

Case Report



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Conflict of Interest

The author has no financial conflicts of interest.

The Shunt Slippage: A Complication of Pumping Test

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ABSTRACT

Surgery for the placement of a ventriculoperitoneal shunt incurs numerous procedure-related complications. Distal dislodgment of the device from the cranial insertion site after pumping of the shunt chamber has rarely occurred and it has not been evaluated to date. Herein, we report an interesting case of a 20-year-old man who underwent shunt revision for ventricular catheter migration after a manual pumping test. We reviewed previously reported cases related to such rare conditions and described a simple method of valve fixation for preventing disconnection and migration of the proximal shunt system.

Keywords: Hydrocephalus; Shunt malfunction; Ventriculoperitoneal shunt

INTRODUCTION

Implanting a ventriculoperitoneal shunt is a common treatment option for patients with symptomatic hydrocephalus. Neurosurgeons are blessed with this technology; however the devices for the procedure have relatively high failure rate, often requiring revisions.^{8,25)} The mechanical dysfunctions of shunts commonly come from the catheter misplacement, fractured distal tubing, disconnection or migration of the apparatus.⁵⁾

Shunt pumping test is often conducted to predict the functional status of the ventricular and peritoneal sides.²³⁾ Although dislodgement of the catheter and valve following this bedside procedure has not been referenced in the literature, it possibly occurs due to mechanical compression of the shunt system. The authors describe a rare case who suffered from the shunt slippage after repeated manual pumping of the chamber, with introducing a novel technique for securing the valve to the cranium.

CASE REPORT

A 20-year-old male presented with headache and drowsiness secondary to the pineal germinoma (**FIGURE 1A**). The patient emergently underwent shunt procedure for obstructive hydrocephalus. A Strata system (Medtronic, Goleta, CA, USA) with programmable valve preset at the highest opening pressure was implanted along with the frontal entry point to

the lateral ventricle. The valve was fixed by suturing it to the pericranium. The device was correctly installed at the desired location, but the lateral and third ventricles were notably dilated in postoperative computed tomography (CT) (**FIGURE 1B**). This patient was still somnolent after the shunt surgery, so that the manual pumping test was conducted to verify the patency of the shunt system. The chamber of the shunt was freely pressed and filled up. His mentality gradually improved after multiple compressing the chamber at the bedside. However, the patient became unconscious 60 hours after shunting. The follow-up CT scan revealed migration of the proximal catheter into the cerebral parenchyma resulting in the aggravation of hydrocephalus (**FIGURE 1C & D**). The patient underwent revision surgery to replace the ventricular catheter. The previous wound was reopened. Intraoperative findings included the distally migrated proximal catheter and complete disconnection between the catheter and shunt valve. The valve was moved back from its primary location. A self-tapping 4 mm titanium screw was inserted directly through the collars of the valve reservoir to fix it to the cranium (**FIGURE 2A**). And then, the ventricular catheter was reinserted under the navigation guidance. The connection site between the valve and tube was fastened with silk sutures to the anchor screws near the burr hole (**FIGURE 2B**). He recovered consciousness immediately after repositioning the proximal component. He received adjuvant radiotherapy for his tumor and is being followed up regularly.

