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Intraoperative fluoroscopy with contrast medium for correct lumbar catheter placement in lumboperitoneal shunts

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We use intraoperative fluoroscopy with contrast medium for correct placement of lumbar catheters in lumboperitoneal (LP) shunts. The patients are in the left or right lateral decubitus position on a radiolucent operating table and a portable C-arm fluoroscope is placed vertically. After confirming the puncture level fluoroscopically, a lumbar puncture is performed. The catheter is introduced into the spinal canal, and its placement is confirmed fluoroscopically by injecting contrast medium into the catheter. If loop formation and/or caudal migration of the catheter are discovered, the catheter is placed correctly under fluoroscopy with contrast medium. Because filling the catheter with contrast medium improved visualizing it in the spinal canal, using this method, we successfully corrected all four misplaced catheters observed in 20 consecutive LP shunt patients (20%). There were no complications, such as shunt malfunction and/or migration, infection, or radiculopathy in either leg at a median follow-up of 4.5 years (range, 3.8-5.2 years). The conventional, i.e., "blind" LP shunt procedure risks incorrect placement of the lumbar catheter; therefore, intraoperative fluoroscopy with contrast medium improves the accuracy of the shunt placement and minimizes the risk of complications.

Key words: contrast medium, fluoroscopy, hydrocephalus, lumboperitoneal shunt

Introduction

Since 1975, when the percutaneous silastic lumboperitoneal (LP) shunt was popularized by Spetzler et al,[1,2] its greatest application has been in the treatment of communicating hydrocephalus because of the advantages of extracranial surgical management and the simplicity of the shunt compared with cranial cerebrospinal fluid (CSF) shunts.[3-5]

The insertion of the catheter into the lumbar CSF space determines the success or failure of the LP shunt. Because this involves a manual maneuver with a "blind" tap, the catheter may be inadvertently placed incorrectly.[3,6-10] In the present study, we used intraoperative fluoroscopy with contrast medium to improve the safety and efficacy of this procedure.

Technique

The technique of using intraoperative fluoroscopy with contrast medium is used for patients undergoing LP shunt placement or replacement. A Codman-Hakim™ Programmable Valve System (Medos Sarl, Codman & Shurtleff, Raynham, MA, USA) is used for the procedure. The anesthesia equipment and the anesthetist are at the head of the patient. All patients are in the left or right lateral decubitus position on a radiolucent operating table; a portable C-arm fluoroscope (OEC® 9800 Plus, GE Healthcare Japan, Tokyo) is placed vertically so that lateral-view images can be obtained. After fluoroscopic confirmation of the puncture level, usually between L3 and L4, lumbar puncture is performed with a 14-gauge Tuohy needle through an approximately 1-cm midline skin incision in the patient's back. Initial catheter insertion is attempted without fluoroscopy, i.e., by the conventional "blind" procedure. The correct placement of the catheter in the spinal canal is routinely confirmed fluoroscopically after the injection of contrast medium (Iotrolan; 240 mgI/ml, Bayer Healthcare, Osaka) into the catheter using a 5-ml syringe through a connector in the shunt system. After confirming that the catheter is pointed in the cephalad direction, that its length (5-10 cm) is appropriate, and that there is no loop formation, the catheter is advanced to an incision in the flank. A pararectal laparotomy is

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performed after placing the patient in the supine position, and a valve with a peritoneal catheter is connected to the lumbar catheter. Finally, the peritoneal catheter is introduced into the peritoneal cavity, and each wound is closed in the standard fashion.

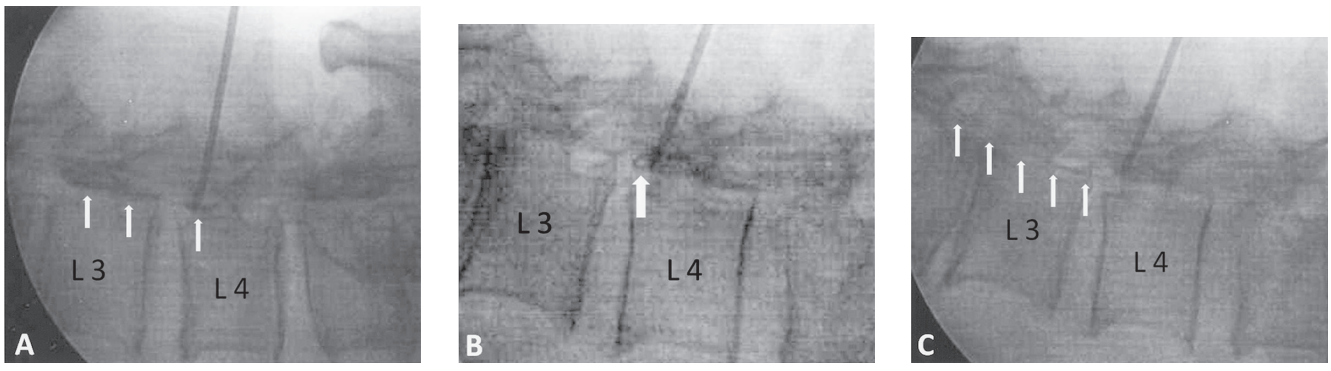
If the catheter is placed in an incorrect position, it is corrected under a fluoroscope with contrast medium. An example case is presented. This 75-year-old man with communicating hydrocephalus underwent an LP shunt placement. After fluoroscopic confirmation of the puncture level, between L3 and L4, a lumbar puncture was performed with a Tuohy needle. Brisk CSF flow was obtained after withdrawal of the puncture needle stylet. However, when the catheter was advanced, there was resistance at the tip of the needle, and the attempt at insertion was abandoned. Injection of contrast medium into the catheter showed the ventral epidural space. Therefore, we recognized that the puncture needle was inserted too deeply into the ventral dura (Figure 1A). Under fluoroscopy, we attempted a slight redirection of the puncture needle in the cephalad direction and succeeded in advancing the catheter without encountering resistance. However, the catheter formed a hairpin-shaped loop approximately 1 cm cephalad from the puncture site and was oriented caudally (Figure 1B). We, therefore, pulled it back repeatedly and torqued it under fluoroscopy until it was oriented in the cephalad direction (Figure 1C). After confirming the correct placement of the catheter in the spinal canal, its appropriate length and direction, and the absence of a loop formation, we performed a routine surgical technique.

