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# Complete Intestinal Obstruction and Necrosis as a Complication of a Ventriculoperitoneal Shunt in Children

## *A Report of 2 Cases and Systematic Literature Review*

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**Abstract:** Ventriculoperitoneal (VP) shunt complications are common, but abdominal complications are rare. The objective of this report is to present 2 cases of intestinal obstruction due to a VP shunt and review the literature for data on this rare occurrence.

A 4-month-old boy received surgical resection of a medulloblastoma and a VP shunt was inserted to manage progressive hydrocephalus. Two months later, he was admitted with intermittent vomiting, and plain abdominal radiography showed complete intestinal obstruction. Emergency laparotomy revealed an adhesive intestinal obstruction around the catheter, and approximately 5 cm of necrotic ileum was resected. His recovery was uneventful. In the second case, a 6-year-old boy was diagnosed with a primary nongerminomatous malignant germ cell tumor and a VP shunt was place to treat hydrocephalus. Two weeks after the first course of chemotherapy, he went into a coma; computed tomography demonstrated enlargement of the tumor and gross total resection was performed. Two weeks later, he developed abdominal distention; plain radiography showed intestinal obstruction and laparotomy revealed adhesive intestinal obstruction around the catheter with 15 cm of necrotic ileum. The necrotic bowel was resected. Unfortunately, the patient developed sepsis and despite treatment remained in a vegetative state.

Medline, Central, Embase, and Google Scholar databases were searched up to May 9, 2014, using the terms VP shunt, shunting, and/or intestinal obstruction. Only cases involving children or adolescents were included. Eleven reports involving patients with abdominal complications resulting from a VP shunt for hydrocephalus were identified. The dates of the reports spanned from 1971 to 2014. Volvulus was the most common cause of VP shunt-related obstruction, and mechanical obstruction due to twisting of the catheter the second most common. Only 1 case in the literature review was related to intestinal adhesions. Treatment in most cases was laparotomy.

Although intestinal obstruction is a rare complication of a VP shunt, it should be considered in the presence of abdominal symptoms and prompt treatment provided to have a good outcome.

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**Abbreviations**: CSF = cerebrospinal fluid, VA = ventriculoatrial, VP = ventriculoperitoneal.

## INTRODUCTION

A ventriculoperitoneal (VP) shunt that diverts cerebrospinal fluid (CSF) to the peritoneal cavity via a catheter remains the gold standard treatment for infants and adults with congenital or acquired hydrocephalus, such as that due to a tumor.[1–3] The main advantage of shunting is that excessive CSF is completely removed from the central nervous system (CNS). A VP shunt to treat hydrocephalus is the most common pediatric neurosurgical procedure, and although initial placement is typically uneventful, complications of VP shunts are common with reported frequencies ranging from 45% to 59%.[3–6] Complications include infection (usually caused by *Staphylococcus epidermidis*), obstruction of the shunt itself, failure of a valve, or over- and underdrainage of a ventricle.[7] Intra-abdominal complications of a VP shunt are rare, and intestinal obstruction as a result of the shunt is very rare. In this report, we describe 2 cases of intestinal obstruction as a result of a VP shunt, and perform a systematic literature review to obtain data of this rare occurrence.

## CASE REPORTS

### Case 1

A 4-month-old boy was admitted to our hospital for progressive head enlargement. Physical examination revealed a bulging fontanelle. Magnetic resonance imaging (MRI) showed a heterogeneously enhancing mass ($5.3 \times 3.4 \times 4.7$ cm) centered in the posterior fossa with compression of the fourth ventricle and obstructive hydrocephalus (Figure 1A). The patient underwent posterior fossa craniotomy and gross-total resection of the tumor (Figure 1B). Histological examination of the tumor revealed a cellular neoplasm arranged in a sheet-like architecture with diffuse invasion of the surrounding cerebellum, and the final pathological diagnosis was medulloblastoma with anaplasia. A VP shunt was inserted to manage the progressive hydrocephalus 2 weeks after resection.

