Case Report

Lumbar Subarachnoid Hematoma Following an Epidural Blood Patch for Meningeal Puncture Headache Related to the Implantation of an Intrathecal Drug Delivery System

Erik C. Hustak, MD, Mitchell P. Engle, MD, PhD, Ashwin Viswanathan, MD, and Dhanalakshmi Koyyalagunta, MD

From: University of Texas MD Anderson Cancer Center, Houston, TX.

Additional Author information on P. E410

Address Correspondence:
Dhanalakshmi Koyyalagunta, MD
U.T. MD Anderson Cancer Center
Department of Pain Medicine
1515 Holcombe Blvd, Unit 409
Houston, TX 77030-0409
E-mail: dkoyyala@mdanderson.org

Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 11-12-2013
Revised manuscript received: 01-13-2014
Accepted for publication: 01-21-2014

Free full manuscript:
www.painphysicianjournal.com

Persistent meningeal puncture headache (MPH) is a known complication following both intentional and unintentional puncture of the dura mater. We present a case of persistent MPH following implantation of an intrathecal drug delivery system (IDDS). Two separate epidural blood patches (EBP) were performed under radiographic guidance with contrast visualization of the epidural space on postoperative days 16 and 28, respectively. The case was complicated by the development of a symptomatic lumbar subarachnoid hematoma diagnosed on postoperative day 35. The patient subsequently underwent a laminectomy, evacuation of the hematoma, and explanation of the IDDS. This case illustrates a potential unique morbidity associated with the EBP in a patient with an IDDS. The report concludes with a brief review of MPH followed by a discussion of possible mechanisms underlying this complication.

Key words: Epidural blood patch, post dural puncture headache, meningeal puncture headache, complications, spinal subarachnoid hematoma, intrathecal drug delivery, implantable pain therapies, ziconotide, tinnitus, pain, pain procedures

Pain Physician 2014; 17:E405-E411

Meningeal puncture headaches (MPH), traditionally referred to as post-dural puncture headaches, can occur following disruption of the dura and arachnoid mater. Disruption of cerebrospinal fluid (CSF) dynamics secondary to the dural injury is thought to lead to the development of the MPH (1). According to the International Classification of Headache Disorders, a MPH is by definition postural in nature with an exacerbation of symptoms within 15 minutes of assuming an upright position and alleviated within 15 minutes of assuming a recumbent position (2). Many MPHs are initially managed using conservative measures such as fluids, caffeine, recumbent posture, and analgesic therapy. For most patients, symptoms resolve within days to weeks but they occasionally persist for longer periods of time. Often, both the severity and duration of the symptoms encourages the practitioner to explore invasive treatment options such as the epidural blood patch (EBP).

Conceptually, the EBP originates with Gormley (3) in the 1960s when he noticed that patients with traumatic (bloody) meningeal punctures were less likely to develop a MPH. In 1970, DiGiovanni (4) published his successful utilization of epidural injections of autologous blood for the treatment of MPH. Although multiple other treatment modalities are frequently utilized, the EBP still remains the gold standard for treatment of the MPH.

A complex management decision arises when a patient develops a persistent MPH after implantation of an intrathecal drug delivery system (IDSS). Unique factors such as the risk of infecting an implanted medical device, damage to the IDDS catheter, and altered meningeal anatomy need to be considered prior to proceeding with an EBP in this setting. Furthermore, fluoroscopic guidance to ensure both appropriate needle position and contrast spread in the epidural space is essential. We report a case of a MPH following implantation of an IDDS. The patient received 2 EBPs with reasonable pain relief. However, the patient subsequently developed severe back pain with bilateral radiculopathy and was found to have a lumbar subarachnoid hematoma necessitating neurosurgical evacuation and IDDS explantation.

