medical history was significant for severe lumbar and cervical degenerative disease, treated unsuccessfully with several multilevel lumbar and cervical decompressions with fusions. At the time of initial evaluation, the patient was managed on chronic opioid therapy with minimal relief of his back pain. Given his extensive surgical history, lack of improvement in his back pain with a conservative management strategy, and the associated benefit in pain but intolerable side effects from oral systemic opioids, the patient was considered appropriate for a tunneled trial with bupivacaine and dilaudid.

The patient was taken to the operating room (OR) with monitored anesthesia care. The T12-L1 interspace was identified with anterio-posterior (AP) fluoroscopy, just superior to the patient's prior L1-4 spinal fusion hardware. A 5-cm right-sided paramedian incision was made down to the level of the fascia and a 14-guage Touhy needle was inserted into the T12-L1 interspace. The intrathecal space could not be accessed at this level due to his prior lumbar fusions, and the needle was subsequently redirected superiorly into the T11-12 interspace. Under continuous fluoroscopic guidance the catheter was threaded superiorly until the catheter tip was at the T9 level (Fig. 1A). There was good CSF egress and no evidence of catheter buckling and the patient denied experiencing discomfort or paresthesias. The catheter was then anchored to the fascia and the remaining distal catheter was tunneled subcutaneously to the flank region and connected to an external pain pump. Continuous flow of CSF from the catheter was confirmed throughout the procedure.

The patient reported immediate postoperative reduction in his back pain from 9/10 to 2/10 on the Numeric Rating Scale. He was seen frequently in the pain clinic, during which time he underwent medication titration and was placed on antibiotics for infection prophylaxis. Two weeks postoperatively, however, the patient endorsed return of his baseline preoperative pain. This pain remained refractory to all attempted alterations in his infusion regimen, prompting electronic interrogation of the pump. An occlusion error was identified and the system was further evaluated under live fluoroscopy. The catheter could not be definitively identified and attempts to aspirate CSF from or inject contrast into the intrathecal space were unsuccessful. Immediate return to the interventional suite was scheduled for removal of the tunneled trial system.

During the attempted catheter extraction, the patient reported acute onset radiculopathic pain radiating into the buttocks, groin, and posterior aspect of his left lower extremity. Using AP fluoroscopy, it was noted that the catheter tip had migrated superiorly and turned 180 degrees on itself, generating a half loop at the upper border of the T10 vertebral body. The procedure was aborted and the patient was admitted for further evaluation. Noncontrast computed tomography (CT) of the lumbar and thoracic spine showed the catheter ascending to the T9-10 disc space, looping anteriorly to posteriorly, forming a coil around the left T10 nerve root, and protruding towards the T10-11 disc space (Fig. 1B).

The patient was taken to the OR under general anesthesia for removal of the intrathecal catheter with continuous fluoroscopic guidance and neuromonitoring. Consulting with neurosurgery, a possible laminectomy and intradural approach was planned if needed. Before proceeding, removal of the catheter was attempted, with noted resistance. Prior to performing laminectomy and dural opening, a soft-tipped stylet