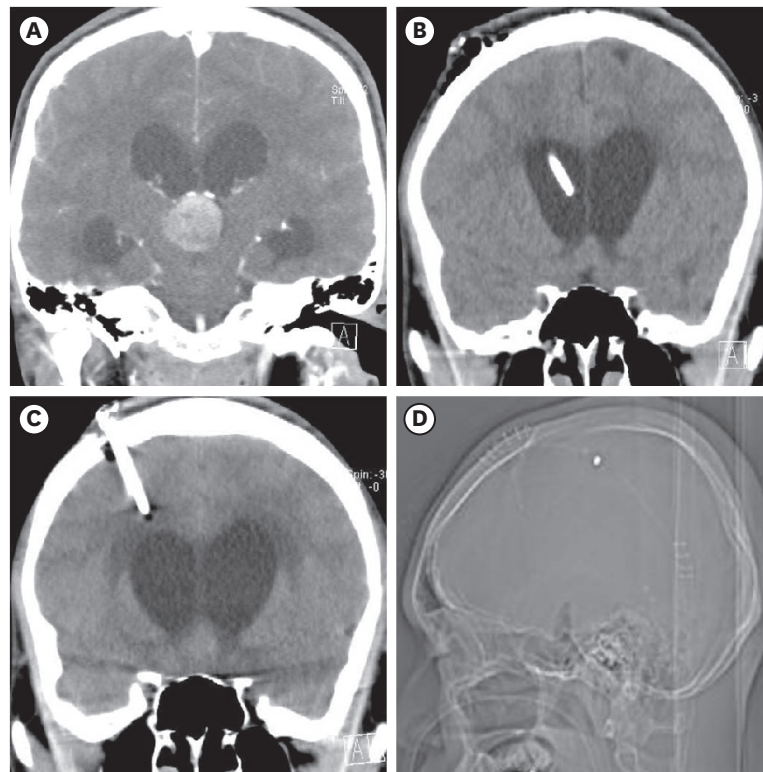


FIGURE 1. The shunt dislocation following the pumping test. (A) Preoperative CT shows an enhancing tumor in pineal region and occlusive hydrocephalus. (B) Immediate postoperative scan depicts the well positioned proximal catheter into the right frontal horn of the lateral ventricle. (C) Post-pumping test CT demonstrates the ventricular tube located in the parenchyma of the frontal lobe. (D) The scout image discovers that the valve and the catheter moved backwards from its original position. CT: computed tomography.

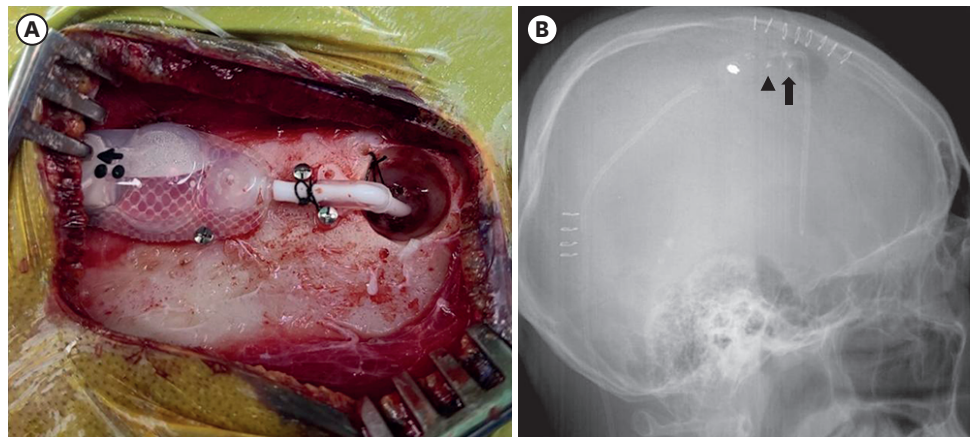


FIGURE 2. The anchoring of device. (A) Operative photograph of the fixation technique using titanium screws and silk suture to fasten the proximal component to the cranium. (B) Anchor screw (arrowhead) is placed directly at the collar of the reservoir. Two screws (arrow) are also applied to bind the point for joining of the valve to the ventricular tube.

