Case Reports/Case Series

Subarachnoid lumbar drains: a case series of fractured catheters and a near miss

[Drains lombaires sous-arachnoïdiens : série de cas de cathéters brisés et un « near miss »]

Hernando Olivar MD,* John S. Bramhall MD PhD,* Irene Rozet MD,*†‡ Monica S. Vavilala MD,*†‡
Michael J. Souter MB BCH FRCA,*‡ Lorri A. Lee MD,*‡ Arthur M. Lam MD FRCPC*‡

Purpose: Lumbar subarachnoid catheters for cerebrospinal fluid (CSF) drainage (lumbar drains) are indicated for several medical and surgical conditions. A number of complications can occur from the placement of this type of catheter, including catheter breakage from excessive traction or shearing over the Tuohy needle.

Clinical features: Five cases of lumbar subarachnoid catheter breakage/shearing and catheter fragment retention, as well as one near miss, were identified over a one-year period at a single institution. All ($n = 6$) patients were undergoing neurosurgical procedures. Four patients required surgical retrieval of the catheter fragments. No patient experienced long-term neurological sequelae.

Discussion: From these experiences, the following risks factors for catheter rupture are identified: 1) intentional or accidental retraction of the catheter through the needle during placement; 2) faulty use of the guidewire; or 3) use of excessive force during removal of the catheter. Methods to prevent such complications are suggested, including minimal use, or complete avoidance of a guidewire.

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Objectif : Les cathéters lombaires sous-arachnoïdiens pour le drainage (drains lombaires) du liquide céphalorachidien (LCR) sont indiqués pour de nombreuses conditions médicales et chirurgicales. Un nombre de complications peut survenir lors du positionnement de ce type de cathéter, y compris un bris de cathéter dû à une traction excessive ou à un cisaillement de l'aiguille Tuohy.

Éléments cliniques : Cinq cas de bris/cisaillement de cathéter lombaire sous-arachnoïdien et de rétention de fragment de cathéter, ainsi qu'un « near miss », ont été identifiés au cours d'une période d'une année dans une seule institution. Tous les patients ($n = 6$) subissaient des procédures neurochirurgicales. Quatre patients ont nécessité une récupération chirurgicale des fragments de cathéter. Aucun patient n'a souffert de séquelles neurologiques à long terme.

Discussion : Nous avons pu identifier les facteurs de risque suivants pour le bris de cathéter suite à ces expériences : 1) rétraction intentionnelle ou accidentelle du cathéter à travers l'aiguille pendant le positionnement; 2) mauvais usage du fil guide; ou 3) utilisation de force excessive pendant l'extraction du cathéter. Certaines méthodes afin de prévenir de telles complications sont suggérées, y compris une utilisation minimale, voire nulle, du fil guide.

LUMBAR subarachnoid catheters for cerebrospinal fluid drainage (lumbar drain) are indicated for several medical and surgical conditions. Such catheters can improve surgical exposure during surgical clipping of cerebral aneurysms or resection of skull base tumours.^{1,2} Intraoperative cerebrospinal fluid (CSF) drainage may also provide spinal cord protection and decrease the risk of paraplegia during thoracoabdominal aortic aneurysm repair.^{3–5} Other indications include management of CSF fistulas⁶ and short-term treatment of hydrocephalus. However, CSF catheters are not

From the Department of Anesthesiology,* Pediatrics,† and Neurological Surgery,‡ Harborview Medical Center, University of Washington, Seattle, Washington, USA.

Address correspondence to: Dr. Hernando Olivar, Acting Assistant Professor, Department of Anesthesiology Harborview Medical Center, University of Washington 325 9th Avenue Seattle, WA, 98104, USA. E-mail: olivah@u.washington.edu

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without risk, and a number of complications associated with placement of intrathecal catheters have been reported, including infection,^{7,8} intracranial hypotension, intradural hematomas,^{1,5,6} and breakage/shearing of the catheter and retention of the catheter fragments.⁷⁻¹¹ This latter complication is either uncommon or under-reported, and little is known about its clinical implications, optimal management, or clinical outcome. We undertook a detailed chart review of five cases of catheter breakage/shearing and retention of catheter fragments, as well as a near miss, that occurred over a one-year period at our institution. The purpose of this review was to evaluate the risk factors of catheter fracture, and suggest protocols to prevent this complication.

