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Intracranial Migration of a Ventriculoperitoneal Shunt Reservoir in a Child-An Unusual Complication

Oswaldo A. Guevara Tirado, MS[1], Livja Mertiri, MD[2], Thierry A.G.M. Huisman, MD[2*]

[1]Ponce Health Sciences University School of Medicine, Ponce, Puerto Rico, USA
[2]Edward B. Singleton Department of Radiology, Texas Children's Hospital and Baylor College of Medicine, Houston, Texas, USA

[*]**Corresponding author:** Thierry A.G.M. Huisman, Edward B. Singleton Department of Radiology, Texas Children's Hospital and Baylor College of Medicine, 6701 Fannin Street, Suite 470, Houston, TX, 77030. Phone: +1 832-822-5363; Fax: +1 832-825-0160; Email: huisman@texaschildrens.org

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Abstract

Ventriculoperitoneal (VP) shunt placement is one of the most common interventions in neurosurgery. Out of all the known complications, complete intracranial migration of a VP shunt reservoir is one of the rarest with only a limited number of cases described in the current literature. Given its rarity, it is essential to document and understand the potential risk factors that contribute to this complication to prevent future re-occurrences. Here, we present a case of a 2-year-old female patient with complete intracranial migration of a VP shunt reservoir and review the potential risk factors that can lead to this rare complication. The features highlighted in this case report, along with the identification of risk factors, offers valuable insights for future physicians to consider when addressing similar complications.

Keywords

- *VP Shunt*
- *Intracranial migration*
- *VP Shunt complication*
- *VP Shunt reservoir migration*
- *Pediatric Neuroradiology*

Introduction

VP shunt placement is one of the most common neurosurgical interventions performed in the pediatric population. It is often used for the treatment and management of hydrocephalus and refractory idiopathic intracranial hypertension. Shunt failure is the most frequent complication occurring in approximately 40-70% of cases and causing a wide range of symptoms such as headaches, vomiting, progressive head enlargement, and other neurological manifestations [1-6]. Shunt failure can be due to a multitude of reasons including obstruction, damage, and displacement of the ventricular or distal catheter, as well as valve damage and malfunction [2-5,7-8]. Proximal migration of the shunt tube has been reported to occur in approximately 0.1-0.4% of total cases with complete intracranial migration, being exceedingly rare [1,4,6,8]. Here we present a unique case of a complete intracranial migration of the VP shunt reservoir in a 2-year-old child and discuss the potential risk factors that can lead to this unique complication.

Case Summary

The patient is a 2-year-old female with a history of in-utero bilateral periventricular hemorrhagic venous ischemia (PVHI) (formerly known as grade 4 germinal matrix or intraventricular hemorrhage) with secondary obstructive hydrocephalus managed with a ventriculoperitoneal (VP) shunt placement in the neonatal period. She presented to the emergency department of our quaternary children's hospital after two episodes of generalized tonic-clonic seizures lasting 15 minutes. No tongue biting, bowel/bladder incontinence, trauma, infection, or other symptoms were reported. Neuroimaging was performed for seizure evaluation.

Imaging Findings

A non-contrast CT scan of the head demonstrated the presence of two shunt catheters (figure 1): a stable right posterior approach shunt catheter terminating along the superior margin of the right lateral ventricle, and a second right frontal approach catheter extending through the right lateral, third, and into the left aspect of the fourth ventricle

with the shunt reservoir intracranially displaced just below the burr hole (figure 2). The left lateral ventricle was markedly enlarged, while the right lateral ventricle and third ventricle were moderately enlarged (figure 3). Extensive, chronic left more than right white matter volume loss as sequela of the previous PVHI was also visualized. The cerebellum appeared preserved, the brainstem was diffusely small, and there was left-sided Wallerian degeneration with a smaller left thalamus and brainstem. No calvarial fractures, intracranial hemorrhage, or extra-axial fluid collections were appreciated.

