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Case Report

Ventriculoperitoneal Shunt Failure Due to Raised Intraabdominal Pressure: Case Report and Review of the Literature

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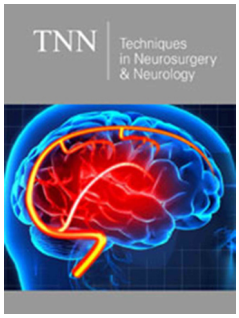

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Abstract

Ventriculoperitoneal Shunt (VP) 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 Cerebro-Spinal 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. We report a case of repeated VP shunt failure because of constipation and successful conservative management by lowering intra-abdominal pressure without surgical revision of the VP shunt system and reviewed the relevant literature.

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

Abbreviations: VP: Ventriculoperitoneal; CSF: Cerebro Spinal Fluid; IAP: Intraabdominal Pressure; SBO: Small Bowel Obstruction; CT: Computerized Tomography

Introduction

A malfunctioning 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 failure because of constipation as uncommon etiology of VP shunt failure and reviewed the relevant literature.

Case Report

A 29-year-old man, in whom a VP shunt 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 like nausea, vomiting, meningism or fever. His routine laboratory investigation was normal. Emergency computerized tomography (CT) of the head revealed a hydrocephalic ventricular system, suggesting a functional VP shunt failure (Figure 1). A shunt series showed a Codman-Hakim-ventil (pressure level: 90mmHg) without evidence of shunt disconnection. However, radiographs of the abdomen revealed faecal 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 (SBO) 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 2). Therefore, operative VP shunt 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 two days after. The patient was immediately transferred to the intensive care unit and endotracheal intubation was required (Figure 3). 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 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 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 shuntdys function (Figure 4). The patient was extubated the following day with no neurological deficits.

Figure 1: Xray of the abdomen showing a faecal retention with bowel distention.

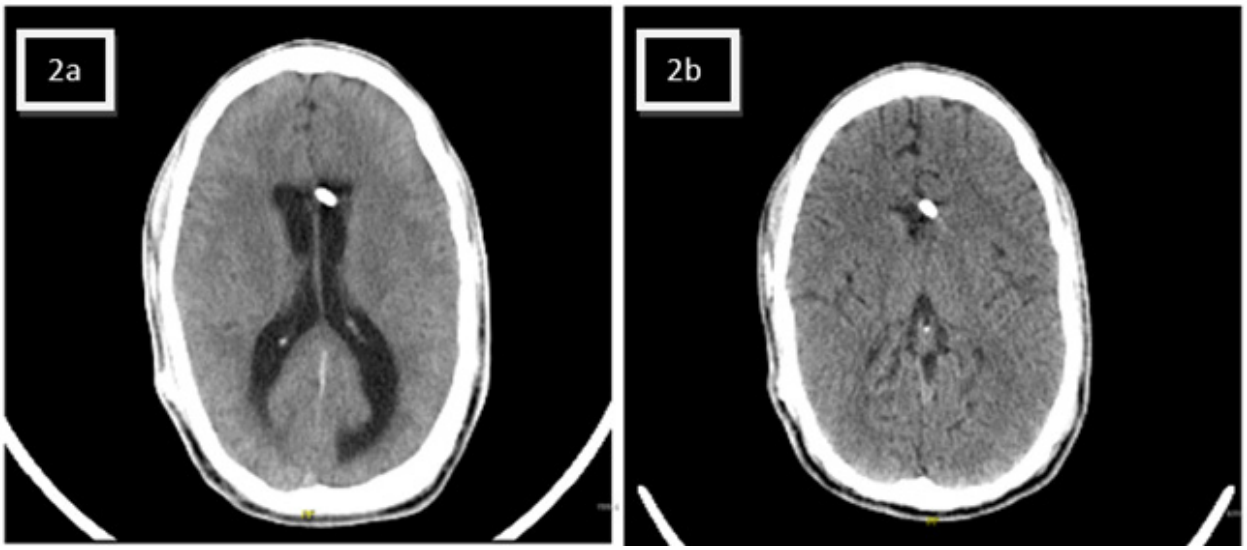

Figure 2a and 2b: CT studies of the head showing hydrocephalus at the time of admission 2a and its regression after medical treatment of constipation 2b.

