

## Distal ventriculoperitoneal shunt catheter tightly coiled around the valve in the absence of a subgaleal cerebrospinal fluid collection: illustrative case

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**BACKGROUND** Among the known complications of ventriculoperitoneal (VP) shunts, subcutaneous or subgaleal migration of distal catheters is rare. Prior case reports have proposed several risk factors, including inadequate fixation of the shunt device, presence of a large subgaleal space filled with cerebrospinal fluid (CSF), and repetitive flexion/extension movement of the head producing a “windlass effect.” Tight coiling of a distal catheter around the valve without a large subgaleal space has not been reported.

**OBSERVATIONS** The patient was born prematurely and underwent VP shunt placement for posthemorrhagic ventricular dilatation at 3 months of age with reassuring postoperative imaging. At approximately 3 years of age, shunt radiography and head computed tomography unexpectedly showed excess tubing coiled extracranially around the shunt valve. The patient did not exhibit any clinical symptoms of shunt malfunction and underwent an uneventful revision of the VP shunt system. No CSF-filled subgaleal space was observed intraoperatively.

**LESSONS** Distal catheter migration can occur without the clear presence of a subgaleal CSF collection and symptoms of acute hydrocephalus. Appropriate fixation of the shunt system using nonabsorbable stitches is recommended to prevent catheter migration caused by the windlass effect.

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**KEYWORDS** ventriculoperitoneal shunt; complication; catheter migration; cerebrospinal fluid collection; subcutaneous space; subgaleal space

Placement of a ventriculoperitoneal (VP) shunt is the most common treatment for hydrocephalus in children. Various types of complications have been reported in the literature, but reports of subcutaneous or subgaleal coiling of distal catheters are relatively rare, with only 12 such cases in the literature.<sup>1–11</sup> In all of the previous cases, the distal catheters had migrated into a relatively large cerebrospinal fluid (CSF)-filled subcutaneous or subgaleal space, which accompanied symptoms of acute hydrocephalus. Herein we report a rare asymptomatic case with a distal catheter that was tightly coiled around a shunt valve without any subgaleal CSF collection at the site of coiling. Potential mechanisms and preventive measures are discussed.

### Illustrative Case

The patient is a boy aged 2 years 11 months with a history of premature birth (gestational age 29 weeks 5 days). The neonatal

course was complicated by grade 4 intraventricular hemorrhage with posthemorrhagic ventricular dilatation. He initially underwent insertion of a reservoir with serial CSF aspirations. The device was later removed because of central nervous system infection, and an external ventricular drain was inserted. He ultimately underwent insertion of a VP shunt when he was approximately 3 months of age (corrected gestational age of 42 weeks). Postoperative shunt series radiographs showed no focal kinking, coiling, or defect in the shunt tubing (Fig. 1A and B). Postoperative magnetic resonance imaging (MRI) showed large ventricles and a catheter appropriately terminating in the lateral ventricle (Fig. 1C). He did not require any revisions.

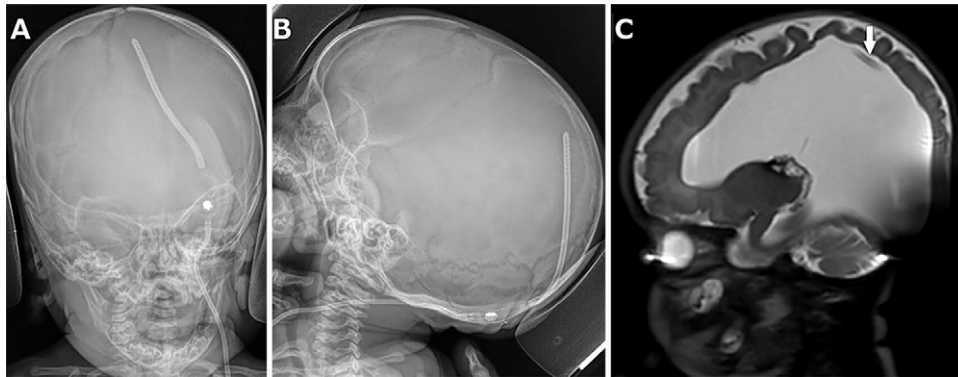
Recently, his family noted that he had a small area (approximately 1 cm in diameter) of swelling on his neck over the area of the shunt tubing. The swelling had disappeared at the time of review, and its etiology was unclear. He had no other clinical symptoms of shunt malfunction or infection. His blood work results were

**ABBREVIATIONS** CSF = cerebrospinal fluid; CT = computed tomography; MRI = magnetic resonance imaging; VP = ventriculoperitoneal.