Case Report

A 46-year-old Caucasian man was referred to the MD Anderson Cancer Pain Management Center with a chief complaint of left groin and lower extremity pain. His pain sequela was the result of treatment he received for adenocarcinoma of the prostate. Specifically, he underwent a robotic assisted radical prostatectomy utilizing a left partial cavernous nerve sparing technique. Fortunately, the patient had no evidence of persistent or recurrent cancer at the time of our consultation. Unfortunately, the pain, described strictly in neuropathic terms, severely limited his ability to enjoy an active lifestyle. The patient failed extensive attempts at medication management with anti-convulsants, tricyclic antidepressants, and opioids. The pain was also refractory to a local anesthetic injection to the prostatic bed performed by the urologist under transrectal ultrasound guidance. After 9 months of suboptimal oral medication management, alternative interventional techniques were proposed including a trial of spinal cord stimulation and/or intrathecal drug delivery. The patient's health insurance company denied a trial of spinal cord stimulation and, ultimately, the patient underwent an intrathecal trial with ziconotide and bupivacaine. The single shot intrathecal trial was performed utilizing a 25-gauge pencil point needle at the L3-4 interspace. The dose delivered was 3 mcg of ziconotide and 2 mg of bupivacaine. The patient reported his pain relief as a "100% success." Eventually, he was taken to the operating room and underwent an uncomplicated IDDS implantation with catheter introduction through the L2-L3 inter-laminar space. The catheter tip was advanced to the inferior aspect of the T10 vertebral body. The IDDS was set to deliver 1 mcg of ziconotide and 2 mg of bupivacaine daily. Post-operatively he again reported exceptional pain relief and was discharged home.

On postoperative day (POD) 7, the patient reported a mild postural headache along with mild wound tenderness and erythema. He was afebrile and no meningeal signs were appreciated. The patient was provided a prescription for oral antibiotics and instructed to increase his oral intake of fluids. The tenderness and erythema subsequently resolved as did the headache. However, on POD 16 the patient reported a severe postural headache with the additional complaint of tinnitus. His tinnitus was thought to be secondary to ziconotide so his dose was decreased to 0.7 mcg per day. Given the severity of his headache and the fact that it fulfilled diagnostic criteria for a MPH, an EBP was performed at L5-S1 interspace, below the level of the lumbar incision using radiographic guidance. An 18-gauge Tuohy needle was utilized and the epidural space was identified using a standard loss of resistance technique. Appropriate needle tip position in the epidural space was confirmed by a lack of CSF return from the Tuohy needle and by radiographic evidence of epidural contrast spread (Fig. 1A). Twenty mL of autologous blood was then collected in a sterile fashion and injected slowly through the needle. After the procedure, the patient reported good headache relief. On POD 23 he reported near complete resolution of his headache. From a functional standpoint, he had returned to work and was pleased with the procedural outcome.

On POD 28 the MPH and tinnitus recurred and the patient returned to clinic for a repeat EBP. An EBP was performed at L4-L5 interspace utilizing an identical technique except that after the epidural space was identified, a catheter was advanced just distal to the epidural needle up to the L2-L3 interspace level within the epidural space. Aspiration from the catheter was negative and contrast was again injected, radiographically demonstrating epidural spread (Fig. 1B). Twenty mL of autologous blood was then slowly injected. To-