Figure 3: Xray of the abdomen showing meteorism.

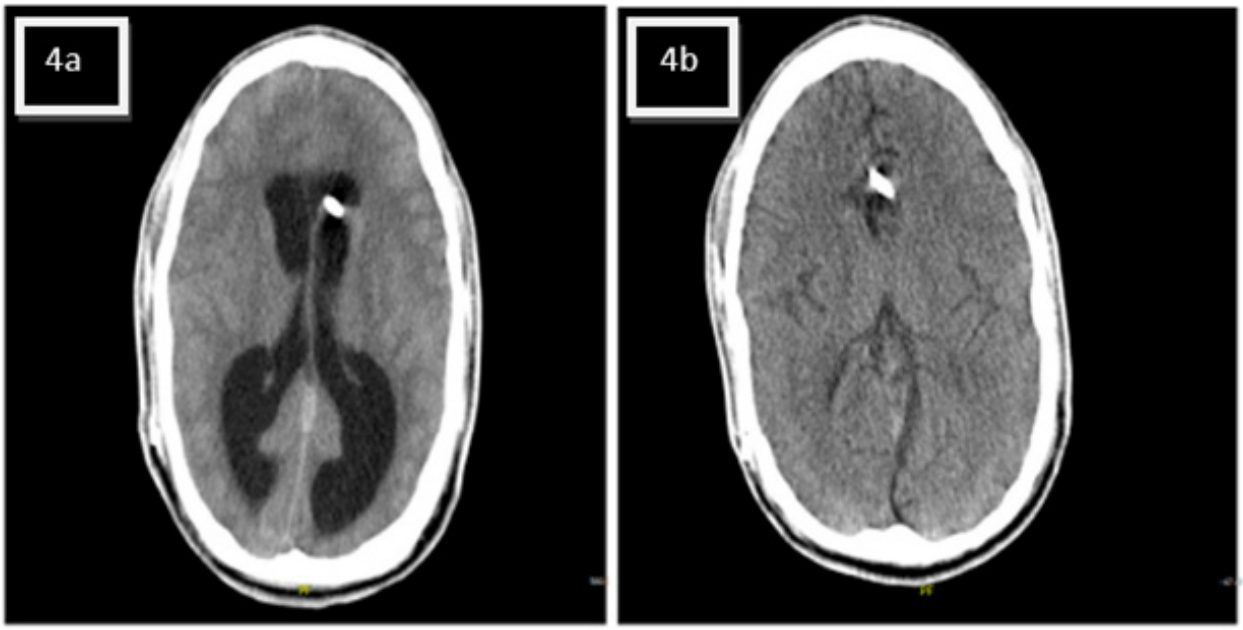

Figure 4a & 4b: Hydrocephalus due to meteorism 4a and its resolution after the downregulation of the valve pressure 4b.

Discussion

Currently, the treatment of choice for most patients with hydrocephalus is a VP shunt placement. Unfortunately, the rate of complications after ventriculoperitoneal shunt surgery is high. The most common causes of shunt failure in both pediatric and adult populations are shunt obstruction followed by infection. A rare cause of shunt dysfunction is a significant increase of the intraabdominal pressure with the consequence of a reduced differential pressure gradient between the ventricular and intraabdominal space, thereby reducing the amount of CSF drained into the intraperitoneal space. Therefore, we performed a systematically literature review for case reports and reasons of increased intra-abdominal pressure leading

to VP-shunt dysfunction according to the PRISMA framework (Figure 5). The database MEDLINE (PubMed) was systematically searched for the keywords "ventriculo-peritoneal 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 VP shunt failure due to other causes (eg. infection, obstruction or disconnection).