The VP shunt placed was the CODMAN HAKIM Programmable Valve System (Codman, Johnson & Johnson Company, Raynham, MA) Programmable Valve System. The catheter is silastic, but not antibiotic impregnated. Intraperitoneal placement of the catheter was 20 to 25 cm. During the placement of the distal catheter, a horizontal incision was made about 3 cm below the costal margin and centered at the lateral border of the rectus musculature. In most children, this can be accomplished with an incision of approximately 1.5 to 2 cm in length. After the superficial rectus fascia was opened, the rectus muscle was separated vertically in a muscle-sparing fashion, the deep rectus fascia was grasped with 2 hemostats, and a 3- to

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4-mm incision was made with Metzenbaum scissors. The peritoneum can be picked up with 2 mosquito hemostats and incised with the Metzenbaum scissors; the peritoneum cavity can then be confirmed by gently probing with a Penfield 4 instrument. The distal catheter tip was then inserted into the peritoneal cavity in a craniocaudal direction. Closure was performed in layers, with a single 3-0 absorbable suture reapproximating the deep fascia and interrupted 4-0 absorbable sutures in the superficial fascia and dermis layers. During closure, it was confirmed that the catheter has not been cut or dislocated into the subcutaneous tissue. CSF cytology was negative at shunt placement. His postoperative course was uneventful, and symptoms resolved rapidly.

The patient was asymptomatic for 2 months, but was readmitted for an acute episode of intermittent vomiting lasting for 13 hours. Physical examination revealed abdominal distention with minimal tenderness. Plain abdominal radiography showed complete intestinal obstruction (Figure 1C and D). An emergency laparotomy was performed, and intestinal obstruction due to adhesions was detected around the catheter, though the catheter had not migrated and was not directly compressing the intestine. No metastases were noted. Approximately 5 cm of necrotic ileum was found due to an adhesive band. The necrotic bowel was resected, and an anastomosis was performed. An Ommaya reservoir was implanted for external drainage until the shunt system could be replaced. Culture of CSF from the abdominal component of the shunt grew *S epidermidis*, and the patient received antibiotics for 2 weeks. The patient recovered, and a new VP shunt was inserted 4 weeks postoperatively. Because of his clinical course, chemotherapy was delayed until the 5th month after the initial surgery, at which time he received 3, 2-month cycles of chemotherapy, with each cycle consisting of cyclophosphamide, methotrexate, vincristine, carboplatin, and etoposide. At 8 months of follow-up, the patient exhibited no neurological deficits and no radiographic evidence of tumor recurrence.

## Case 2

A 6-year-old boy presented to our emergency department with a 2-week history of headaches and vomiting. Computed tomography (CT) of the head showed the aqueduct of the midbrain was compressed, the supratentorial ventricles were dilated (Figure 2A and B), and there was a mixed density 4.0 (transverse) × 3.2 (anteroposterior) × 5.1 (superoinferior) cm mass centered in the pineal region with effacement of the third ventricle and obstructive hydrocephalus (Figure 2C). MRI confirmed the presence of an inhomogeneous tumor occupying