DISCUSSION

The references on the malfunction with migrated and dislodged shunts are introduced in the form of case report.^{6,26} Previous studies listed the possible mechanisms predisposing to the proximal or distal migrations of the device in the shunted adults and children. The risk factors associated with the patients included younger age, thin cortical mantle, marked ventriculomegaly, obesity, short stature, malnutrition, habit of rubbing the valve area, the gradient between intracranial and intra-abdominal pressure, and number of previous shunt surgery.^{1,9,12,14} In terms of proximal system migration, the “windlass effect” in which flexion-extension or rotational movements of the head and neck also influence extrusion of the ventricular catheter from the ventricles.¹¹ Surgery-related factors also included larger craniostomy, wider durotomy, rapid decompression of hydrocephalus, tethering of the tubing, and tortuous subcutaneous tract that can facilitate the upward or downward movements of the tubing.^{15,21} In regards to this case, the subgaleal pocket for the device was excessively dissected, thus migration of the proximal element physically easily occurred after the shunt pumping tests.

As illustrated, the shunt pump test has a potential risk that leads to pulling out the ventricular catheter.^{18,20} Although the accidental slippage of the implant is a very rare event of distal migration, clinicians should be aware of the potential risk of repetitive flushing the reservoir, especially in acute stage after shunt surgery. In particular, if the pressure to the valve is repeatedly applied at an inclined angle, a downward force vector can be generated to induce dislocation of the proximal catheter or the valve. This could be one of the main possible mechanisms of slippage of the implant related to shunt pumping test in the current case. The preventive method is to apply mechanical pressure force perpendicular to the skull and the reservoir that can reduce the slippage risk associated with valve pumping test. A bedside ultrasonography could be applied as a useful tool to identify the right location of valve and appropriate angle of pressure for patients who underwent the shunt pumping test. In addition, the needle aspiration of chamber is a safe and reliable option that can be performed for patients in whom the proximal device is not firmly fixed to the bone.¹⁶

As observed in this patient, slippage of implanted catheter can cause acute shunt failure with sudden neurological deterioration. Clinical manifestations in cases with shunt migration are similar to those of obstruction, including signs and symptoms related to elevated intracranial pressure.¹⁹⁾ In rare instances, intraventricular dislocation of the device can develop convulsions, meningitis, or abscess.²²⁾ Although most shunt migrations are detected often subtle on physical examination, some cases might show palpable changes in the position of the valve or a fluid collection around the dislocated tubing.²⁴⁾ Practically, observations of the displaced segment are confirmed by comparing the repeated images with postoperative survey and CT scans.

Shunt migrations are managed only by surgical repositioning the errant ventricular catheter, the valve or the peritoneal tube. Downward migrations following detachment from the valve chamber are more commonly observed, and they have no difficulty in proper management.^{12,23,26)} In most cases, however, the revision surgery involves additional removing and replacing the distal system from the valve caudally. Retained distal tubes are frequently reached and withdrawn through the laparoscopic approach, without formal exploration of the abdomen.⁵⁾ In order to reduce the risk of shunt migration, previous studies have suggested some modifications in the device design and operative techniques. Choosing multicomponent device, smaller tubing passage, following a straight line between the valve and the abdomen inlet, laparoscopy-assisted falciform technique, and anchoring clip for the inferior end to the peritoneum are all key factors that against the migration of shunt system.^{2-4,7,17)} In the present case, the traditional suture technique provided no solid fixation for the valve and tube at the time of placing the first shunt. The screw fixation has now become a novel solution to the slippage of proximal components for shunted patients. This method does not prolong the operation time much, rather keeps the proximal system from the migration. The self-biting screw gives a firm anchorage for the ventricular tapping reservoir the underlying bone, thus shunt migration hardly occurs.¹³⁾ This technology can also reduce the mobility of the posterior fossa shunts in which dislodgement of the valve occurs more frequently and decrease the needs for shunt revision.¹⁰⁾ This modified fixation using screws does not add another stabilizing device or special surgical skills for its clinical utility.

CONCLUSION

The occurrence of shunt slippage is an exceedingly rare complication following pumping test of the valve. Fixing the proximal devices to the cranium using surgical screw can be an effective way to counteract the mechanical failure due to dislodgment of the proximal shunt system.

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