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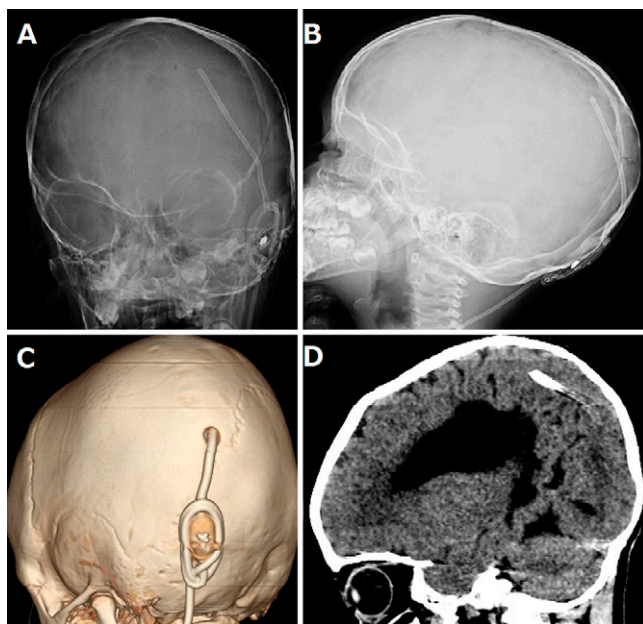
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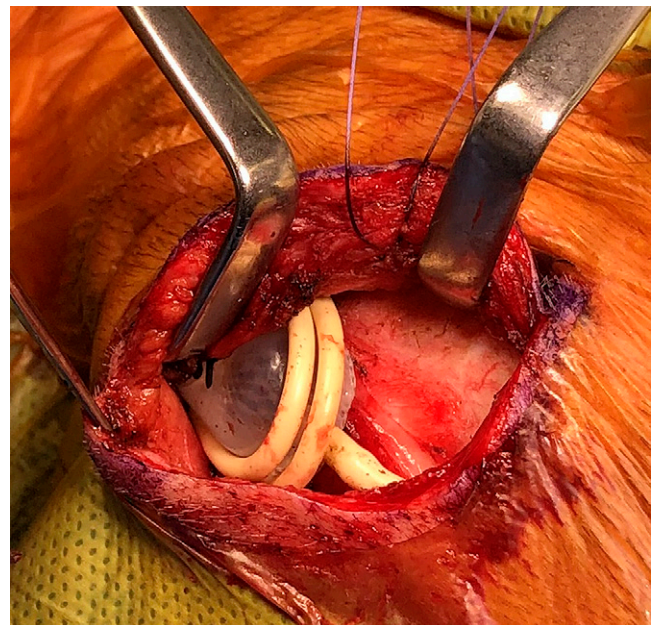
**FIG. 1.** Skull radiography and MRI performed 2 months after the initial VP shunt placement. **A and B:** Anteroposterior and lateral skull radiographs demonstrating no coiling of the distal catheter. **C:** Sagittal T2-weighted MRI sequence demonstrating marked ventriculomegaly with the tip of the ventricular catheter in the lateral ventricle (*white arrow*).

unremarkable. Shunt series radiography and head computed tomography (CT) showed no concern in the area of the swelling but demonstrated excess tubing coiled extracranially around the shunt valve (Fig. 2A–C). A CT scan showed no significant increase in the size of the ventricles and indicated that the tip of the ventricular catheter terminated outside the ventricle (Fig. 2D). After discussion with his parents regarding the options of continued observation or revising the shunt system, the decision was made to proceed with shunt revision while the patient remained well.



**FIG. 2.** Skull radiographs and head CT images obtained 2.5 years after the initial VP shunt placement. **A and B:** Anteroposterior and lateral skull radiographs demonstrating coiling of the catheter around the valve. **C:** A three-dimensional reconstructive CT image of the skull and VP shunt showing that the catheter is tightly coiled around the valve. **D:** A sagittal CT section demonstrating the tip of the ventricular catheter outside the lateral ventricle.

The shunt valve was located approximately 2 cm more inferiorly than anticipated from the previous skin incision. The previous skin incision was reopened and extended inferiorly. The ventricular catheter, the proximal end of the valve, and the coiled distal catheter were partially exposed using monopolar cautery (Fig. 3). The ventricular catheter was detached from the valve, and a small egress of CSF from the proximal catheter was observed. The peritoneal catheter was embedded in the connective tissue and carefully exposed using monopolar cautery. Two coils of the peritoneal catheter were wound tightly around the valve. The proximal end of the peritoneal catheter was truncated and connected to the new programmable valve (STRATA, Medtronic). The previous burr hole was



**FIG. 3.** Intraoperative photograph of the VP shunt catheter tightly coiled around the valve. No CSF collection was present around the valve and catheter.

expanded anteriorly, and a new ventricular catheter (Bactiseal, Codman) was inserted into the left lateral ventricle. Significantly better CSF outflow was observed from the new catheter. The new ventricular catheter was connected to the valve, which was repositioned superiorly and secured to the pericranium with two 4-0 Prolene sutures. The old ventricular catheter was removed, and the surgical incision was closed in layers. After surgery, the patient recovered rapidly and remained clinically well.