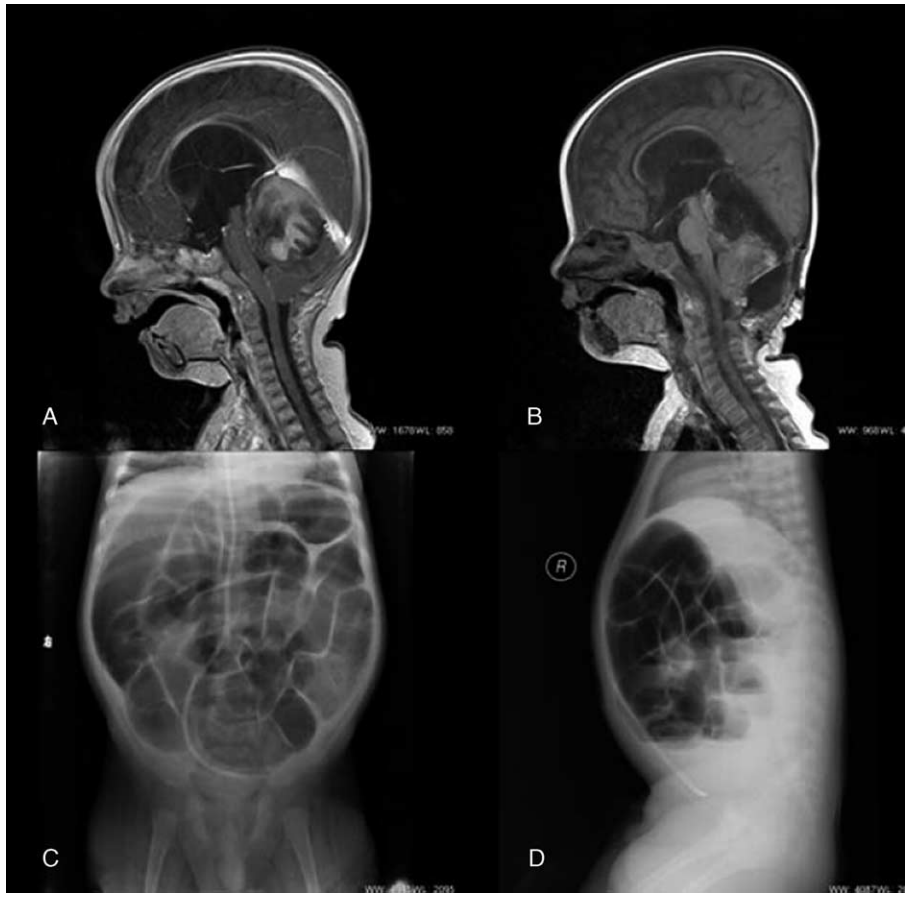


**FIGURE 1.** Case 1. (A) Preoperative sagittal contrast-enhanced T1-weighted magnetic resonance images showed a heterogeneously enhancing mass centered in the posterior fossa with compression of the fourth ventricle and obstructive hydrocephalus. (B) Postoperative sagittal T1-weighted magnetic resonance imaging confirmed gross total resection of the tumor. (C and D) Anteroposterior and lateral plain abdominal radiography showed complete intestinal obstruction.

