NEW!

Emergency Department Evaluation of Patients With Intrathecal Pumps

Resistant pain syndromes may require the use of more invasive therapies, including a wide variety of nerve blocks and procedures designed to alleviate pain, improve function, and enhance quality of life. The authors review intrathecal pumps, their mechanism of operation, initiation of therapy, and potential complications.

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Chronic pain is prevalent among those presenting to the emergency department and is often associated with severe suffering and disability. Treatment may involve a variety of nonpharmacologic and pharmacologic interventions, including opioids; however, many patients who have been on a trial of opioids and have developed tolerance are unable to withstand high-dose opioid regimens, due to well-known adverse effects.

Many interventional pain practices offer patients intrathecal therapies, often with fewer side effects than with an equianalgesic dose of systemic opioids.[1] Intrathecal pumps were initially used as treatment for cancer patients with a high pain burden unresponsive to systemic analgesics and other interventional treatments; increasingly, however, these systems are being used to treat chronic nonmalignant pain.

PATIENT PRESENTATIONS

Case 1. A 35-year-old woman with a history of chronic pain treated with an implanted neuraxial intrathecal pump arrives by ambulance with active seizures after a minor motor vehicle collision earlier in the day. Her medical history includes arthritis and chronic back pain due to postlaminectomy syndrome. She has no history of epilepsy. Her daily regimen for pain management consists of three doses of oral methadone 10 mg, one tablet of 5/325 mg oxycodone/acetaminophen up to three times as needed, and a mixture of morphine, bupivacaine, and baclofen through the intrathecal pump. Her seizures have responded to intravenous lorazepam and the remainder of her physical exam is unremarkable. Her pain physician is paged.

Case 2. A 55-year-old man with failed back syndrome treated with a neuraxial intrathecal infusion pump presents with pain, anxiety, nausea, and fatigue after a fall. He reports that the pump, which has been delivering a combination of ziconotide, fentanyl, and clonidine, was refilled uneventfully 2 days ago. Interrogation of the pump with an external programmer shows no malfunction. A CT scan confirms a break in the catheter. An equianalgesic dose of opioids is given intravenously while the pain physician is paged.

Case 3. A 48-year-old woman presents with severe right upper quadrant abdominal pain and vomiting. The patient has a history of chronic intractable back pain treated with a neuraxial intrathecal pump containing morphine, bupivacaine, and clonidine. She describes the abdominal pain as steady and aching. She displays a positive Murphy's sign but no peritoneal signs. The emergency physician is concerned that an infectious complication of the patient's intrathecal pump is causing her symptoms. Preparation for ultrasound examination is initiated and her pain physician is contacted.

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DISCUSSION

Opioid receptors in the spinal cord are the primary site of opioid-induced analgesia. By delivering medication directly to those receptors, an intrathecal pump can achieve a high degree of pain relief using a relatively small quantity of medication. This direct approach decreases opioid-induced sedation and many of the gastrointestinal side effects that are commonly seen with oral opioid use.[2]

The more common nonmalignant indications for intrathecal analgesia include failed back syndrome, chronic regional pain syndrome, and peripheral nerve injury.[3] In addition to opioids, drugs delivered intrathecally may include local anesthetics, clonidine, baclofen, and ziconotide.

Intrathecal pump implantation should be performed only after careful patient screening and demonstration of a positive response to a trial of epidural or intrathecal opioids. Typically during such trials, patients should exhibit at least a 50% decrease in pain intensity, accompanied by functional improvement.[4] The surgical technique for pump placement, which can be performed by a pain physician or by a neurosurgeon, involves placing an infusion catheter in the intrathecal space and tunneling the catheter to a pump. The pump is placed subcutaneously in the right or left lower abdominal quadrant and contains a reservoir that is percutaneously refilled approximately every 2 to 3 months. An additional injection port allows direct injection into and aspiration from the intrathecal space.

