



Case Report

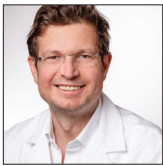
# Ventriculoperitoneal shunt failure due to raised intra-abdominal pressure: A case report and review of the literature

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## ABSTRACT

**Background:** Ventriculoperitoneal (VP) shunt implantation is the standard neurosurgical procedure to treat hydrocephalus for various reasons. Its function depends on the differential pressure between the ventricular space and the peritoneal cavity. Correct functioning of cerebrospinal fluid (CSF) valves requires a gradient of pressure between the ventricular and the abdominal cavity. Any reason that disrupts this balance can result in dysfunction of the system. Increased intra-abdominal pressure (IAP) may be a reason to induce shunt failure by decreasing CSF drainage from the ventricular system to the peritoneal cavity.

**Case Description:** We report a case of repeated VP shunt failure because of constipation and successful conservative management by lowering IAP without surgical revision of the VP shunt system and reviewed the relevant literature.

**Conclusion:** Increased IAP for a variety of reason should always be considered as a possible reason for shunt failure that can often be treated conservatively and therefore can reduce unnecessary shunt revision surgery.

**Keywords:** Abdominal surgery, Constipation, Intra-abdominal pressure, Ventriculoperitoneal shunt dysfunction

## INTRODUCTION

A malfunctioning ventriculoperitoneal (VP) shunt was always a challenging for neurosurgeons and mostly resulting from obstruction, infection, or disconnection. In this article, we discussed a case of repeated VP shunt (VPS) failure because of constipation as uncommon etiology of VPS failure and reviewed the relevant literature.

## CASE REPORT

A 29-year-old man, in whom a VPS had been inserted at the age of 4 months to treat congenital hydrocephalus, presented in our clinic with altered state of consciousness and gait apraxia. The patient did not report other symptoms typical for raised intracranial pressure or shunt infection such as nausea, vomiting, meningism, or fever. His routine laboratory investigation was normal. Emergency computerized tomography (CT) of the head revealed a hydrocephalic

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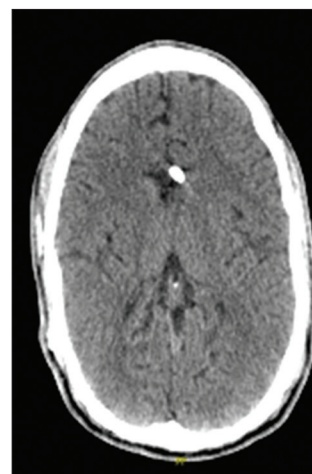
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ventricular system, suggesting a functional VPS failure [Figure 1]. A shunt series showed a Codman-Hakim-ventil (pressure level: 90 mmHg) without evidence of shunt disconnection. However, radiographs of the abdomen revealed fecal retention and a striking distention of the right colon [Figure 2]. Furthermore, the patient was operated on a week ago to treat adhesive small bowel obstruction in another hospital. The department of abdominal surgery was advisedly contacted. The performed CT of the abdomen showed a large amount of stool in the small intestine and colon, confirming the diagnosis of severe constipation. Therefore, the patient's manifestation of shunt failure was attributed to his severe constipation. He was conservatively treated by administration of neostigmine. In the following, the neurological status of the patient improved continuously as his constipation resolved. Moreover, the CT imaging of the head demonstrated that the width of his ventricular system had returned to its previous size [Figure 3]. Therefore, operative VPS revision was not necessary.

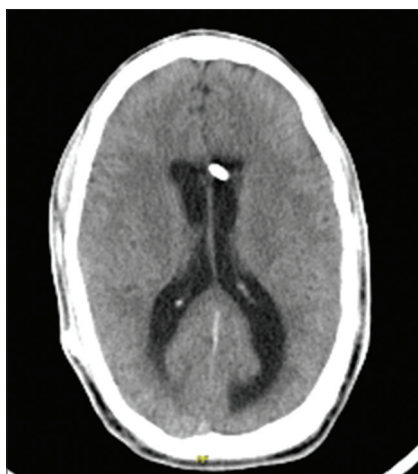
Further evaluation of the medical history of the patient revealed a similar situation in 2017. The patient underwent ileus surgery and was admitted to our hospital with suspected meningitis because of fever and alteration of consciousness 2 days after. The patient was immediately transferred to the intensive care unit and endotracheal intubation was required. A spinal tap was ensued, thereby excluding meningitis. A CT of the head showed an advanced hydrocephalus [Figure 4]. Shunt series did not display a shunt disconnection but revealed an obvious meteorism [Figure 5] and a right-sided pneumonia, which was treated by antibiotic. The patient's condition started to improve after administration of antibiotics. In addition to the shunt series, a shuntogram (using a contrastive medium) was performed. It demonstrated a good peritoneal dissemination of the