Clinical features

With approval of the University of Washington's Institutional Review Board we undertook a retrospective chart review of all patients who experienced breakage/shearing of subarachnoid lumbar catheters or near miss of this complication during the year 2006. Individual patient consent for the chart review was not mandated. During 2006, approximately 150 lumbar drains were placed at our institution. Five (3.3%) cases of broken/sheared lumbar subarachnoid catheters and one near miss were identified. All patients ($n = 6$) had neurosurgical procedures. After induction of general anesthesia all catheters were placed in the left lateral decubitus position, using a mid-line approach. The lumbar drains were placed either by an anesthesia resident or the attending anesthesiologist following universal sterile technique using lumbar drain sets (INS-5010 Hermetic™ Lumbar Catheter Closed Tip, Integra NeuroSciences™, Hampshire, England, UK) which contains one 80 cm silicone barium impregnated closed-end lumbar catheter (0.7 mm internal diameter $\times$ 1.5 mm outer diameter), one 14-G $\times$ 8.8 cm Tuohy needle, one Teflon®-coated guidewire, and relevant dressings and adapters.

Four of the cases were identified at the time of placement of the catheter and the remaining two (including the near miss) were identified at the time of removal of the catheter.

Cases

Case #1

A 49-yr-old male was scheduled for frontal lobectomy and resection of epileptic foci. The indication for the lumbar drain was perioperative management of hydrocephalus. The needle was inserted into the L3-L4 intervertebral space without difficulty, obtaining free flow of CSF. The catheter could not be advanced

FIGURE 1 (Case #1) - Guidewire retrieved with traction - The guidewire is complete but unraveled. A) Tip of the guidewire; B) Unraveled portion of guidewire; C) Normal portion of guidewire.

beyond the tip of the needle into the subarachnoid space. The needle was repositioned with rotation followed by gentle manipulation involving advancement and withdrawal. Despite free flow of CSF during these maneuvers, it was not possible to advance the catheter into the subarachnoid space. The teflon coated stainless steel guide wire was inserted into the catheter and the catheter-guidewire complex was then advanced into the subarachnoid space without difficulty. The needle was removed, but retrieval of the guidewire was difficult due to resistance. After applying traction, the guidewire was retrieved in its entirety but in an unraveled condition (Figure 1). The catheter was not functional, and the anesthesiologist chose to discontinue it. There was resistance in removing the catheter and a surgical clamp was used. Eventually the catheter broke at the level of skin. A decision was made to remove the fragment surgically before the planned surgical procedure. The retained catheter fragment was removed without difficulty, from underneath the lumbodorsal fascia, where the catheter had folded upon itself. Another catheter was placed by the surgeon under direct vision in the L4-L5 intervertebral space, which was removed 24 hr later. The planned surgery was performed uneventfully. Postoperative follow-up revealed no neurological complications related to the catheter.

Case #2

A 51-yr-old female was scheduled for right craniotomy for ophthalmic artery aneurysm clipping. The indication for the lumbar drain was to improve surgi-

FIGURE 2 (Case 2) - The fragment of the lumbar drain catheter is seen in the right interlaminar space at the L3–L4 level.

cal exposure. The Tuohy needle was inserted into the L3–L4 intervertebral space without difficulty. Despite free flow of CSF, there was difficulty advancing the catheter. The needle was retrieved as well as the catheter. It was noted that the catheter was sheared off and a fragment was missing. A second catheter was placed uneventfully at L4–L5 space. Surgery proceeded, and the second catheter was removed at the end of surgery. A computed tomography (CT) of the lumbar spine revealed the fragment of the first catheter at L4 level, with its tip in the epidural space (Figure 2). A decision was made to leave the fragment *in situ*, and to follow the patient in a conservative manner. Two months later, the patient complained of lumbar and radicular type pain. An L3–L4 exploration was performed, and the 2.4 cm catheter fragment was removed without difficulty. The patient was discharged with improvement of her radicular pain.

