Interdisciplinary Neurosurgery 16 (2019) 79–81

Contents lists available at ScienceDirect

Interdisciplinary Neurosurgery

journal homepage: www.elsevier.com/locate/inat

Technical Notes & Surgical Techniques

Ventriculoperitoneal shunt valve fracture after traumatic motor vehicle collision

Adam T. Leibold (MSc)*, Jonathan Weyhenmeyer (MD), Richard Rodgers (MD), Albert Lee (MD)

Department of Neurological Surgery, Indiana University School of Medicine, Indianapolis, IN, United States of America

ARTICLE INFO

Keywords:
Ventriculoperitoneal shunt
Trauma
Hydrocephalus
Neuroradiology

1. Introduction

Hydrocephalus, a pathologic accumulation of cerebrospinal fluid (CSF), was described as early as Hippocrates. The use of a permanent shunt to reroute that excess CSF was first used in 1893 in the form of a ventriculo-subarachnoid-subgaleal shunt. Today, ventriculoperitoneal (VP) shunts, diverting CSF from the lateral ventricle to the peritoneal cavity, are the most common shunt systems used to treat hydrocephalus. These devices consist of three main components: a ventricular catheter, a valve system, and a distal catheter. Within the valve system is a reservoir used to sample CSF, deliver drugs, or test shunt function, as well as a silastic diaphragm that controls the flow of CSF.

VP shunts are highly effective in relieving a patient's hydrocephalus, but they are also notoriously susceptible to complications including obstruction, fracture, infection, and overdrainage, leading to the need for shunt revision. These complications are common, with revision rates reported to be as high as 85% in the 15 years following the initial procedure and some patients needing 10 or more revisions in that time period [1,2]. If a shunt malfunction is suspected it should be investigated using a plain X-ray of the shunt system (lateral skull, AP chest, and AP abdomen), known as a "shunt series," and a CT scan of the head looking for enlargement of the ventricles. Revisions used to treat shunt malfunctions consist of everything from simply a distal catheter revision to a replacement of the entire shunt system. Here we describe a unique case in which a trauma fractured the diaphragm within the valve system, requiring subsequent revision.

2. Case report

2.1. History and examination

Our patient is a 26-year-old male who had a VP shunt placed in 1991 at the age of 3 months for post-infectious hydrocephalus due to meningitis. He has had multiple revisions in the past with his last one being three years prior to this incident. Per EMS, the patient was struck by a vehicle traveling around 30–35 MPH and his head struck the windshield of the car. The patient was found unresponsive and classified as a trauma 2 at the scene. He improved to a Glasgow Coma Score (GCS) of around 14 while in route to the hospital and was upgraded to a trauma 1. On arrival the initial survey showed a left posterior scalp laceration, near the patient's old VP shunt incision and right superficial knee abrasions. The patient did not display any neurologic deficits and the rest of his physical exam was unremarkable. A work up including a head, chest, and abdominal CT scan, a CTA of the neck, and X-rays of the chest, knee, and pelvis was then performed.

Initial CT evaluation of the head revealed a small volume of subarachnoid hemorrhage in the right frontal lobe and right cerebellopontine angle, as well as a laceration and hematoma in the left parietal scalp. The CT also showed the patient's VP shunt to be in the expected position with no evidence of hydrocephalus (Fig. 1A, C). Two days later the patient began exhibiting increased lethargy, prompting a repeat head CT. This head CT showed increased hydrocephalus and displacement of the VP shunt (Fig. 1B, C). The patient was then promptly taken to the operating room for a VP shunt revision.

* Corresponding author.
E-mail address: aleibold@iu.edu (A.T. Leibold).

https://doi.org/10.1016/j.inat.2018.12.008
Received 18 October 2018; Received in revised form 13 December 2018; Accepted 16 December 2018
2214-7519/

