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Case Report

# False Positive Radiographical Evidence of Pump Catheter Migration into the Spinal Cord

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Intrathecal drug delivery systems are becoming an increasingly common modality used by physicians to treat patients. Specifically, chronic spasticity secondary to multiple sclerosis (MS) may be treated with intrathecal baclofen (ITB) therapy when oral antispasmodics do not provide adequate relief. ITB therapy is effective, localizes drug delivery, and does not have the same degree of intolerable systemic effects often seen with oral and parenteral medications. As the use of intrathecal drug delivery systems has become more common, so has the incidence of adverse events. ITB administration requires the surgical implantation of indwelling catheters and a pump reservoir. Although this therapy is useful in treating spasticity, risks unique to intrathecal drug delivery systems include medication dosing errors, pump malfunction, infection, and catheter breakage or dislocation. To our knowledge intrathecal pump catheter migration into the spinal cord is a very rare complication with only 2 such complications reported. We present a case of an intrathecal baclofen pump catheter that was initially believed to have migrated into the spinal cord and the innovative use of cinefluoroscopy and digital subtraction used to identify catheter placement. Moreover, after confirmation of the catheter position within the spinal cord on magnetic resonance imaging (MRI) our team elected to perform a laminectomy, which demonstrated that the catheter was not in the spinal cord but was surrounded by arachnoid adhesions. We hope our efforts will provide the clinician insight into the common difficulties that arise and how best to troubleshoot them to serve this specific patient population and prevent potentially life-threatening complications.

**Key words:** Intrathecal pump, intrathecal catheter, multiple sclerosis, pain medicine, spasticity, cine mode, baclofen

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Multiple sclerosis (MS) is the most common cause of neurological disability in young adults (1). More than 30% of patients with MS report spasticity that interferes with activities of daily living (2). Patients with MS, spinal cord injury, brain injury, stroke, and cerebral palsy are often afflicted with this condition. Spasticity is the source of physical and emotional distress for many patients (3). In patients with MS, it is the increasingly destructive de-myelination of the fatty sheath nerve endings secondary to inflammation that presents similar to gamma-amino butyric acid (GABA) deficiencies.

Spasticity manifests clinically as a feeling of stiffness and involuntary muscle spasms - both muscle contractions and sudden movements. It is a result of hypertonia with a resistance to stretch, where a lack of inhibition results in excessive contraction of muscle. This results in a velocity-dependent increase in tone which develops when an imbalance occurs in the excitatory and inhibitory input to $\alpha$-motor neurons caused by damage to the spinal cord or central nervous system.

Baclofen is an antispasmodic medication and GABA-B agonist that acts at the spinal cord level to inhibit release of the excitatory neurotransmitter glu-

tamate by inhibiting calcium influx into the pre-synaptic nerve terminal (4). Frequently, intrathecal baclofen (ITB) is better tolerated than oral baclofen with direct effects on neuronal receptors in the spinal cord (5). The decrease in systemic side effects in comparison to oral medication allows for an increase of total dose with minimal side effects when MS exacerbations develop. The long-term beneficial effect of ITB treatment has been well documented, providing emotional and physical relief with a consistent improvement in the modified Ashworth score (3). Baclofen withdrawal syndrome remains a potentially life-threatening syndrome in the event of pump or system dysfunction; symptoms can include fever, hallucinations, rebound spasticity, autonomic instability and, in severe cases, mental status changes, seizures, and rhabdomyolysis. An understanding of how to troubleshoot intrathecal catheters and how to manage potential acute withdrawal remains imperative in protecting patient health.

## Case Report

A 41-year-old woman with a history of progressive MS, initially diagnosed in 1995, underwent replacement of an expiring Medtronic Synchromed II 8637-20 ITB pump due to end-of-life battery failure to continue treating her severe spastic quadriplegia. The day after an uneventful surgical replacement of the abdominally placed pump, the patient presented to the emergency department (ED) with symptoms of increased spasticity and baclofen withdrawal including pruritus. Her acute spasticity was thought to be related to an MS-flare related to surgery. In the ED, thoracic and lumbar plain films were ordered to evaluate for catheter kinking, dislodgment, or disconnection. Subsequently, 50 mcg of baclofen was bolused via the pump demonstrating no benefit. The next decision was to evaluate her baclofen pump which was then fully evaluated in the operating room (OR) setting using proper pump evaluation protocol including catheter dye study and electronic analysis/reprogramming (6). Normal function was based on easy cerebrospinal fluid (CSF) aspiration via the catheter access port and appropriate reservoir volume. The catheter dye study demonstrated easy injection of visualized contrast and confirmed patency of the entire catheter; the catheter tip was identified at the C7 vertebral level. Unfortunately, visualization of contrast in the intrathecal space was not achieved.

One week later, on follow-up, the baclofen was completely emptied from the pump and replaced with preservative-free intrathecal baclofen and set at a 15% dose increase at 717 mcg/day. This was secondary to her sub-adequate clinical response at her current dose. In addition, oral baclofen treatment (10 mg TID) was also trialed and provided symptomatic relief. Subsequently, the patient was discharged with a follow-up appointment in the clinic. At follow-up a week later, her oral baclofen therapy was further titrated to 20 mg TID along with initiating tizanidine 2 mg QID. At this visit, her ITB pump dosage was again increased by 15% to 824.2 mcg/day.