Case #3

A 39-yr-old female was scheduled for cranioplasty for a skull defect after resection of a meningioma and removal of bone flap due to brain swelling. The indication for the lumbar drain was postoperative management of intracranial volume. At the end of the surgical procedure, and after two attempts, the 14-G

FIGURE 3 (Case #4) - Functional lumbar drain (A) and retained fragment into the spinal canal (B).

Tuohy needle was inserted into the L3–L4 intervertebral space, obtaining free flow of CSF, but the catheter could not be advanced beyond the tip of the needle into the subarachnoid space. A Teflon-coated stainless steel wire was then inserted into the catheter, and the catheter-guidewire complex was advanced into the subarachnoid space without difficulty. An attempt to retrieve the guidewire with the needle still in place was unsuccessful. The needle was removed, and further attempts to remove the guidewire were ineffective until it broke, leaving a fragment behind. At this point the catheter was not functional and a decision was made to have it discontinued. Resistance was encountered during removal of the catheter, and finally it broke, leaving a retained fragment. The patient underwent a CT scan of the lumbar spine which revealed the catheter and guidewire fragments in the spinal canal from L2–L1. Surgical removal of both fragments was undertaken 24 hr later due to the patient experiencing new-onset lumbar and radicular type pain. Another catheter was placed at L4–L5 level without difficulty and removed 48 hr later. The patient was discharged home, without further complications related to the lumbar drain, and complaining only of mild back pain.

Case #4

A 45 yr-old male was scheduled for deep exploration of a posterior cervical wound infection following a decompressive operation for an Arnold-Chiari I malformation. The indication for a lumbar drain was to improve surgical exposure and to facilitate perioperative management of intracranial volume. The Tuohy needle was inserted into the L3–L4 intervertebral space without difficulty. Free flow of CSF was obtained from the catheter and surgery was uneventful. On emergence from anesthesia, the patient was agitated and moving vigorously. Examination of the lumbar area revealed that the catheter had broken at the skin level. Another subarachnoid catheter was placed in the L3–L5 interspace, which was removed uneventfully three days later. Subsequent CT scans of the spine revealed that the retained segment of the original catheter was moving freely in the subarachnoid space at S1 level (Figure 3). A laminotomy at the S1 level was performed, and the catheter fragment was removed without difficulty. The patient was discharged from the hospital in good condition and without neurological deficit.

Case #5

A 43-yr-old male (198 kg) was scheduled for right internal carotid aneurysm clipping. The indication of the lumbar drain was to improve surgical exposure. During the first attempt the Tuohy needle was inserted to the hub at L3–L4 intervertebral space without obtaining any CSF. A longer (15 cm) Tuohy needle was then used at the same level obtaining free flow of CSF. However, there was difficulty threading the catheter more than 3 cm into the subarachnoid space. The needle was withdrawn but the catheter was not functional. It was then removed, revealing that it had been sheared off and a fragment was retained. Another catheter was placed at L4–L5 intervertebral space without complications. The planned surgical procedure was performed. A postoperative CT scan revealed that the fragment was at the L3–L4 level in the epidural space. A decision was made to leave the fragment *in situ* and follow the patient with conservative management. To date, the patient has not complained of any symptoms related to the catheter fragment.