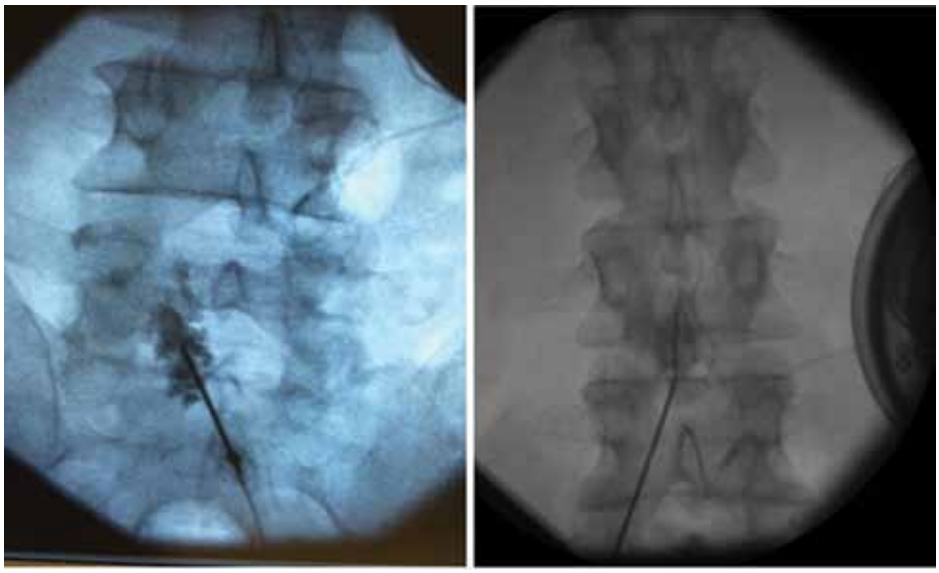

Fig. 1. *The epidural space was appropriately identified during both epidural blood patches (EBP). A: Epidural contrast spread during the initial EBP performed with an 18 G Touhy needle at the L5-S1 interspace. B: Epidural contrast spread during second EBP performed with an 18 gauge Touhy needle and catheter at the L4-5 interspace.*

ward the end of this procedure, the patient felt mild pressure behind his eyes. The next day the patient was sent for a neurology consultation for his persistent tinnitus. By the time he was seen, he experienced slight return of MPH symptoms. A magnetic resonance imaging (MRI) scan of his brain was performed and was unremarkable.

On POD 34, the patient presented to the MD Anderson emergency department with increasing headache, low back pain, bilateral lower extremity radicular pain, and subjective complaints of urinary retention. A STAT MRI of his lumbosacral spine was obtained which revealed a blood collection within the thecal sac at the L4-L5 level (Fig. 2A-B). A neurosurgical consultation was obtained, and given the patient's subjective assessment that his symptoms were worsening, the decision was made to offer surgical exploration. On POD 35 the patient was taken to the operating room for an L4 and L5 laminectomy, evacuation of a subarachnoid hematoma (Fig. 2C), and explantation of the IDDS. The dura was closed with silk sutures along with application of Duraseal (Fig. 2D; Covidien, Mansfield, MA). No signs of superficial or deep surgical site infections were identified. The patient was discharged home without MPH symptoms. His original lower extremity and groin neuropathic pain complaints subsequently returned and he was again managed pharmacologically with anti-convulsants, tricyclic antidepressants, and opioid therapy.

Discussion

MPH is a relatively common complication following puncture of the dura mater. The incidence of MPH increases with both increasing needle diameter and with the utilization of cutting tip needles (5). The headache usually begins within 24 – 72 hours after dural puncture and is classically described in the occipital and frontal regions. It can be associated with nausea, vomiting, dizziness, photophobia, phonophobia, tinnitus, diplopia, neck stiffness, and scapular pain. Left untreated, most MPH will resolve within 1 – 2 weeks, however some may persist for several months or longer (6).

The mechanism of MPH is classically described as a disruption of CSF homeostasis where CSF is produced by the choroid plexus and absorbed by the arachnoid villa. Following puncture of the dura mater a potential pathway is created allowing the extrusion of CSF through the dural defect resulting in a reduction of CSF in the intracranial space (1). Previous work has demonstrated that dural defects from needles greater than 25 G are capable of producing CSF extrusion greater than CSF production (7). The relationship between MPH and loss of CSF is more complicated than frequently