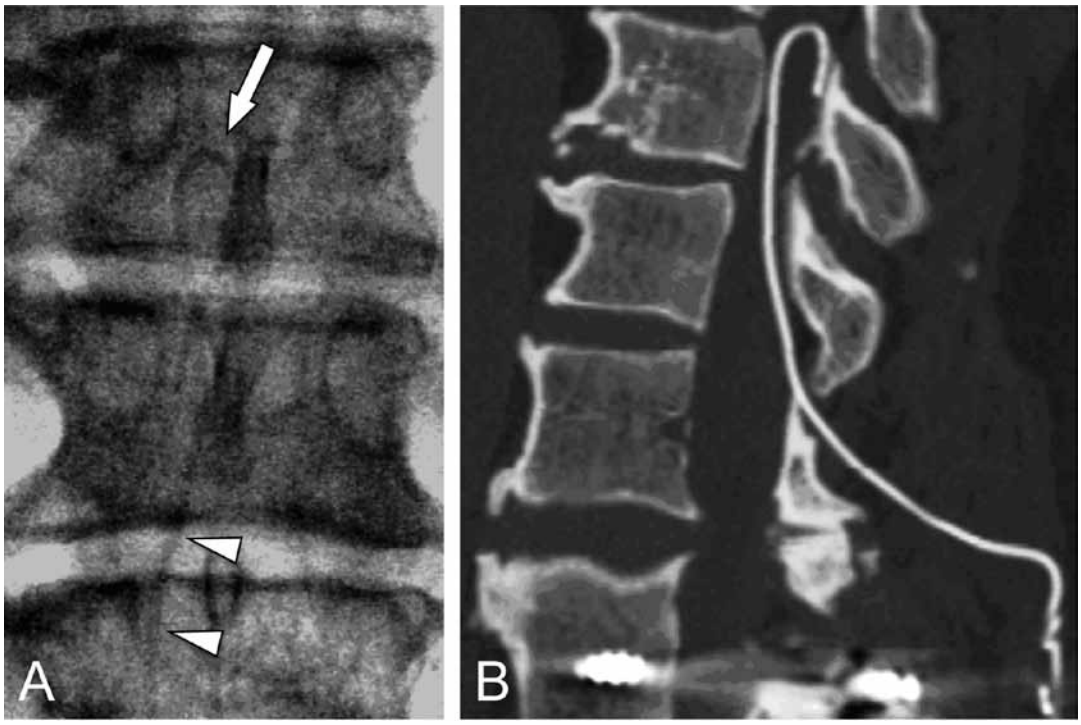

Fig. 1. *X-ray fluoroscopic image shows looping of the catheter during implantation (A), which was left uncorrected at the time. Noncontrast CT of the thoracic spine (B) shows the intrathecal catheter as it enters the spinal canal between T11 and T12 spinous processes. It courses superiorly towards the left anterolateral thecal sac, partially folds back upon itself at the T9-10 disc space, and courses posterior medially in a caudal direction. It terminates at the level of the mid-T10 vertebral body.*

was first inserted in an endeavor to unkink the catheter while simultaneously attempting extraction, in efforts to avoid the more invasive procedure. The original incisions were reopened, the distal end was removed, and the proximal end was cannulated with an inner stylet and successfully removed with slow continuous tension under fluoroscopic guidance. The proximal catheter was intact and appeared to be in good condition. Throughout the procedure, intraoperative somatosensory and motor evoked potentials remained normal with no changes from baseline. Upon awakening, complete resolution of his left lower extremity radicular symptoms was achieved.

Discussion

Targeted intrathecal (IT) infusion with IDDS (also known as targeted drug delivery) has become a standard part of the treatment algorithm for chronic pain syndromes (3). When comprehensive medical management fails, IDDS is a proven and valuable approach to achieving symptom management and improving quality of life. A recent randomized clinical trial comparing IDDS to comprehensive medical management (CMM) offered convincing evidence that in many respects, IDDS can be considered safer and more effective than multiple combination pharmacotherapies. IDDS correlates with improved pain control, drug toxicity, and survival time relative to CMM (4). De Lissovoy et al (5) also compared IDDS to CMM in patients with FBSS over a 60-month treatment course and found that targeted drug delivery was a more cost-effective management strategy, beginning at 11 – 22 months. In contrasting IDDS to other invasive pain management methodologies, a retrospective study comparing therapeutic effectiveness of spinal cord stimulation (SCS) versus IDDS in the treatment of mechanical low back pain established that patients who received intrathecal opioids reported greater pain reduction and improvement across multiple dimensions (e.g., depression, coping, dependency, sleep) than the SCS group (6).

Advantages aside, the use of an implanted device is associated with measurable risks (7). Patients with non-cancer pain receiving IT opioid therapy showed increased mortality of 3.89% at one year, likely due to complications of opioids, among other factors (8). Severe complications such as mechanical failure (5), drug-related direct neurotoxic damage (9), and compression secondary to intrathecal granuloma formation have also been reported (10). Thus, although the therapeutic benefits of IDDS are strongly supported throughout the literature, these benefits must be balanced with the potentially serious complications. In order to optimize patient outcomes, practitioners must take all possible precautions during patient selection and catheter placement to minimize the risk of rare catheter-based complications. The present case report emphasizes the importance for immediate correction of an unreported, subtle, and frequently disregarded element of catheter placement: catheter looping.

Considering the spectrum of IDDS-related complications, catheter-associated complications are by far the most clinically relevant in terms of prevalence (11,12). In a single tertiary care center, researchers found that the annual rate of complications requiring surgical correction was 10.5%, with 25% being pump-related and 65% being catheter-related (13). A prospective analysis of a multicenter study identified a 20 – 25% catheter failure rate in implanted pump systems, usually related to leakage, dislocation, disconnection, and occlusion (14). Catheter migration is the most common procedure-related complication of intrathecal catheter placement (approximately 25%) (14). Despite its prevalence, inadvertent implantation is often overlooked due to its characteristically nonspecific symptomatology, non-localizing examination findings, and passive distribution of drug throughout the subarachnoid space (14,15).