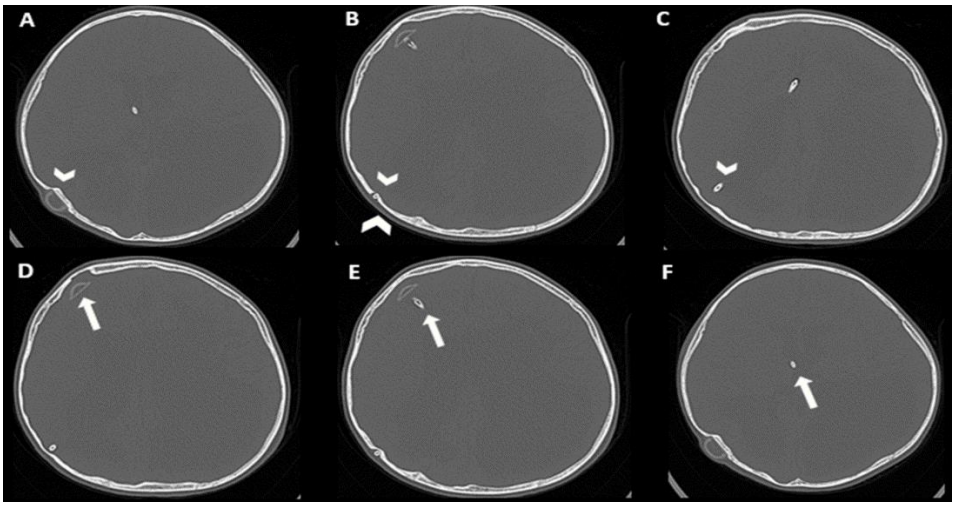

Figure 1: Axial CT scan of the head demonstrates a stable right posterior approach shunt catheter with normal extracranial position of the shunt reservoir (A,B,C), and a second right frontal approach catheter with the shunt reservoir intracranially displaced just below the burr hole (D,E,F).

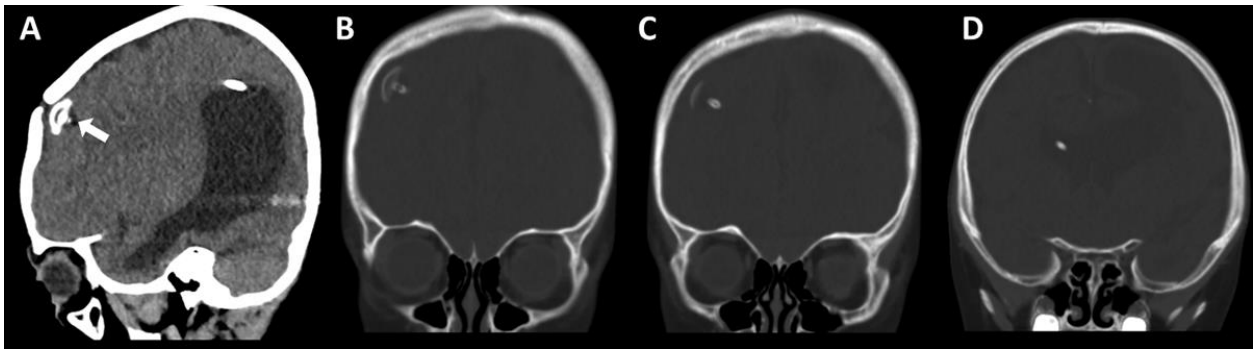

Figure 2: Sagittal (A) and coronal (B,C,D) CT scan of the head demonstrates intracranial displacement of the shunt reservoir just below the burr hole and shows the catheter extending through the right lateral ventricle.

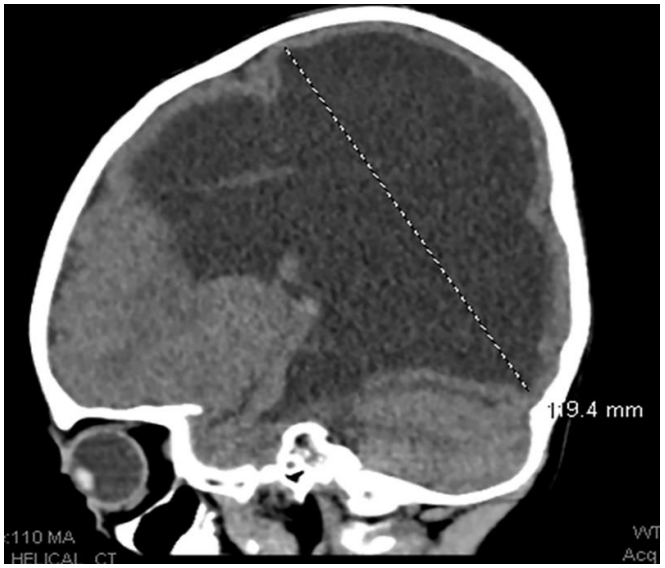

Figure 3: Sagittal CT scan of the head shows hydrocephalus causing marked enlargement of the left lateral ventricle.