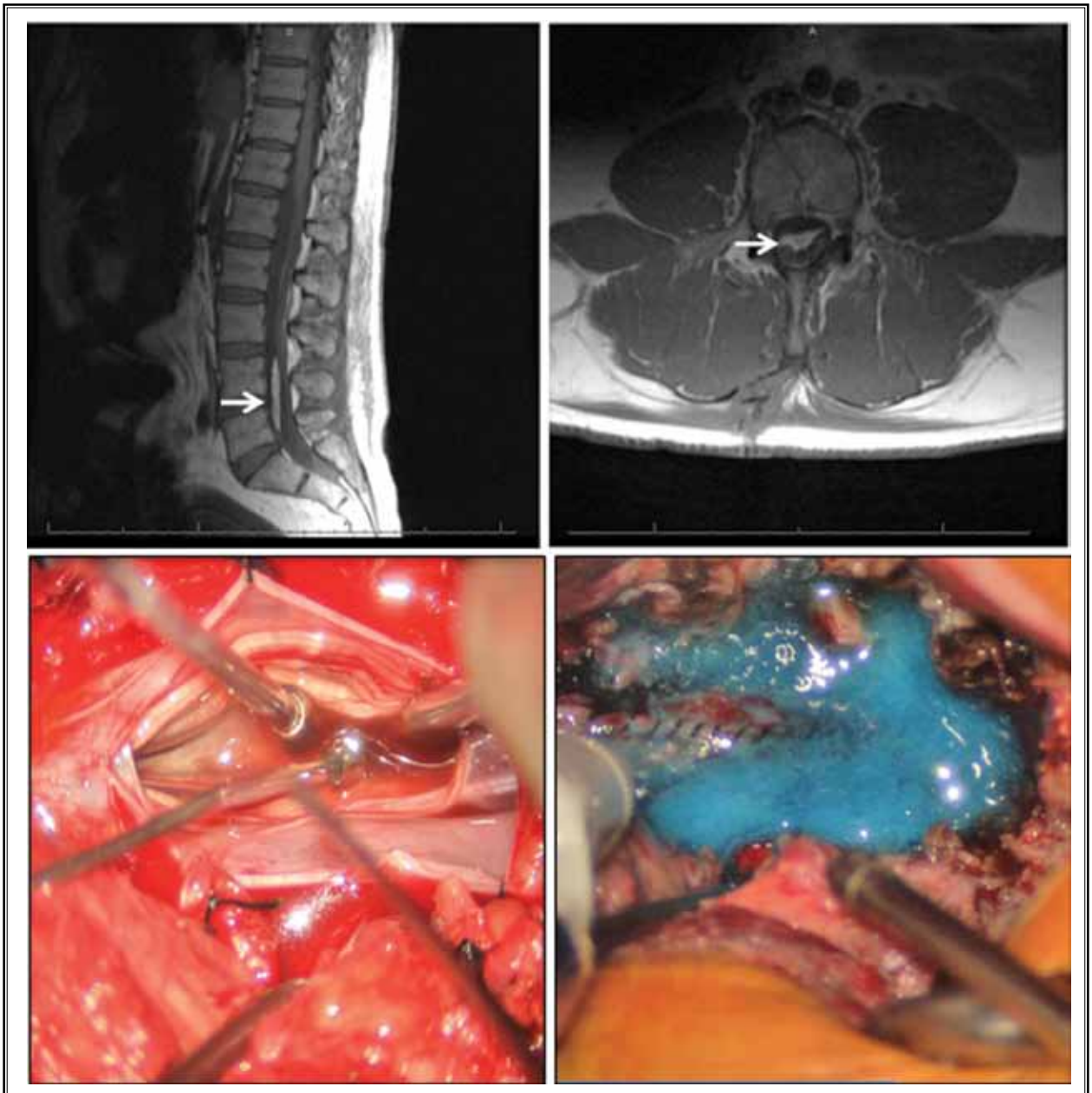

Fig. 2. *Localization and removal of the lumbar subarachnoid hematoma. Magnetic resonance imaging T1 sagittal (A) and axial (B) images showing the subarachnoid hematoma (white arrows) at the L4 and L5 vertebral levels. Surgical evacuation of hematoma (C) and dural repair with silk suture and Duraseal (D).*

thought and likely depends on other patient characteristics. For instance, some patients develop a MPH with relatively little CSF loss while others do not develop a MPH despite significant CSF loss.