**Figure 2:** X-ray of the abdomen showing a faecal retention with bowel distension.



**Figure 3:** Regression of hydrocephalus after medical treatment of hydrocephalus.



**Figure 1:** Computed tomography studies of the head showing hydrocephalus at the time of admission.



**Figure 4:** Hydrocephalus due to meteorism.

contrast medium. Therefore, no surgical shunt revision was necessary. Consequently, the valve pressure was reduced from 120 to 90 mmHg. This measure led to complete resolution of shunt dysfunction [Figure 6]. The patient was extubated the following day with no neurological deficits.



**Figure 5:** X-ray of the abdomen showing meteorism.



**Figure 6:** Resolution of hydrocephalus after downregulation of valve pressure.

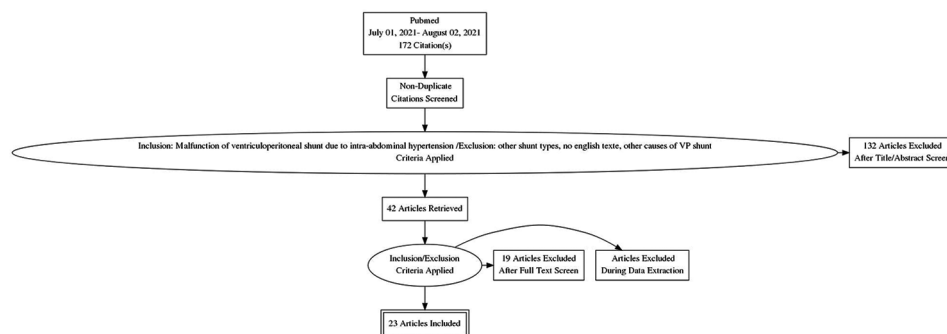
## DISCUSSION

At present, the treatment of choice for most patients with hydrocephalus is a VPS placement. Unfortunately, the rate of complications after VPS surgery is high. The most common causes of shunt failure in both pediatric and adult populations are shunt obstruction followed by infection.<sup>[13]</sup> A rare cause of shunt dysfunction is a significant increase of the intra-abdominal pressure (IAP) with the consequence of a reduced differential pressure gradient between the ventricular and intra-abdominal space, thereby reducing the amount of cerebrospinal fluid (CSF) drained into the intraperitoneal space.

Therefore, we performed a systematically literature review for case reports and reasons of increased IAP leading to VPS dysfunction according to the PRISMA framework [Figure 7]. The database MEDLINE (PubMed) was systematically searched for the keywords “ventriculoperitoneal shunt, malfunction, intra-abdominal hypertension, and constipation” between 1980 and 2021. All articles that discussed other shunt types such as atrioventricular or lumboperitoneal shunts were excluded as well as articles about VPS failure due to other causes (e.g., infection, obstruction, or disconnection).

Actually, constipation is an unusual cause of VPS failure and was first described by Bragg in 1994.<sup>[1]</sup> Subsequently, various similar reports and papers were published. In 2004, three cases of VPS malfunction due to constipation were reported by Miele *et al.*<sup>[8]</sup> and in 2006, two cases were reported by Powers *et al.*<sup>[14]</sup> This phenomena was also observed in the pediatric population by Muzumdar and Ventureyra<sup>[12]</sup> and Martínez-Lage *et al.*<sup>[7]</sup> They reported one case in 2006 and 2008. In each case, treatment of constipation resulted in both clinical and imaging documented resolution of shunt failure. In 2018, Morais *et al.* presented a 6-year-old girl with severe transitory VPS failure, which also resolved after her constipation was relieved, avoiding unnecessary surgery.<sup>[10]</sup>

However, our literature research revealed several additional reasons of raised IAP, leading to VPS failure.



**Figure 7:** PRISMA flow diagram.

**Table 1:** Literature review of different causes of VP shunt dysfunction due to increase of intra-abdominal pressure and treatment options.