Case #6 (near miss)

A 65-yr-old female was scheduled for right posterior communicating artery aneurysm clipping. The indication for a lumbar drain was to improve surgical exposure. The Tuohy needle was placed in the L3–L4 intervertebral space without difficulty, obtaining free

FIGURE 4 (Near miss) - Catheter sheared longitudinally multiple times.

flow of CSF. There was some resistance encountered during advancement of the catheter into the subarachnoid space, and there was manipulation with some unintentional pulling on the catheter through the needle. A Teflon-coated stainless steel wire was then inserted into the catheter and the catheter-guidewire complex was advanced into the subarachnoid space without difficulty. The needle and guidewire were removed uneventfully. Cerebrospinal flow through the catheter was sluggish, but the planned surgery was performed without complications. At the end of surgery, the catheter was removed by the attending anesthesiologist and was observed to be split longitudinally at multiple sites but without missing fragments (Figure 4). The patient was discharged in good condition.

Discussion

There are several indications for intraoperative placement of subarachnoid catheters including improvement of surgical exposure in neurosurgical procedures, protection of the spinal cord during repair of aneurysms of the thoracic aorta, and treatment of CSF fistulas.^{1–6} Although there are many potential mishaps during catheter placement in the subarachnoid space, the safety of continuous lumbar CSF drainage and associated complication rates have not been well documented. In one review of 63 patients who had lumbar drains placed, Acikbas⁶ proposed that complications of continuous lumbar drainage can be divided into three groups: 1) problems with drainage rate, 2) mechanical complications of the catheter and, 3) infection. In his study the overall complication rate was 44% ($n = 28$),

and mechanical complications of the catheter (blockage of the catheter, nerve root pain or weakness in lower extremities) were the most frequent (19%, $n = 12$). In that review, there were no catheter fractures.

There are several case reports of retained fragments of intrathecal catheters.⁹⁻¹¹ In 1997, Simmerman and Fahy⁹ reported two retained fragments of lumbar subarachnoid drains placed for CSF drainage, one of which was removed surgically and the other one was left *in situ* with no sequelae. In a retrospective analysis of the thoracic aortic surgical database at the University of Pennsylvania, Cheung *et al.*⁴ assessed the safety of lumbar subarachnoid drains during aortic operations. In 432 patients undergoing thoracic or thoracoabdominal aorta operations, 162 received lumbar subarachnoid drains. Six (3.7%) had complications related to the drains, with three (1.8%) of them involving breakage of the catheter. This incidence is about half that observed in our current series (3.3%). It is noteworthy that the lumbar drain kit used at their institution (Moni-Torr ICP, Integra Neurosciences, Plainsboro, NJ, USA) differs from ours (Hermetic Lumbar Catheter Closed Tip, Integra NeuroSciences™, Hampshire, England, UK), and to what extent this might affect the incidence of catheter fracture is not known. There are currently several lumbar CSF drainage sets available in North America. In addition to the Integra kit, the Medtronic lumbar drainage set (Medtronic, Minneapolis, MN, USA), and a lumbar external drainage kit by Codman (Codman, Raynham, MA, USA) are commercially available. All kits share common features and components including a 14-G Tuohy needle, a steel guidewire and a siliconized catheter. Additionally, the Tuohy needle used in both the Integra and Medtronic kits are supplied by the same manufacturer. The siliconized catheters are used to reduce potential damage to nerve roots and/or spinal cord. Alternatively, a lumbar epidural kit can be used, placing a smaller but stiffer catheter into the subarachnoid space. Although this may theoretically reduce the risk of catheter fracture, it may increase the risk of nerve root/spinal cord damage. Moreover, the CSF drainage rate in an adult is generally not adequate for intracranial neurosurgical procedures (personal experience of the senior author A.L.).

Given that the incidence of catheter fracture is low, the risk factors for this complication have not been analyzed. Based on our experience we propose that the catheter can be fractured by one of two mechanisms; it is either broken (by excessive force on stretching) or sheared (by the Tuohy needle) or a combination of the two. The scenarios under which this fracture can occur include: 1) intentional or accidental retraction of the catheter through the needle during placement,

with the catheter being sheared by the sharp edge of the Tuohy needle; 2) faulty use of the guidewire with misplacement of the catheter and retrieval through the needle; 3) use of excessive force during removal of the catheter, thus stretching the catheter and breaking it.