The literature supports a series of preoperative, intraoperative, and postoperative measures that can be used to improve patient outcomes following IT catheterization. Preoperatively, it is critical that physicians examine features of patient anatomy that may present challenging landscapes for pump and catheter access and placement, including spinal deformities, previous spinal surgery/instrumentation, body habitus, and a review of existing spinal radiographs. Intraoperatively, it is recommended to insert the catheter at the L2-3 or L3-4 level unless patient anatomy, prior surgical history, or disease process dictates otherwise. In this case, the patient had undergone 4 prior surgical attempts to relieve his pain, including L1-4 posterior lumbar interbody fusion and L4-S1 fusion. We initially attempted an unsuccessful entry at the superior aspect of the right L1 pedicle. After weighing the risks, benefits, and alternatives, we proceeded to advance into the T11-12 interspace due to the boney fusion caudal to this level. Though non-ideal, entry at this level is a viable option and has been successfully executed without deleterious outcomes. While there are no definitive guidelines for optimal catheter placement (3), the technically challenging aspects associated with low thoracic entry cannot be excluded as a contributor to catheter looping during initial implantation in our patient.

Catheter insertion under intraoperative fluoroscopy should be used to ensure that the tip is positioned at the desired level, that the guide wire remains in place during subsequent maneuvering of the catheter, and that removal of the stylet does not cause dislodgment or migration (16). Candler et al (17) recommend using intraoperative 3D spinal navigation to help place IT catheters in patients with complex anatomy or history of prior surgery. In patients with FBSS, this intraoperative adjunct would provide additional support in securing catheter implantation through complex bony architecture. Minimizing the length of the catheter outside the spine can help prevent dislodgment or migration of the IT catheter associated with ambulatory movement (18). Postoperatively, a low threshold for acquiring diagnostic studies of the spine is essential to enable early diagnosis and intervention, as catheter removal is associated with complete recovery in the majority of patients. Careful tracking of pump contents, volume, and settings during refill visits can serve as an early indication of any postoperative issues (19). In the stable patient not at risk for developing uncontrollable withdrawal, quantitative nuclear medicine scans following radioisotope delivery over several days can also confirm catheter integrity (19).

In patients with IDDS who complain of new onset neurologic symptoms, a high index of suspicion for catheter migration and low threshold for acquiring diagnostic imaging is essential. X-ray fluoroscopy can serve as a rapid initial imaging study to assess catheter integrity and visualize any fractures or dislodgements (19). Magnetic resonance imaging is suggested to be the primary imaging modality to survey the spinal architecture and evaluate for potential stenosis or granuloma formation (19-21). However, re-imaging with CT is ideal to accurately delineate the course of the catheter and visualize nerve root compression within the intervertebral foramina (20). In our case, catheter migra-

tion itself was not the etiology of the patient's neurologic symptoms; the looping of the migrated catheter around the thoracic nerve root remained neurologically asymptomatic in situ. Although the catheter migration manifested in an occlusion error necessitating catheter removal, it was only upon attempted extraction of the looped catheter that irritation of adjacent neural structures occurred. This culminated in acute radiculopathic symptomatology and resistance to further removal. Once the catheter was extracted and the compression relieved, the patient's symptoms immediately resolved.

Transient nerve root irritation presenting as radicular pain has previously been reported, and is a self-limited phenomenon that resolves on the order of days to weeks after implantation (22). We identified 2 other cases describing iatrogenic nerve root entrapment and impingement that required surgical intervention (2,20). In each case, removal by traction was attempted and aborted when resistance was felt, and the patient was taken to the OR for decompression surgeries to either remove or reposition the catheter. Ko and Ferrante (20) suggest that the distal catheter tip be placed within the facet joint articulation of the 2 adjacent foramina, thereby reducing the risk of migration by maximizing the distance from the catheter tip to the foramina. Thus, depending on the severity of the symptoms and the anticipated difficulty of removing the IT catheter, removal strategies might include slow continuous tension by the operating surgeon under live continuous fluoroscopy, open laminotomy and removal of the catheter under direct vision, and even open laminotomy with durotomy and removal with continuous neuromonitoring and subsequent dural repair (2). Ambulatory removal was unsuccessful in our patient, who returned to the OR, but was fortunate to have ultimately avoided a more invasive and extensive intervention at that time. However, we postulate that had looping been prevented or addressed immediately during initial implantation, the subsequent complication of return to the OR could have been avoided. This case illustrates the importance of serial neurologic examinations with low threshold for acquiring diagnostic imaging (magnetic resonance and/or CT-myelography) in the management of patients with IDDS who complain of new acute onset neurologic symptoms.

Conclusions

Intrathecal catheter looping is often overlooked as an insignificant finding during implantation. While adequate placement can be confirmed with intraoperative fluoroscopy, it is also important to visualize the integrity of the catheter within the intrathecal space. Should a catheter curve during implantation, immediate reduction must be performed in order to minimize the risk of nerve root irritation or entrapment requiring surgical exploration and catheter removal.

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