Author	Cause of the increased intra-abdominal pressure	Treatment of the VP Shunt dysfunction
Hanakita <i>et al.</i> 1985	Increase of intraperitoneal pressure due to pregnancy	Insertion of a ventriculoatrial shunt
Bragg <i>et al.</i> 1994	Constipation	Completion of a bowel cleaning
Lee <i>et al.</i> 2002	Ovarian hyperstimulation syndrome	The shunt was converted into a ventriculoatrial shunt system
Miele <i>et al.</i> 2004	3 cases of constipation	Bowel regime
Mirzayan <i>et al.</i> 2006	Severe meteorism due to diverticulitis	Simeticone and amidotrizoid acid
Powers <i>et al.</i> 2006	Constipation	Bowel regime of oral polyethylene glycol und phosphosoda enema
Muzumdar and Ventureyra 2007	Constipation	A bowel enema
Fletcher <i>et al.</i> 2007	Labor	Emergency Caesarean section
Bulduk and Celtikci 2008	Urinary retention with globe vesical	Urinary catheter was administered
Martinez-Lage <i>et al.</i> 2008	Constipation	The use of laxatives and enemas
Morais <i>et al.</i> 2018	Constipation	Enema and bowel regime
Morais <i>et al.</i> 2018	Obesity (BMI: 48) THE patient presented with 5 episode of shunt dysfunction	The shunt was converted into a ventriculoatrial shunt system

BMI: Body mass index, VP: Ventriculoperitoneal shunt

Already in 1985, Hanakita *et al.* described a malfunction of a VPS in a 25-year-old woman at 32 weeks of gestation induced by increase of intra-peritoneal pressure due to pregnancy and the VPS system had to be converted into a ventriculoatrial shunt system.<sup>[5]</sup> In 2002, Lee *et al.* reported a rare case of VPS failure after a secondary ovarian hyperstimulation syndrome<sup>[6]</sup> and again the VPS system had to be converted into a ventriculoatrial shunt system.<sup>[4]</sup>

In 2006, Mirzayan *et al.* described a patient with exacerbation of a previously shunted hydrocephalus due to meteorism which was conservatively treated by simethicone and amidotrizoic acid for meteorism and constipation.<sup>[9]</sup>

In an obstetrical case report, published by Fletcher *et al.* in 2007, labor was identified as the cause of VPS malfunction. A shunted parturient had an uneventful pregnancy until the 36<sup>th</sup> week when she presented to the labor ward with drowsiness and decreasing consciousness. The reason was acute shunt malfunction due to increased IAP and the patient recovered after emergency caesarean section.<sup>[4]</sup>

Another rare case of VPS dysfunction in a pediatric patient caused by urinary retention was reported by Bulduk and Celtikci. in 2008.<sup>[2]</sup> Treatment consisted solely of a basic indwelling urinary catheter.

Moreover, obesity is considered an important factor of an inadequate function of VPSs. In obese individuals, the IAP reaches values between 8 and 12 mmHg. Morais *et al.* reported in 2018 repeated VPS malfunction in a 16-year-old girl with a body mass index of 48. Revision operations did not

show any evidence of malfunction. Ultimately, the VPS was converted into a ventriculoatrial shunt system.<sup>[11]</sup> [Table 1] summarizes the various reasons of shunt dysfunction due to intra-abdominal pathologies.

Besides this physical aspect of VPS dysfunction focusing on changes in the differential pressure, various other factors are described in the literature how intra-abdominal pathologies can influence shunt function. Hypothetically, a stool or a huge bowel loop could mechanically occlude the peritoneal end of the VPS. In addition, increasing intra-peritoneal and IAP decreases the resorptive ability of the peritoneum for CSF.<sup>[2]</sup> In addition, abdominal surgery has been blamed for inducing CSF shunt failure as residual inflammation may lead to more adhesions and impairment of CSF absorption, especially in children.<sup>[3]</sup>

## CONCLUSION

While evaluating a shunt dysfunction, not only shunt dependent factors but also abdominal related problems must be considered with the goal to minimize unnecessary shunt revisions. We, therefore, recommend that patients with a VPS and the need for an abdominal surgery should be treated in a hospital with an additional neurosurgical department.

## STATEMENT OF ETHICS

### Study approval statement

Ethical approval was not required for this study according to paragraph 15 of the code of the professional conduct for

Bavarian doctors: Mrs Sanja Fricke, head of the office, Ethics committee (Bayerische Landesärztekammer, Munich).

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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