This study included 20 consecutive patients (10 men and 10 women; mean age, 65.7 years; range, 38-84 years) who underwent an LP shunt placement between April 2006 and October 2007 at our hospital. Median follow-up was 4.5 years (range, 3.8-5.2 years). Indications for LP shunt placement were idiopathic normal pressure hydrocephalus (55%) and communicating hydrocephalus due to subarachnoid hemorrhage (45%). Loop formation and caudal migration of the catheter occurred in 4 of 20 patients (20%). All four of the migrated catheters were placed correctly under fluoroscopy with contrast medium. Although we were unable to see the total length of each catheter in the spinal canal, visibility was improved in all cases upon filling the catheters with contrast medium. Our final technical success rate for catheter placement was 100%. There were no complications, such as shunt malfunction or migration, infection, or radiculopathy in either leg.

Discussion

The advantages of an LP shunt over a ventriculoperitoneal shunt include the avoidance of brain puncture, the absence of the need to access hard-to-reach slit ventricles, short operating time, and decreased incidence of infection, shunt malfunction and/or migration, and mortality.[1-3,8,11-13]

The indication for this procedure in patients with vertebrospinal diseases, such as spondylosis, canal stenosis, or lumbago, must be considered especially carefully. Wang et al.[9] reported that LP shunt placement failed due to lumbar stenosis in 2 of 74 patients, who



Injection of contrast medium into the catheter shows the position of the catheter in the ventral epidural space. This photograph indicates that the puncture needle has been inserted too deeply into the ventral dura (arrows).

The catheter forms a hairpin-shaped loop approximately 1 cm cephalad from the puncture site and is directed caudally (arrow).

Final confirmation of correct catheter placement (arrows). The catheter in the spinal canal is oriented in the cephalad direction, and the approximate 6-cm length is appropriate.

Figure 1. Detection and correction of an incorrectly placed lumbar catheter using intraoperative portable fluoroscopy with contrast medium

then required a laminotomy in a second attempt. Because this condition is particularly common, in elderly persons with a history of lumbago or gait disturbance, the possible presence of lumbar lesions must be ruled out preoperatively.

According to Yoshikai et al.,[10] in 2 of their 104 patients, as in the present study, the lumbar catheter was inserted into the subdural space. Loop formation and caudal migration of the catheter occurred in 4 of 20 patients (20%) in the present study. As demonstrated in the present study, a hairpin loop in the catheter may be created when it hits the dorsal septum in the subarachnoid space and bends back.[14,15] Such loop formation may impede the postoperative CSF passage. Lumbar catheter migration into the radicular foramen, resulting in radicular pain immediately after surgery, can be corrected if detected during the procedure.[3,6,7,9,10,16]

The efficacy of fluoroscopic guidance in the placement of a lumbar catheter in patients treated with an LP shunt has been reported.[17] The method in the present study, using intraoperative portable fluoroscopy with contrast medium, offers several advantages. The direction of the inserted catheter, either cephalad or caudal, can be confirmed, and loop formation or absence thereof can be detected intraoperatively. Moreover, it is possible to confirm that the catheter has not migrated into the extra-CSF space or the intervertebral foramen containing the spinal nerve roots. Improved visibility of the catheter in the spine, by filling it with contrast medium, is the key to the success of this procedure.

Because intraoperative fluoroscopy exposes the patient and the staff to radiation, the fluoroscopy time should be as short as possible, general radiation protection measures should be taken, and staff access to the operating room should be controlled. Also, because of the risk of possible side effects from the use of a contrast medium, preoperative informed consent is necessary. This method should not be used for patients with poor renal function and/or for those who have a history of an allergic reaction to a contrast medium.

The present study showed that the conventional "blind" LP shunt procedure has a risk of inadvertent incorrect placement of the lumbar catheter. Therefore, we recommend that intraoperative fluoroscopy with contrast medium be used to improve the accuracy of shunt placement, to minimize the risk of complications, and thereby improving the safety and efficacy of this procedure.

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