The mechanism by which this perturbation in CSF leads to MPH is not entirely clear. The classically described mechanism for the development of the MPH is caudal movement of brain structures after a loss of CSF leading to traction on pain sensitive intracranial structures (dura mater, venous sinuses, bridging veins, cranial nerves, and cervical nerves). However, MRI evidence does not consistently demonstrate this caudal

movement of the brain is necessary for MPH (1). An additional etiology is that loss of CSF causes a reflexive intracranial vasodilation in order to maintain the same intracranial volume as dictated by the Monroe-Kellie doctrine (1,8). This vasodilation then drives nocicieptive intracranial inputs in ways similar to migraine headache and possibly sensitizes the trigeminocervical complex leading to the full MPH symptomatology (9,10).

The treatment of MPH generally starts with conservative management that includes bed rest, hydration, and caffeine therapy. Unfortunately, none of these are exceptionally effective in the treatment of MPH (6). Other pharmacological therapies previously studied include triptans, DDAVP, cosyntropin, hydrocortisone, and gabapentin (8,11). Several recent articles have demonstrated the efficacy of occipital nerve blocks in the treatment MPH, presumably by blocking the trigeminocervical input (9,10,12). Although other treatments may show promise, the EBP still remains the gold standard for the treatment of MPH with good evidence for its efficacy (13).

This patient's clinical presentation was slightly atypical in that his postural MPH symptoms started one week following meningeal puncture. Furthermore, after originally responding to conservative treatments he eventually developed tinnitus. Cranial nerve symptomatology, including tinnitus, is occasionally reported with MPH. Ravi (14) reported a case of isolated tinnitus following intrathecal catheter placement in a parturient which was treated successfully with an EBP. However, the tinnitus in our case was confounded by his ziconotide infusion with its established central nervous system side effects, including auditory hallucinations. Expert opinion recommends low dosing with gradual titration in order to decrease ziconotide toxicity (3). Although our patient's ziconotide infusion was decreased, his auditory symptoms continued. The exact etiology of the tinnitus could have been secondary to the ziconotide despite the reduction in dose as the therapeutic window is variable between patients. However, given the overall clinical picture, we felt that the patient's symptoms could also be secondary to meningeal puncture pathology.

Literature on performing an EBP in the context of an IDDS is quite scarce (15,16). In addition to the common risks associated with an EBP, this circumstance must also take into account additional complications such as infection of an implantable device, damage to the IDDS catheter, rostral spread of the IDDS drug, and a known path for tracking of blood and contaminants into the CSF (17). Subarachnoid hematomas can occur despite appropriate precautions. In this case, the development of a lumbar subarachnoid hemorrhage resulted in the need to remove the IDDS.

In order to enhance the safety of the EBPs performed in the context of an IDDS, we confirmed epidural localization utilizing radiographic guidance along with contrast confirmation of injectate location. Despite these efforts in conjunction with the observation of negative CSF flow from the Tuohy needle (both EBPs) and negative aspiration of CSF via a catheter (second EBP), the patient developed a lumbar subarachnoid hematoma. In retrospect, it may have been justified to consider alternative imaging of the spine in an effort to evaluate the precise location of the dural defect. Indium radionucleotide scans, computed tomography (CT) with intrathecal contrast, or MRI with intrathecal gadolinium have all been utilized to detect CSF leaks (8,18). Understanding the location of the dural defect may allow a more targeted EBP or even deposition of epidural fibrin glue (6).