Two weeks later, the patient continually reported increased spasticity. Her oral spasticity medications were titrated up (baclofen dose to 30 mg TID, tizanidine dose to QID) and ITB pump dosage increased 15% to 947.9 mcg/day. The pump was once again evaluated, but during this analysis our team performed a rotor study, under fluoroscopic guidance, to rule out pump malfunction with the CINE-mode of digital subtraction, displaying real-time injection of contrast with simultaneous CSF spread from the catheter tip. The dye study using CINE-mode digital subtraction showed proper delivery of medication into the intrathecal space. With the above negative studies, further imaging was ordered. Magnetic resonance imaging (MRI) revealed that the pump catheter tip extended superiorly to the C4 level and traversed through the spinal cord by entering it posteriorly and exiting back ventrally into the intrathecal space. After conferring with the multidisciplinary team (pain specialists, neurosurgery, and device representatives), the decision was made to perform a cervical 4-5 laminectomy. Surgical exploration showed that the catheter tip did not traverse the spinal cord but was surrounded by arachnoid adhesions. Ultimately, the replacement of the baclofen pump demonstrated that debris partially occluded the catheter at the catheter-pump attachment site. Postoperatively, the patient's spasticity was alleviated. It was concluded that the source of the problem was at the catheter-pump attachment site. This problem could not be visualized during our work-up, and most likely prevented adequate CSF flow of baclofen into the intrathecal space.

## Pump Catheter Migration into the Spinal Cord

We conducted a PubMed literature search and there have only been 2 published reports of catheter migration into the spinal cord visualized on MRI. Catheter migration remains the single most common complication encountered with pump catheters (7). Harney and Victor, in 2004, presented a case of a patient who

developed a traumatic syrinx secondary to the presence of an intrathecal catheter within the spinal cord (8). This case illustrated a woman with chronic low back pain status post multiple cervical and lumbar fusions who underwent an intrathecal morphine pump placement with immediate complaints of pain after awakening from general anesthesia. An urgent neurological examination demonstrated motor and sensory deficits of the left lower extremity and MRI showed catheter penetration of the spinal cord with concomitant syrinx formation extending from T6 to L5. The catheter was removed and the patient was treated with dexamethasone. An intrathecal catheter was later replaced under general anesthesia with immediate MRI follow-up with an uneventful intraoperative and postoperative course.

Albrecht et al (9), in 2005, published a case report of a patient who developed phantom limb pain after a mid-thigh amputation due to a left femur osteosarcoma. The patient's pain was successfully treated with a clonidine intrathecal pump until several years later when the pump was revised. Seven months after the revision, the patient complained of reappearance of his left thigh and stump pain. A work-up was initiated with results of the T2 MRI showing that the patient's catheter was visualized to have migrated into the spinal cord from T12-L1 up to T9. The catheter tip could be visualized in the anterior portion of the spinal cord although the patient never exhibited any adverse neurological signs. Albrecht and associates decided that "intra-medullary" catheter removal was inappropriate and a second catheter was placed, providing adequate pain relief (9).

A laminectomy to visually confirm migration of an intrathecal catheter was not done in the previous 2 studies. We elected to perform the procedure as a surgical option for management of intrathecal catheter migration. The neurosurgeon on our team performed a cervical 4-5 laminectomy showing that the catheter was surrounded by adhesions and not, in fact, traversing through the spinal cord. In the above-mentioned reports published by Albrecht et al as well as Harney and Victor, even though radiographic imaging demonstrated catheter migration into the spinal cord, these radiologic findings may be inaccurate if not actually visualized (8,9). We present this evaluation technique as a confirmation after a positive radiographical study for suspected catheter migration into the spinal cord. Clinical parameters such as neurological deficits, patient comfort, and symptom progression should be considered before continuing with invasive medical treatments.

## CINE Fluoroscopy and Digital Subtraction

A literature search was performed and the innovative technique of CINE digital extraction to verify the catheter tip has not been used to verify proper placement of an intrathecal baclofen pump catheter. CINE fluoroscopy is a technique which involves taking numerous frames per second. Digital subtraction involves elimination of bone and soft tissue structures from an image so that only the contrast-filled catheter remains. The first step includes the production of a scout or mask image. A mask image contains all the anatomy of interest prior to the injection. Next, the injection process occurs which produces a native image, displaying all of the anatomy, including the contrast-filled catheter. Finally, the mask image is laid over the native image and a computer subtracts all of the like structures, leaving the contrast-filled catheter in the image (10).

## Conclusion

ITB administration is an underutilized treatment used to reduce spasticity in patients with MS. This intervention decreases pain, improves sleep, and increases physical activity (11). However, administration failures are becoming more common with the increasing use of ITB devices. Withdrawal is potentially life threatening as it may acutely decrease a patient's quality of life. Baclofen withdrawal syndrome may result making timely identification of pump or catheter malfunction imperative (12). Although MRI remains the modality of choice for identifying catheter position, the MRI utilized in this case could not differentiate the spinal cord from surrounding subarachnoid adhesions. We suggest that a computed tomography myelogram may be more definitive in identifying catheter position because the spinal cord and nerve roots can be seen with greater clarity; and if necessitated, a consideration for surgical exploration should be undergone prior to accepting the definitive conclusions of radiographical data. With a greater understanding of ITB management, clinicians can better coordinate radiologic imaging results with a thorough and timely work up to identify intrathecal pump catheter malfunction; this process remains imperative for clinicians and patients because medication dosing errors related to ITB dysfunction may result in life-threatening overdose or withdrawal as well as extreme suffering in the form of patient spasticity and pain.

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