PROGRAMMING THE PUMP

For managing chronic pain, a programmable pump is usually chosen. The clinician uses a handheld input device to program the pump to deliver an analgesic solution at a set rate. The pump can be programmed for different rates at different times of day and, if necessary, for bolus dosing over a period of time when the patient tends to experience increased pain. There is also a new device, the patient therapy manager, which allows the patient to deliver a bolus as needed using a preset rate and dosage.

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The programmable pumps have cadmium batteries that last approximately 5 to 6 years, depending on the program required. Nonprogrammable pumps, which are rarely used, have their infusion rates set at the factory. To modify the infusion regimen for this type of pump, the concentration or contents of the medication mixture must be changed. These pumps do not have a battery and last until they are removed.

Only a few medications are considered eligible for use in intrathecal pumps. All must be preservative-free. Morphine is the most commonly employed opioid; however, hydromorphone and fentanyl are also used. As patients may develop tolerance, adverse effects, or both even with intrathecal therapies, adjuvant therapies—including the gamma-aminobutyric acid agonist baclofen, the local anesthetic bupivacaine, and the alpha-adrenergic agent clonidine—are also employed. Ziconotide is a newly available calcium channel blocker that provides analgesia only when administered by the intrathecal route. It was synthesized to duplicate the chemical structure of the venom secreted by the *Conus magus* snail. Clinical studies have shown ziconotide to be a safe and effective treatment for refractory pain, and the FDA approved its use in 2005.[4-6] Doses must be titrated up slowly, and the pain physician should observe for increasing confusion, which is the main side effect. Ziconotide is now indicated as a therapy option for patients whose pain is refractory to intrathecal morphine. Experience has shown that it is better tolerated when started at a low dose and titrated slowly, with the dose increased no more than once a week.[6]

Some patients receiving intrathecal therapy may require oral opioids concomitantly despite even the best efforts to eliminate the need for them.

COMPLICATIONS OF PUMP PLACEMENT AND OPERATION

As with any procedure or device, intrathecal pumps carry associated risks and complications.[7] Potential postplacement issues include bleeding, wound infections, and cerebrospinal fluid leaks.

Bleeding. Bleeding in the epidural or intrathecal space, while extremely rare, is associated with increased neurologic morbidity. If persistent, it warrants intraoperative consult for laminectomy. Persistent bleeding can lead to epidural hematoma, spinal cord compression, and paralysis.[4] If a patient presents after pump placement with signs and symptoms that are suspicious for these complications, spinal MRI or CT must be performed as soon as possible to confirm.

Infection. Sterile technique is of the utmost importance when implanting and handling intrathecal pumps, and prophylaxis with preoperative intravenous antibiotics and intraoperative antibiotic irrigation is an essential precaution. Infections should be cultured and treated aggressively with systemic antibiotics, and the patient should be observed for symptoms of meningitis. Refractory infections may require pump removal.[8]

Follett and colleagues reviewed data pertaining to infections associated with drug delivery systems.[9] The majority of infections involved the pump pocket site (57% to 80%). Recommendations for prophylaxis include the administration of a single dose of antibiotic effective against gram-positive skin flora within 1 hour before the skin incision. More potent or later-generation antibiotics may be considered in special cases, such as patients with drug allergies or a history of infection with resistant organisms. Available data do not support the use of postoperative antibiotics. Double-gloving with minimal- or no-touch surgical technique helps minimize the risk of device-related infection. Application of a sterile, occlusive dressing after closure of the surgical site may reduce the risk of infection from use of a nonsterile device to program the pump in the early postoperative period. Despite these precautions, postoperative infections occur in 5% of patients.[9]