Spinal subarachnoid hematoma is exceedingly rare, as the term was recently coined in 1984 and the distinction between subarachnoid hematoma and hemorrhage is often confused in the literature (5,13). The mechanisms underlying the formation of a space-occupying lesion, hematoma, is not well understood. Subarachnoid hemorrhages rarely form a hematoma as a result of CSF dynamics diluting any small amount of blood present (13). The literature proposes several factors predisposing to hematoma formation including vascular trauma in the context of coagulopathy associated with spinal anesthesia and epidural procedures (5,7,13). Introduction of blood in excess of CSF flow in the subarachnoid space can lead to hematoma formation (9). The etiology of the spinal subarachnoid hematoma in our case is not entirely clear. He did not have any known coagulopathy. Although we did not aspirate on the Tuohy needle during the first EBP in order to prevent further meningeal punctures, others have reported inadvertent intrathecal hematoma following this technique (19). In addition, inadvertent intrathecal delivery of autologous blood despite negative aspiration on an intrathecal catheter has also been reported (20). It remains unknown to the authors whether the hematoma developed as a result of introduction of autologous blood during the EBP or if the hematoma was secondary to vascular trauma from any one of the procedures along this patient's neuroaxis. Reasonable hypotheses in this case include unrecognized needle or

catheter migration through the dura mater during the EBP, new or old dural punctures which served as tracks for blood to flow into the intrathecal space, or disruption of the normal meningeal architecture such that conditions were favorable for the subarachnoid flow of blood along the implanted catheter.

Spinal subarachnoid hematomas in the absence of neurological deficits may often resolve nonoperatively with frequent neurological monitoring and symptomatic treatment with non-steroidal anti-inflammatory drugs (NSAIDS) and steroids (5,7,13). The decision to proceed with surgical evacuation of the subarachnoid hematoma in this case was based upon several factors. First, the patient's subjective complaints of urinary dysfunction were of concern. Second, it was felt that operative intervention was needed to help seal the dural leak that was refractory to multiple EBPs. Indeed, the dural leak was confirmed and sealed intraoperatively by the neurosurgeon. Furthermore, the MPH symptoms resolved shortly after the operation suggesting that the etiology of the patient's symptoms were a result of the dural leak. However, the subarachnoid hematoma itself could have also contributed to headache complaints (7). The final impetus for surgical evacuation and IDDS explantation was secondary to the patient's request for explant. He became distraught over the MPH symptoms and did not feel comfortable continuing with IDDS treatment. Ironically, after nearly a year removed from IDDS explant and continuation of the previous suboptimal pharmacologic regimen, the patient's insurance eventually approved spinal cord stimulation. The patient is currently doing well with an implanted neurostimulation system and minimal anti-convulsant, tricyclic antidepressants, or opioid medications.

Conclusion

Although the EBP is considered the gold standard treatment for MPH, the clinical decision to perform this procedure following implantation of an IDDS is complex. Our patient presented relatively late after IDDS implantation with a severe MPH. Despite appropriate clinical steps to prevent inadvertent intrathecal injection, the patient developed a subarachnoid hematoma necessitating neurosurgical laminectomy, hematoma evacuation, dural repair, and IDDS explantation. Given this potential clinical outcome, in addition to the risk of infecting an implanted IDDS, interventional physicians should consider exhausting less invasive techniques prior to proceeding with an EBP in a patient with an IDDS.

Author Affiliations

Dr. Hustak is a Fellow in the Department of Pain Medicine, University of Texas MD Anderson Cancer Center, Houston, TX. Dr. Engle is an Assistant Professor in the Department of Pain Medicine, University of Texas MD Anderson Cancer Center. Dr. Viswanathan is an Assistant Professor in the Department of Neurosurgery, University of Texas MD Anderson Cancer Center, Houston, TX. Dr. Koyyalagunta is a Professor in the Department of Pain Medicine, University of Texas MD Anderson Cancer Center, Houston, TX.