Figure 5: Prisma flow diagram.

Mirzayan et al. [1] described a patient with exacerbation of a previously shunted hydrocephalus due to meteorism which was treated by simethicone and amidotrizoic acid for meteorism and constipation. Another case of VP shunt dysfunction in a pediatric patient caused by urinary retention was reported. Treatment consisted solely of a basic indwelling urinary catheter. In Australia 2020, Lee et al. [2] reported a rare case of VP shunt failure after a secondary ovarian hyperstimulation syndrome. Hanakita et al. [3] as well wrote about malfunction of a ventriculoperitoneal shunt in a 25-year-old woman at 32 weeks of gestation induced by increase of intra-peritoneal pressure due to pregnancy. It was treated by insertion of a ventriculoarterial shunt. Moreover, obesity is considered an important factor of an inadequate function of ventriculoperitoneal shunts. In obese individuals, the intra-abdominal pressure reaches values between 8-12mmHg. Morais et al. [1] reported repeated ventriculoperitoneal shunt malfunction in a 16-year-old girl with a Body Mass Index (BMI) of 48. Revision operations did not show any evidence of malfunction. Ultimately the VP-shunt was converted into a ventriculoatrial shunt surgery. In an obstetrical case report, published by Fletcher et al., labor was identified as the cause of ventriculoperitoneal shunt malfunction. A shunted parturient had an uneventful pregnancy until the 36th week when she presented to the labor ward with drowsiness and decreasing consciousness. The reason was acute shunt malfunction due to increased intra-abdominal pressure and the patient recovered after emergency caesarean section. Actually, constipation is an unusual cause of VP shunt failure and was first described by Bragg [4]. Subsequently, various similar reports and papers were published. However, the incidence of VP shunt failure due to constipation is so far unknown. In 2006, Powers [5] reported 2 cases of VP shunt malfunction due to constipation. Treatment of constipation resulted in both clinical and imaging documented resolution of shunt failure. Morais et al. [6] presented a 6-year-old girl with severe transitory VPS failure, which also resolved after her constipation was relieved, avoiding unnecessary surgery. Table 1 summarizes the various reasons of shunt dysfunction due to intra-abdominal pathologies. Besides this physical aspect of VP shunt dysfunction focusing on changes in the differential pressure various other factors are described in the literature how intra-abdominal pathologies can influence shunt function [8-10]. Hypothetically, a stool or a huge bowel loop could mechanically occlude the peritoneal end of the VP shunt. Additionally, increasing intra-peritoneal and intra-abdominal pressure decreases the resorptive ability of the peritoneum for CSF [12-17]. 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.

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

Author	Cause of the Increased Intra- Abdominal Pressure	Treatment of the VP Shunt Dysfunction
Bragg et al. [4]	Constipation	Completion of a bowel cleansing
Bulduk et al. [7]	Urinary retention with globe vesical	Urinary catheter was administered
Fletcher et al. [11]	Labor	Emergency Caesarean section
Hanakita et al. [3]	Increased of intraperitoneal pressure due to pregnancy	Implacement of ventriculoatrial shunt
Lee G et al. [2]	Ovarian hyperstimulation syndrome	The shunt was converted into ventriculoatrial shunt system
Martínez-Lage et al. [18]	Constipation	The use of laxatives and enemas
Miele et al. [19]	3 cases of constipation	Bowel regime
Mirzayan et al. [20]	Severe meteorism due to diverticulitis	Simeticone and amidotrizoid acid
Morais et al. [6]	Constipation	Enema andbowel regime
Morais et al. [1]	Obesity (BMI:48) The Patient presented 5 episode of shunt dysfunction	The shunt was converted into ventriculoatrial shunt system
Muzumdar et al. [21]	Constipation	A bowel enema
Powers et al. [5]	Constipation	Bowel regime of oral polyethylene glycol und phosphosoda enema

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 VP shunt and the need for an abdominal surgery should be treated in a hospital with an additional neurosurgical department [22,23].

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