Management & Follow Up

The patient underwent both neurosurgical and neurological evaluation, and no immediate interventions were required as the shunt appeared to be functioning adequately. Appropriate medications were prescribed, and the child was discharged home.

Two years later, the patient returned to the emergency department after having seizures of her typical semiology, however a non-contrast CT scan of the head demonstrated no significant changes, and the child was discharged with an increased dosage of her seizure medication.

Discussion

VP shunt placement is a well-established neurosurgical procedure often used for the treatment of hydrocephalus and the management of refractory idiopathic intracranial hypertension. However, shunt failure is a frequent complication that occurs in approximately 40-70% of cases [1-3]. Symptoms of shunt failure include headaches, vomiting, gradual enlargement of the head, decreased oral intake, lethargy, gait imbalance, disorientation, drowsiness, ocular movement deficits, papilledema, nuchal rigidity, meningism, and worsening of neurologic status [1,2,4-6]. Shunt failure can be attributed to multiple factors including obstruction, damage, and displacement of the ventricular or distal catheter, in addition to valve damage and malfunction [2-5,7-8].

Shunt migration is a well-known complication in children who are still growing over time and secondary shunt disconnection may occur resulting in slowly progressing or even acute shunt failure. However, shunt tube proximal migration occurs in approximately 0.1-0.4% of total cases with complete intracranial migration being incredibly rare [1,4,6,8]. Given this, it is important to document and understand the potential risk factors to prevent such a complication from happening in the future. The risk factors can be divided into 3 categories: anatomical, mechanical, and patient-related risk factors.

The first anatomical risk factor for shunt migration, specifically for the pediatric population, is a shorter distance between the peritoneum and cranium [1,6,8]. This decreased distance in conjunction with excessive or uncontrolled head and neck movements such as seizures can cause displacement of the shunt [1,3,4,6,8]. Thin cerebral mantles, large ventricles, and wide fontanelles pose an additional anatomic risk as they can generate an intracranial pressure similar to that of atmospheric pressure [1,4,6,8]. Furthermore, because the abdominal pressure remains positive (especially in episodes of increased strain), a positive pressure gradient is created increasing the potential for displacement of the shunt [1,3-6,8].

Mechanical causes for intracranial VP shunt/shunt reservoir migration include a poor fixation of the shunt either at the proximal or distal end, a large burr hole, a larger dural opening, and re-exploration as it decreases the availability and quality of local tissue for anchoring [1,4,6,8].

Finally, patient-related factors include young age, malnutrition, a thin cortical layer, and severe hydrocephalus [1,4,6,8]. In the pediatric population, young age is a particularly important risk factor to be mindful of as children tend grow rapidly early on in life which augments the risk of detachment [1,4,6,8]. Similar, to re-exploration, malnourished patients are also at a higher risk for intracranial displacement due to the decrease in available subcutaneous tissue for anchorage [1,4,6,8].

Out of the previously discussed risk factors, we believe that in our case the patient's young age, subsequent rapid growth, and history of seizures likely played the most significant role in causing intracranial displacement of the VP shunt/ shunt reservoir. However, inadvertent mechanical errors such as a larger than expected burr hole and dural opening should always be considered especially if we aim to continue improving neurosurgical practices.

Conclusion

Complete intracranial displacement of a ventriculoperitoneal the shunt including shunt reservoir is an exceptionally rare complication with only a few cases reported in the literature to date. To prevent future occurrences, it is important to first understand the anatomic, mechanical, and patient-related risk factors to then address the underlying cause. One approach to prevent this complication would be to optimize initial anchorage of the shunt and minimize the size of burr hole opening. Additionally, consistent follow up in conjunction with patient and family education is essential to recognize complications and red-flag symptoms early on. Finally, the incidence, prevalence, and management options for a patent yet completely intracranially displaced VP shunt should continue to be studied to further optimize patient care.

Conflict of Interest/Author Disclaimer:
There is no conflict of interest to disclose.

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