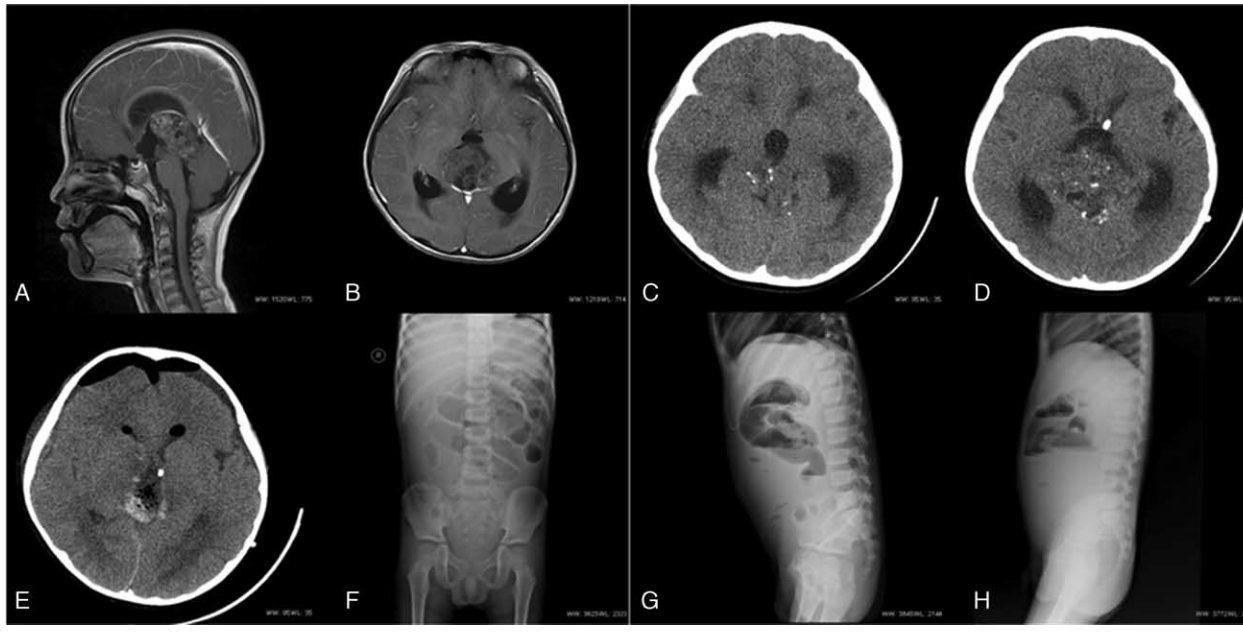


**FIGURE 2.** Case 2 (A and B) Preoperative sagittal and axial contrast-enhanced T1-weighted magnetic resonance images showed an intense but slightly inhomogeneous enhancement of the tumor occupying the posterior third ventricle and spreading though the tentorium. The aqueduct of midbrain was compressed, and the supratentorial ventricles dilated. (C) Preoperative noncontrast computed tomography (CT) showed an isodense tumor in the pineal region with calcifications. (D) Two weeks after the first course of chemotherapy, the patient suddenly fell into coma and the CT scan demonstrated obvious enlargement of the tumor. Shunted hydrocephalus was noted. (E) Postoperative CT showed gross total resection of the tumor. (F and G) Anteroposterior and lateral plain abdominal radiography showed partial intestinal obstruction 17 days after tumor resection. (H) Plain abdominal radiography showed complete intestinal obstruction 15 hours after prior films.

the posterior third ventricle, which had spread through the tentorium. Serum α-fetoprotein was elevated (555 IU/L), and β-human chorionic gonadotropin was normal. This patient was diagnosed with a primary nongerminomatous malignant germ cell tumor. Endoscopic third ventriculostomy (ETV) was considered, but not performed because of concerns of bleeding from the tumor and restriction of the operating space because of the large size of the lesion. Thus, a VP shunt was placed. The shunt placed and the placement procedure was the same as described for case 1, and the placement was performed by the same attending neurosurgeon. CSF cytology was negative at initial shunt placement. Following shunt placement, chemotherapy (carboplatin + etoposide + bleomycin) was administered.

Two weeks after the first course of chemotherapy, the patient suddenly fell into a coma. CT demonstrated obvious enlargement of the tumor (Figure 2D). Emergency surgery was performed via a transcallosal-transseptal-interforniceal approach with gross total resection of the tumor (Figure 2E). The final pathological diagnosis was an immature teratoma. The patient recovered from the surgery uneventfully with no obvious neurological deficits. However, on the 17th day postoperatively, he developed the acute onset of vomiting with abdominal pain. Physical examination revealed abdominal distention, and plain abdominal radiography showed a partial intestinal obstruction (Figure 2F and G). He was conservatively treated for 15 hours; however, the symptoms worsened and plain abdominal radiograph showed complete intestinal obstruction (Figure 2H).

Laparotomy revealed intestinal obstruction due to adhesions around the catheter with 15 cm of necrotic ileum. No metastases were noted. The necrotic bowel was resected, and anastomosis performed. The distal catheter was pulled out of the abdominal wall for continuous external drainage. After surgery, he developed a fever, stiff neck, and positive Kernig sign, and septic shock was diagnosed. Blood and CSF cultures were positive for *Escherichia coli* that proved resistant to most antibiotics. Postoperative and postseptic shock CT without contrast only revealed mild subdural effusion with no evidence of infarction or herniation. MRI was not performed. The shunt device was totally removed, and replaced with an external ventricular catheter. After 4 weeks of antibiotic therapy, a ventriculoatrial (VA) shunt was inserted. However, the patient emerged in a persistent vegetative state.

## Ethics Statements

Owing to the case report that involved a retrospective analysis of 2 patients, the approval of an institutional review board is not required. But this report was prepared in accordance with the Health Insurance Portability and Accountability Act regulations. The patient's parents/legal guardians provided informed consent for the case data to be published.

## Systematic Literature Review

A systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[8] Medline, Central, Embase, and Google Scholar databases were searched for studies published up to May 9, 2014, using the terms VP shunt, shunting, and/or intestinal obstruction. Reference lists generated in the search

were then hand-searched for relevance, and reports were screened to remove duplicates.

## Selection Criteria and Data Extraction

Study inclusion criteria for the systematic review were as follows: patients <18 years of age (children or adolescents; had VP shunt placement; and developed intestinal obstruction as a complication of the shunt. Non-English and non-Chinese reports were excluded. Studies were independently identified by 2 reviewers. In cases of uncertainty or disagreement between the 2 reviewers, a third reviewer was consulted to assess eligibility of the contested article.