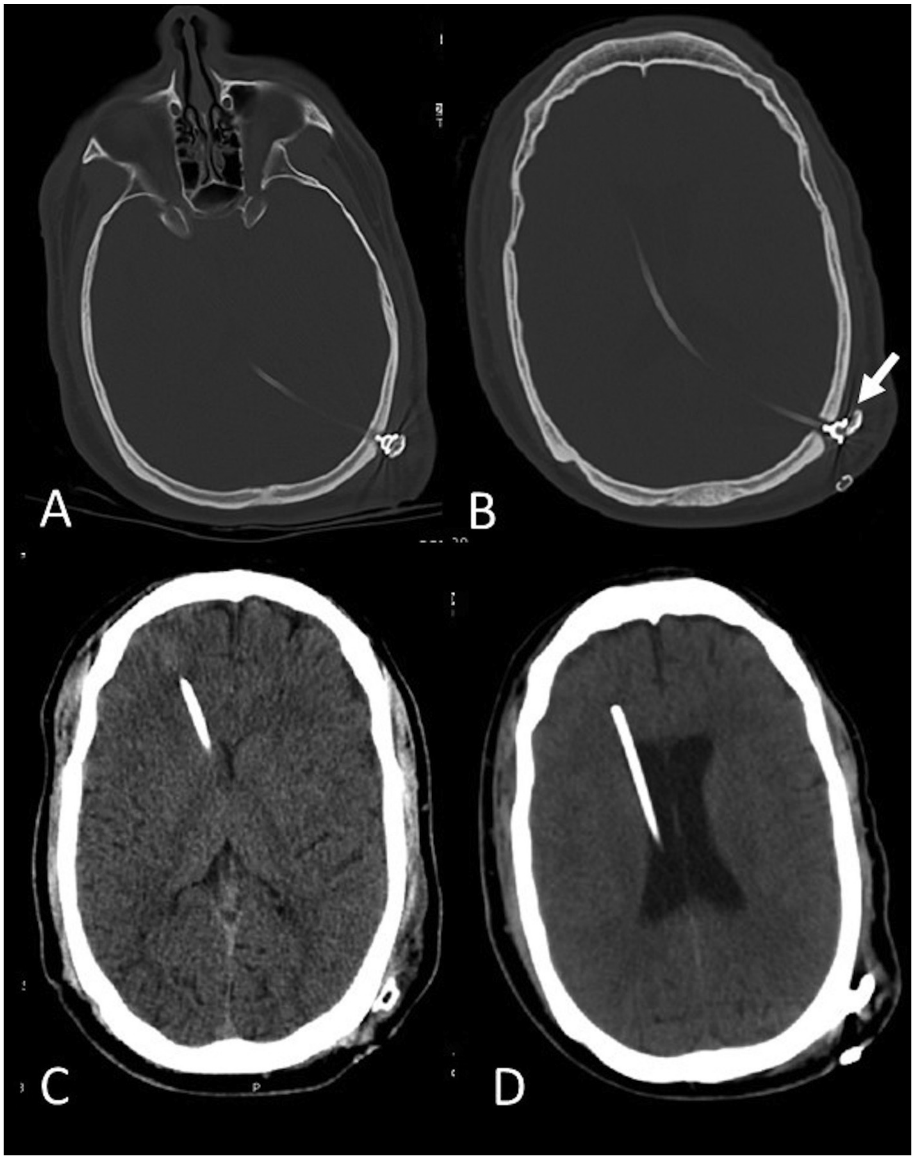

Fig. 1. Brain CT scans demonstrating the position of the shunt on the night of the accident (A) and 2 days later (B). *Arrow* indicates the displacement of the extracranial portion of the shunt. Brain CT scans are also used to evaluate for hydrocephalus, with none demonstrated on the day of the accident (C), and enlarged ventricles exhibited 2 days later (D).

2.2. *Operation*

The shunt was accessed via the patient's old C-shaped incision. Once the shunt tubing was exposed a massive amount of CSF was noted. Further dissection, down to the shunt's Rickham reservoir, noted that the silastic diaphragm was cracked and needed to be replaced. A new Rickham system was opened and connected to the current metal reservoir. The shunt was then tapped, and adequate flow was seen. After closing, the patient was brought back to the ICU intubated.

2.3. *Postoperative course*

On the same day as the surgery the patient was able to be extubated without any issues. He was placed on antibiotics to prevent meningitis due to the suspicion that his scalp laceration may have communicated with his shunt. The patient had no further issues and three days later was discharged to an acute rehabilitation facility.

3. Discussion

Mechanical malfunction is the most common cause for shunt revision, with rates ranging from 8% to 64% [2]. Durability is an issue in shunts, and the shunt system may become compromised over time [3]. Indeed, studies have shown that infections are more frequently developed in the first 6 months of the initial shunt procedure, with obstruction and fracture becoming more common later in the shunt's life [4]. The risk of shunt fracture increases over time due to calcification and tethering of the catheter, which makes the tubing more fragile and susceptible to fracture under mechanical stress [3]. These fractures most often occur in the patient's neck, where the greatest amount of mechanical stress is applied to the catheter tubing.

Like the catheter tubing, the silastic diaphragms in the valves of the shunt system can also become calcified and fracture [5]. These fractures are significantly harder to detect due to the radiolucent nature of these parts of the valve, and a pseudo-disconnection can occur involving the radiolucent components that then leads to further disconnections [5]. In all three cases of valve fracture reported by Hellbusch in 1996, there was no precipitating trauma to the valve, and diagnostic imaging was initially unremarkable. The author concluded that while the silastic valve is radiolucent, its fracture can lead to separation of the radio-paque portions of the valve. This is similar to what was seen in our case, where an undetected fracture in the shunt's valve led to a separation of the catheter from the reservoir.

Comparing current and past radiographs can be helpful when evaluating the integrity of these radiolucent portions, as a valve fracture may lead to a shift in relationship between the proximal and distal catheter [5]. Another way to detect a fracture of the valve system is by examining the skin overlying the valve, if the valve is fractured it will appear “flat” on physical exam [5]. One should be aware of the signs of shunt valve malfunction and of the fact that imaging is unreliable in the detection of these issues.

4. Conclusion

Our case demonstrates the importance of assessing the integrity of the entire shunt system after a trauma. This includes an evaluation not only of the shunt tubing, the most frequently affected component, but also of the valve system itself. A high suspicion of valve fractures and a thorough exam can lead to better detection, halting the deterioration of trauma patients with VP shunts.

References

[1] J.J. Stone, et al., Revision rate of pediatric ventriculoperitoneal shunts after 15 years, J. Neurosurg. Pediatr. 11 (1) (2013) 15–19.

[2] J.M. Wong, et al., Patterns in neurosurgical adverse events: cerebrospinal fluid shunt surgery, Neurosurg. Focus. 33 (5) (2012) E13.

[3] W.G. Blakeney, C. D'Amato, Ventriculoperitoneal shunt fracture following application of halo-gravity traction: a case report, J. Pediatr. Orthop. 35 (6) (2015) e52–e54.

[4] M.-K. Park, et al., A retrospective analysis of ventriculoperitoneal shunt revision cases of a single institute, J. Korean Neurosurg. Soc. 57 (5) (2015) 359–363.

[5] L.C. Hellbusch, Cerebrospinal fluid shunt valve fracture with separation: report of three cases, Childs Nerv. Syst. 12 (3) (1996) 142–144.