## Discussion

### Observations

We present an incidental finding of VP shunt catheter migration with a distal catheter that was tightly coiled around the valve. A small number of previous case reports have described subgaleal or subcutaneous coiling of distal catheters, in which coiling occurred in a larger pocket.<sup>1–11</sup> Our study is unique in that the coiling occurred tightly with a small diameter around the valve. We observed no CSF-filled space around the catheter, which, to our knowledge, has not been previously reported.

### Mechanism of Catheter Migration

Several risk factors for distal catheter migration have been proposed in the literature: vigorous repetitive movement of the neck or head causing a “windlass effect,”<sup>2,6–10,12</sup> negative pressure caused by reabsorption of subgaleal fluid or positive abdominal pressure,<sup>6,11,13</sup> insufficient fixation of the shunt system,<sup>2,8,10,13,14</sup> presence of a large subgaleal space filled with CSF due to VP shunt obstruction,<sup>2,5,6,8,10,11</sup> loose skin,<sup>2,8</sup> retained shunt tubing memory,<sup>2–4,9</sup> valveless shunt systems,<sup>5,7</sup> and a catheter with a course that is not straight.<sup>5,8,13</sup> Of note, Kim et al. proposed that the movability of the scalp and skin in young children compared to that in adults is a unique risk factor for upward sliding of catheters.<sup>8</sup> The presence of a large subgaleal space or CSF collection in pediatric patients who have undergone repeated shunt revisions may further facilitate mobilization and coiling of the distal catheters.

In the current case, we speculate that migration of the proximal catheter contributed to the observed findings. We suspect upward and downward movement of the distal catheter and valve along their axis, which was most likely induced by repetitive flexion and extension movement of the head, causing the windlass effect. During the surgical procedure, we found that the distal catheter was embedded in connective tissue with no CSF collection along the catheter. We therefore speculate that the coiling of the catheter had occurred more than a year before and scarred in this configuration and that the patient was asymptomatic for some time.

### Revision of the VP Shunt in an Asymptomatic Case

Whether the VP shunt in asymptomatic patients like our patient should be revised is controversial. The ventricular catheter in our patient was partially retracted from the ventricle. We therefore performed shunt revision to prevent complete VP shunt malfunction in the future. During the procedure, we noted a small amount of CSF flow from the proximal catheter. This flow may be explained by the presence of a small tract in the parenchyma between the ventricle and the tip of the ventricular catheter, which may have allowed the minimal drainage of CSF. After insertion of the new ventricular catheter, we observed significantly better outflow of CSF.

### Preventive Measures for Distal Catheter Migration

Pang and Wilberger recommended preventive measures when the catheter is to traverse large, loose subcutaneous spaces (i.e., the site of previous fluid collection).<sup>14</sup> Insufficient fixation of the shunt system<sup>5,8,13,14</sup> and the presence of a large subcutaneous or subgaleal space<sup>10,14</sup> are the two major risk factors that would cause distal catheter migration. Therefore, avoidance of overdissection of the subgaleal pocket and appropriate fixation of the shunt system at the valve or reservoir to the surrounding tissue, such as the pericranium or galea, using nonabsorbable stitches will minimize the risk of catheter migration caused by the windlass effect. Creation of a new catheter tract in cases of VP shunt revision and avoidance of traversing a catheter through a wide subgaleal space produced by previous surgeries or collection of CSF are also recommended.

### Lessons

The distal catheter of a VP shunt can migrate and coil tightly around the valve without the clear presence of a subgaleal CSF collection. Appropriate fixation of the shunt system using nonabsorbable stitches is recommended to prevent catheter migration. We also emphasize the utility of routine postoperative shunt series radiographs as baseline images.

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### **Disclosures**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

### **Author Contributions**

Conception and design: Ibrahim, Tamura, Breitbart. Acquisition of data: Ibrahim, Tamura, Branson. Analysis and interpretation of data: Ibrahim, Tamura, Vaughan, Branson. Drafting the article: Ibrahim, Tamura, Vaughan, Breitbart. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Ibrahim. Administrative/technical/material support: Ibrahim, Tamura. Study supervision: Ibrahim.

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