The following data were extracted from studies meeting the inclusion criteria: name of the first author, year of publication, age and sex of the patient(s), clinical presentation, cause of the hydrocephalus, cause of the intestinal obstruction, interval from shunt placement to intestinal obstruction, intervention used to treat the intestinal obstruction, and the outcome. Data extraction was also conducted by 2 reviewers working independently, and a third reviewer was consulted for any disagreement.

# RESULTS

## Literature Search

A flow diagram of study selection is shown in Figure 3. A total of 255 articles were identified in the literature search, and of these, 242 were excluded because they did not meet the inclusion criteria. Thus, the full text of 13 studies was reviewed, and 2 were excluded as they did not mention intestinal obstruction. A summary of findings of the included 11 studies[9–19] and the data of our 2 cases are listed in Table 1. Meta-analysis was not conducted as there was an insufficient quantity of complications that could be categorized to provide a clinically meaningful result.

## Study Characteristics

The dates of the reports spanned from 1971 to 2014. Two of the studies did not provide patient characteristics that could be included in Table 1 because they summarized results from groups of patients.[11,12] The age of the patients ranged from 1 week to 3 years. Intestinal obstruction typically presented as a distended, tender, or acute abdomen, and vomiting. Although intracranial tumors were the cause of hydrocephalus in the 2 patients reported herein, the 11 published reports documented a variety of other causes including myelomeningoceles,[14,17] chronic subdural hematoma,[18] and Dandy-Walker syndrome.[19] The time interval from shunt placement to intestinal obstruction widely varied. Three articles reported evidence of CSF infection: Bal et al[10] reported a peritubal collection of CSF that grew *Klebsiella pneumonia*; the patient reported by Starreveld et al[19] had cellulitis around the shunt tubing under the scalp, and CSF from the P shunt valve tap grew *S aureus*; and the patient reported by Hlavin et al[14] had swelling and skin breakdown along the shunt tract, and CSF grew *S aureus*. Treatments of most cases involved laparotomy,[9,10,15–19] but laparoscopy and other less-invasive procedures were also used.[11,12,14] Only 1 case had necrotic small bowel that required resection.[19] In 1 case, catheter removal was reported as the only treatment.[13] Most studies reported an uneventful recovery. Follow-up times were reported in only 2 of the studies, with a follow-up of 3 weeks in 1 study[10] and 3 years in the other.[14]

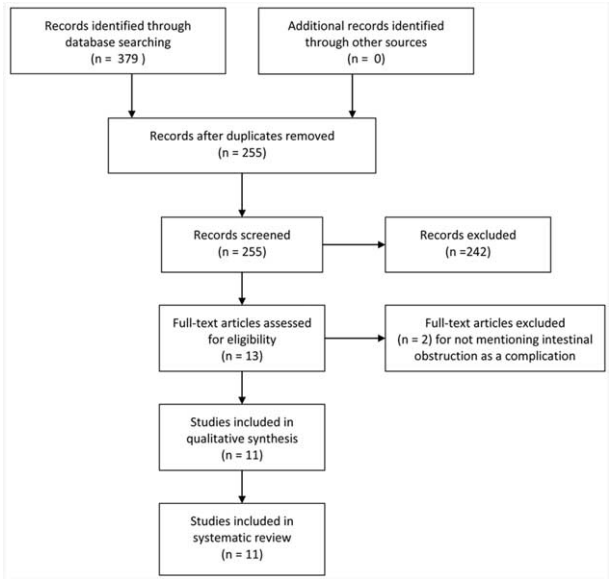


**FIGURE 3.** Flow diagram of study selection.

# DISCUSSION

Over 50% of pediatric brain tumors present with obstructive hydrocephalus at the time of the diagnosis.[20–22] Early radical tumor removal is ideal, so often ETV is concomitantly performed with craniotomy.[22] Although preresection VP shunting is not a standard practice, VP shunting remains one of the most commonly performed interventions for hydrocephalus.[4] Complications of a VP shunt, however, are common in both pediatric and adult patients with a reported incidence of 45% to 59%.[3–6] Abdominal complications include volvulus, peritonitis, ascites, perforation of the bowel, bladder, gallbladder and vagina, peritoneal cysts, CSF ascites, and distal catheter migration via the intestinal tract, umbilicus, scrotum, or vagina.[10,23–26]