Cerebrospinal fluid leaks. The creation of an opening in the dura by introducing a needle that is larger than the entering catheter predisposes the patient to cerebrospinal fluid leakage. Multiple punctures increase the chance of fluid leakage, as well. The incidence of this complication is relatively low, however, probably due to the elastic properties of the dura. Spinal headaches can be treated with a blood patch by injecting 10 to 20 mL of autologous venous blood at the entry point under fluoroscopy.[10] An epidural injection of fibrin glue has been used successfully by some practitioners to prevent leakage. Fluid may leak along the catheter and form subcutaneous hygromas, which need surgical revision if they are persistent.[11]

Side effects. Cephalad migration of intrathecal morphine can cause sweating (hypothalamic response) and peripheral edema (posterior pituitary response triggering vasopressin release).[1]

Device management errors and malfunctions. Most intrathecal pump problems that present to emergency departments are device related. Traumatic disruption of the catheter may cause drug to be deposited into surrounding soft tissue. Programmable pump delivery complications include overfilling, battery failure, pump failure, and pump torsion, which are preceded by loss of analgesia and can be confirmed by radiographs or fluoroscopy. Programming errors can result in oversedation, respiratory depression, and death. Inappropriate injection of drug into the side port may result in the patient receiving a bolus of medication. Newer pumps have been designed to prevent this complication by incorporating a screen into the side port that does not admit a standard refill needle.[1] Reprogramming or turning off an intrathecal pump can be performed only with an external programming device and should be done by trained personnel.

Mechanical complications include catheter dislodgment from the intrathecal space, disconnection of the catheter from the pump, catheter kinking and occlusions, and broken rotors, all of which prevent patients from receiving medication from the pump.

Errors in solution preparation by the pharmacy are rare but can occur. The medication is a mixture of drugs, each with its own concentration, which may be too low or too high due to a mistake in preparation. Changes in concentration must be considered when making dosage adjustments.

Granulomas. The gradual formation of a granuloma at the tip of the catheter can block the release of medication. The etiology of these masses is unclear, but animal experimental data suggest that an inflammatory response may occur after opioids are administered into the intrathecal space.[12] Patients with granulomas present with loss of analgesic effect accompanied by new, gradually progressive neurologic findings over a period of months. Treatment, based on anecdotal reports, includes cessation of drug administration through the catheter with replacement of normal saline for several months. Usually the mass shrinks or disappears over a period of 2 to 5 months, as evidenced by CT myelography or MRI with and without contrast. If neurologic symptoms are severe, a neurosurgeon should be consulted. Higher doses of

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Infections should be cultured and treated aggressively with systemic antibiotics.

morphine (more than 25 mg/day) may be associated with granuloma formation.[11]

Since most emergency physicians have little experience with intrathecal pumps, it is important that patients carry contact information for their pain physicians at all times. Emergency department staff should attempt to contact both the primary physician and the pain physician to obtain additional management advice. If this effort fails, an interventional pain physician or a neurosurgeon experienced with intrathecal pumps should be sought.

Repairing pumps or replacing their batteries rarely requires emergent intervention. Oral and intravenous therapy can control pain and withdrawal symptoms when a pump malfunctions. However, because patients will likely require aggressive titration of medications, hospitalization is usually necessary.

CASE OUTCOMES

The three introductory scenarios illustrate a spectrum of issues that may arise when a patient with an intrathecal pump is assessed in the emergency department. In the first case, the symptoms were caused by mechanical disruption of the catheter, with resultant baclofen withdrawal and seizures. In case 2, the patient presented with signs of opioid withdrawal due to a break in the catheter caused by a fall. With titrated administration of intravenous fentanyl, withdrawal symptoms were controlled. The intravenous dose is 100 times greater than the calculated intrathecal dose.[11] Equianalgesic doses need to be maintained to prevent further withdrawal and may need to be titrated upward to high levels; the patient should be observed for an adequate balance of pain relief and respiratory function.

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The final case illustrates that patients with intrathecal pumps also suffer from common problems unrelated to the intrathecal pump. The patient was eventually diagnosed with gallstones and underwent cholecystectomy. It is important not to overlook common problems or to attribute symptoms to the pump when they can be explained more readily by other conditions. □

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