References

1. Grant R, Condon B, Hart I, Teasdale GM. Changes in intracranial CSF volume after lumbar puncture and their relationship to post-LP headache. *J Neurol Neurosurg Psychiatry* 1991; 54:440-442.
2. The International Classification of Headache Disorders: 2nd edition. *Cephalalgia* 2004; 24:9-160.
3. Williams JA, Day M, Heavner JE. Ziconotide: An update and review. *Expert Opin Pharmacother* 2008; 9:1575-1583.
4. DiGiovanni AJ, Dunbar BS. Epidural injections of autologous blood for post-lumbar-puncture headache. *Anesth Analg* 1970; 49:268-271.
5. Domenicucci M, Ramieri A, Paolini S, Russo N, Occhiogrosso G, Di Biasi C, Delfini R. Spinal subarachnoid hematomas: Our experience and literature review. *Acta Neurochir (Wien)* 2005; 147:741-750; discussion 750.
6. Freeman ED, Hoelzer BC, Eldrige JS, Moeschler SM. Fibrin glue to treat spinal fluid leaks associated with intrathecal drug systems. *Pain Pract* 2013; EPub ahead of print. Nov.20, 2013.
7. Kreppel D, Antoniadis G, Seeling W. Spinal hematoma: A literature survey with meta-analysis of 613 patients. *Neurosurg Rev* 2003; 26:1-49.
8. Schievink WI. Novel neuroimaging modalities in the evaluation of spontaneous cerebrospinal fluid leaks. *Curr Neurol Neurosci Rep* 2013; 13:358.
9. Brem SS, Hafler DA, Van Uitert RL, Ruff RL, Reichert WH. Spinal subarachnoid hematoma: A hazard of lumbar puncture resulting in reversible paraplegia. *N Engl J Med* 1981; 304:1020-1021.
10. Akin Takmaz S, Unal Kantekin C, Kaymak C, Basar H. Treatment of post-dural puncture headache with bilateral greater occipital nerve block. *Headache* 2010; 50:869-872.
11. Wagner Y, Storr F, Cope S. Gabapentin in the treatment of post-dural puncture headache: A case series. *Anaesth Intensive Care* 2012; 40:714-718.
12. Matute E, Bonilla S, Girones A, Planas A. Bilateral greater occipital nerve block for post-dural puncture headache. *Anaesthesia* 2008; 63:557-558.
13. Koyama S, Tomimatsu T, Kanagawa T, Sawada K, Tsutsui T, Kimura T, Chang

YS, Wasada K, Imai S, Murata Y. Spinal subarachnoid hematoma following spinal anesthesia in a patient with HELLP syndrome. *Int J Obstet Anesth* 2010; 19:87-91.

14. Ravi R. Isolated tinnitus following placement of an intrathecal catheter for accidental dural puncture. *Int J Obstet Anesth* 2006; 15:180.
15. Hardy PA. Extradural blood patch of a cerebrospinal fluid cutaneous fistula in the presence of an intrathecal drug delivery system. *Anesthesiology* 1994; 81:1299-1300.
16. Huch K, Kunz U, Kluger P, Puhl W. Epidural blood patch under fluoroscopic control: Non-surgical treatment of lumbar cerebrospinal fluid fistula following implantation of an intrathecal pump system. *Spinal Cord* 1999; 37:648-652.
17. Engle MP, Vinh BP, Harun N, Koyyalagunta D. Infectious complications related to intrathecal drug delivery system and spinal cord stimulator system implantations at a comprehensive cancer pain center. *Pain Physician* 2013; 16:251-257.
18. Vanopdenbosch LJ, Dedeken P, Casselman JW, Vlaminck SA. MRI with intrathecal gadolinium to detect a CSF leak: A prospective open-label cohort study. *J Neurol Neurosurg Psychiatry* 2011; 82:456-458.
19. Kalina P, Craigo P, Weingarten T. Intrathecal injection of epidural blood patch: A case report and review of the literature. *Emerg Radiol* 2004; 11:56-59.
20. Aldrete JA, Brown TL. Intrathecal hematoma and arachnoiditis after prophylactic blood patch through a catheter. *Anesth Analg* 1997; 84:233-234.