In our first case, the intestinal obstruction occurred after an infection. We believe that the shunt infection may have contributed to the development of the bowel obstruction as infection can cause bowel adhesions. Also, of note is that radiotherapy was not administered as the chemotherapy regimen given has been shown to be effective without the addition of radiotherapy.[27] The second case had a much more complicated course. The VP shunt was placed prior to surgery, and the intestinal obstruction occurred after tumor resection. It is possible that necrotic, possibly infected brain tissue passed though the shunt into the abdominal cavity contributing to the formation of adhesions. We believe the patient's neurological deterioration was likely due to poor perfusion as a result of septic shock rather than hydrocephalus as continuous external drainage was begun at the time of laparotomy. There was no evidence that the patient was immunocompromised at that time the septic shock occurred, which may have made him less likely to display signs of an acute abdomen. The patient did not have any signs of intracranial infection after the tumor resection, and there were no obvious neurological deficits. He became symptomatic after the laparotomy for bowel obstruction, at which time he developed a fever, stiff neck, and positive Kernig sign, and blood and CSF cultures were positive for *E coli*. Based on the findings, we believed the intracranial infection was due to septic shock, and the pathogen, *E coli*, implied the infection was

**TABLE 1.** Clinical Characteristics of Pediatric Patients With Intestinal Obstruction After Ventriculoperitoneal Shunt Placement for Hydrocephalus

| 1st Author (Year of Publication) | Age | Sex | Clinical Presentation | Cause of Hydrocephalus | Interval to Intestinal Obstruction | Cause of Intestinal Obstruction | Intervention for Intestinal Obstruction | Outcome | Follow-Up |
|---|---|---|---|---|---|---|---|---|---|
| Present report | 4 mo | Male | Progressive head enlargement | Medulloblastoma of posterior fossa | 2 mo | Adhesive intestinal obstruction around the catheter with 5 cm necrotic ileum | Emergency laparotomy | No neurological deficit or tumor recurrence | 8 mo |
| | 6 y | Male | Headache and vomiting for 2 wk | Immature teratoma of posterior third ventricle | 17 d | Adhesive intestinal obstruction around the catheter with 15 cm necrotic ileum | Conservative treatment then laparotomy | Persistent vegetative state | NA |
| Sanan (1995)[18] | 1 y | Female | Persistent vomiting with a tender distended abdomen | Chronic subdural hematoma | 7 mo | Knotted collection of catheter in the right lower quadrant | Laparotomy | Primary end-to-end anastomosis performed, uneventful recovery | NA |
| Hlavin (1990)[14] | 3 y | Male | Progressive abdominal distension | Lumbar myelomeningocele | 3 y | Residual shunt tubing in a tight knotted coil | Celiotomy with a double-tube enterostomy | Uneventful recovery | 3 y |
| Grosfeld (1974)[13] | 10 mo | Male | Abdominal tenderness, distention, and bilious vomiting | Postmeningitic hydrocephalus | 8 mo | Small bowel volvulus | Catheter removal | Successful relief of obstruction | NA |
| Sakoda (1971)[17] | 5 wk | Male | Vomiting, bloody diarrhea, and distended abdomen | Lumbar myelomeningocele | 5 wk | Intestinal volvulus (adhesive band around the tube) | Laparotomy | A fresh catheter placed with proper function | NA |
| Esposito (1998)[12] | NA | NA | NA | Hydrocephalus | NA | Volvulus | Laparoscopic surgery | Adhesion severed and the catheter repositioned | NA |
| | NA | NA | NA | Hydrocephalus | NA | Catheter twisted around an intestinal loop | Laparoscopic surgery | Catheter removed | NA |
| Ameh (2000)[9] | 8 mo | NA | Vomiting and abdominal distention | NA | NA | Volvulus around a VP shunt tube | Laparotomy | Tube repositioned after untwisting the volvulus | NA |
| Bal (1999)[10] | 11 mo | Male | Fever, vomiting, and abdominal distension | Meningomyelocele | 11 mo | Intestinal volvulus | Laparotomy | A fresh VP shunt placed | 3 wk |
| Esposito (2003)[11] | NA | NA | NA | NA | NA | Mechanical intestinal occlusion due to the catheter that had twisted around an intestinal loop | Laparoscopic surgery | Catheter replaced, no intrasurgical or postsurgical complications | NA |
| Starreveld (1998)[19,*] | 1 wk | Female | Irritable and suffered episodes of bilious and subsequently feculent vomiting | Dandy–Walker syndrome | NA | Intestinal strangulation in a tight loop of the shunt catheter | Laparotomy and resection of a 10-cm loop of necrotic small bowel, with primary end-to-end anastomosis | VP shunt replaced | NA |
| Rahman-Ur-Naim (1996)[16] | 3 y | Male | Abdominal distension and pain in the periumbilical area | Progressive hydrocephalus | 2 mo | CSF collection due to misplacement of shunt | Laparotomy | Functioning peritoneal catheter reimplanted, rapid resolution of symptoms | NA |
| Murtagh (1980)[15] | 16 mo | Female | Acute abdomen | Extraventricular obstructive hydrocephalus | NA | Small bowel obstruction resulting from shunt tubing wrapped around loop of ileum | Laparotomy | NA | NA |