In our opinion, the needle may be too sharp for the soft catheter, allowing the catheter to shear off with minimal retraction or manipulations of the catheter. When difficulty with advancement of the catheter is encountered, there is a tendency to partially withdraw and then re-advance the catheter. We have experimented this scenario *in vivo* and found that the catheter can be sheared off without the operator sensing any resistance under these circumstances. The near miss and case #5 support this contention. Another possible risk factor is the use of the steel guidewire, which when used with the catheter, strengthens and stiffens it, allowing easier passage through the needle, but diminishing the “feel” for the catheter, as in cases #1, #3 and the near miss. This increases the risk of misplacement of the catheter with possible entanglement and difficulty with removal of the catheter, thus increasing the risk of breakage. Additionally, if the guidewire reinforced catheter is withdrawn through the needle, the risk of shearing the catheter is greatly increased as occurred in case #3.

The method of catheter removal is another potential risk factor for catheter fracture. While placement of the catheter is performed with the patient’s back arched and flexed, removal is generally performed without placing the patient in similar position. If there is resistance during removal and the catheter is stretched, breakage can occur. This may explain the breakage in case #4 in which stretching of the catheter could occur during a patient’s period of agitation.

The common predisposing risk factor in our series is the difficulty with threading or advancing the catheter after successful identification of the subarachnoid space. This leads to multiple attempts to manipulate the catheter to facilitate its passage, therefore increasing the risk of shearing. Similarly, some operators may choose to use the guidewire under these circumstances, again increasing the risk of shearing the catheter. Although our series is small, based on our experience, we have implemented a strict protocol regarding placement of these lumbar drainage catheters. First, only anesthesiologists experienced in this technique would place or supervise the placement of the catheter. Secondly, whenever difficulty during advancement of the catheter is encountered, the trainee would immediately stop and the supervising anesthesiologist takes over. We also have initiated discussion with the manufacturer regarding modification of the needle.

Regarding postoperative management, when a catheter breakage or shearing is identified, we believe that a decision to remove the fragment surgically should be made on an individual case basis. A CT scan of the spine should be performed to determine the position and track of the fragment to estimate the subsequent risk of CSF leak or fistula formation. In our small series the catheter fragments were located in the subarachnoid space ($n = 2$), in the epidural space ($n = 2$), or in the lumbar soft tissues ($n = 1$). Although the silicone elastomer material from which the catheter is fabricated is inert, the risk of direct nerve root irritation from a free foreign body into the spinal canal remains.^{7,12} If the catheter fragment is located in the epidural space, conservative management may be advised, but the patient should be followed for symptoms of nerve root irritation and signs of infection.

In conclusion, placing a lumbar drain can be complicated by breakage or shearing of the catheter, so we cannot overemphasize the importance of following a rigorous technique of insertion and removal of these catheters. This procedure should not be performed by inexperienced personnel without supervision, and any technical difficulty during placement or retrieval of the catheter should alert the operator of potential complications.

Although it is not possible to draw definitive conclusions based on our small case series, we have attempted to identify several potential risk factors leading to shearing or breakage of lumbar drain catheters. Based on our observations we suggest that the catheter should never be withdrawn from the needle once it has exited from the tip of the needle. Accidental retraction may occur when difficulty threading the catheter is encountered, thus manipulation attempts should be minimized. Both the needle and catheter should be removed en bloc, and a new puncture started instead of persisting in placement of the catheter. Use of the guidewire should be minimized, or avoided. Removal of the catheter should be accomplished with minimal force, and when resistance is encountered, the patient should be placed in a flexed position to facilitate its removal. Finally, if catheter breakage with a retained fragment occurs despite these precautions, a CT scan of the lumbar spine should be performed and subsequent management individualized according to the patient's clinical status and the location of the catheter fragment.

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