CSF = cerebrospinal fluid, NA = not available, VP = ventriculoperitoneal.
* Note: Only the case described by Starreveld et al[19] had necrotic bowel that required resection.

caused by bacterial translocation from the gut. CT scans were not informative, and unfortunately MRI was not performed as it has been reported that sepsis-induced leukoencephalopathy can be detected using MRI.[28] Unfortunately, the reason for the persistent vegetative state is unclear, but based on the available data, we believe the primary reason is ischemia due to septic shock.

Although complications of a VP shunt are common, abdominal complications, especially intestinal obstruction, are rare. All of the reports of intestinal obstruction related to a VP shunt included in this review were in pediatric patients, but it is worth noting that they also represent the majority of the case reports of this topic, suggesting such problem might be more likely to occur in pediatric patients. Causes of VP shunt-related intestinal obstruction varied, with volvulus being the most common cause, again likely related to the fact that volvulus is a relatively common problem in the pediatric population.[29] Mechanical obstruction due to twisting of the catheter was the second most common cause, and in some cases, obstruction occurred as a loop of the shunt catheter tightened around a bowel loop during removal.[18,19] Interestingly, there were only 3 cases in which obstruction was related to adhesions: 2 in this report and 1 other in which adhesions were related to a volvulus.[17] It is still worth noting that volvulus/bowel obstruction or elevated intra-abdominal pressure can result in the shunt's malfunction or strangulation, a situation that requires urgent externalization or revision to correct.

Regardless of the cause, management of bowel obstruction is the same. Conservative treatment consists of intravenous fluid and electrolyte replacement, along with placement of a nasogastric tube to decompress the stomach. Observation is warranted if a partial bowel obstruction is suspected in the absence of fever, leukocytosis, and localized abdominal pain. In the presence of complete obstruction with fever, pain, and no passage of flatus or stool, immediate surgical exploration is warranted. This is especially critical if a shunt is present as the catheter is a foreign body, and retaining a foreign body is against standard surgical principles of infection management. Furthermore, retrograde infection to the CNS is possible.[6] Laparoscopy has been shown to be useful for the diagnosis and management of shunt-related complications such as shunt catheter entanglement.[11,12] In the second case presented herein, initial surgical management rather than conservative treatment may have results in a different outcome. In addition, while ETV was not performed due to technical considerations, the procedure may have eliminated the need for the VP shunt, and again may have produced a different outcome.

Shunt infection must be confirmed by CSF Gram stain or culture. Once CSF infection is confirmed, it requires treatment with appropriate antibiotics and removal of the shunt hardware and insertion of an external ventricular catheter or Ommaya reservoir. The common practice is to use a new contralateral burr hole. A recently published study suggested that the use of the ventriculostomy site for VP shunt placement may not add morbidity (infection or need for revision) as compared with the use of a fresh contralateral site.[30] However, the study was performed in subarachnoid hemorrhage patients with an existing ventriculostomy and no specific data were reported for infected cases. It has been reported that the mean duration of externalization is about 2 weeks.[31] Once CSF sterility is achieved, a new shunt should be inserted and a VA shunt may be a good choice (case 2); a repeat VP shunt, however, can be placed in patients without extensive abdominal adhesions. It has been reported that secondary ETV instead of shunt revision is a treatment option when shunts fail in patients with obstructive hydrocephalus.[32,33] Based on our experience, if there is no CSF infection, the distal catheter should be pulled out of the abdominal wall and connected to an external collection bag for continuous external drainage. Once a patient becomes stable, the intestinal obstruction is relieved, and multiple CSF cultures remain negative, reinternalization is indicated. It has been reported that secondary

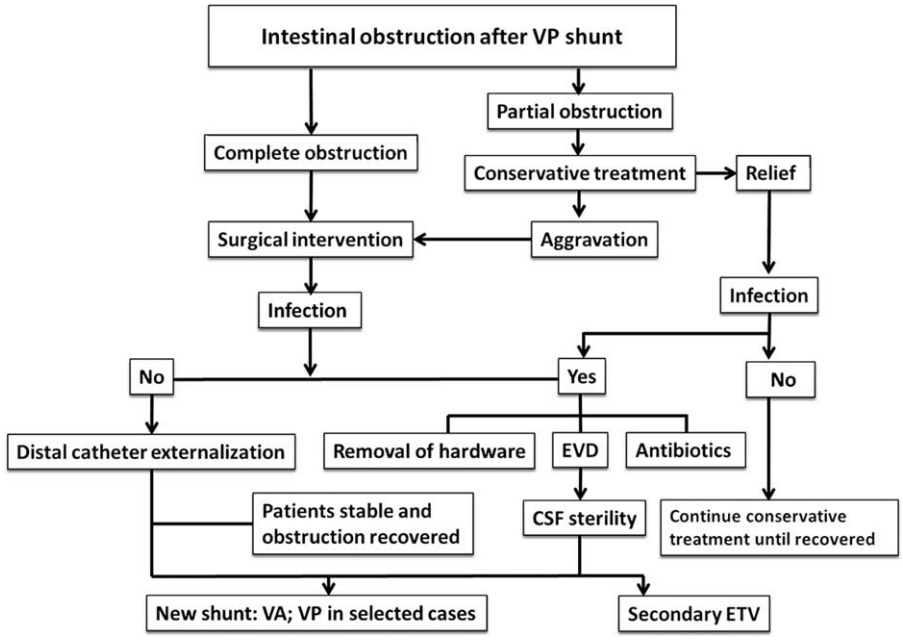


**FIGURE 4.** Treatment algorithm for patients with intestinal obstruction after ventriculoperitoneal (VP) shunt placement. CSF = cerebrospinal fluid, EVD = external ventricular drainage, ETV = endoscopic third ventriculostomy, VA = ventriculoatrial.

ETV instead of shunt revision can be attempted whether the CSF is infected or not.[32,33] A suggested algorithm for the treatment of intestinal obstruction after VP shunt placement is presented in Figure 4.

Of note, according to the Chang Staging System for Metastasis, both patients treated at our hospital were $M_0$; there was no evidence of gross subarachnoid or hematogenous metastasis.[34] Moreover, no abdominal metastases were noted during the laparotomy. Based on these findings, we can exclude the relationship between the tumor cells in the CSF and the intestinal obstruction. However, an important potential VP shunt complication (in addition to infection, obstruction, misplacement, etc.) reported in pediatric patients with the 2 types of brain tumors in the cases at our hospital is metastasis via the VP shunt to peritoneal region. There have been case reports showing that metastasis can occur via the shunt. For example, Boyd et al[35] reported the case of a 23-month-old male patient with a supratentorial primitive neuroectodermal tumor who developed metastasis to the abdomen via the VP shunt. Han et al[36] reported the case of a 9-year-old female patient with an atypical teratoid/rhabdoid tumor of the third ventricle who developed peritoneal metastasis after shunt placement. Ingold et al[37] also reported a rare case of an adult female patient with abdominal seeding of an atypical teratoid/rhabdoid tumor of the pineal gland along a VP shunt catheter. On the contrary, Berger et al[38] reviewed the record of 415 pediatric patients with benign or malignant brain tumors of whom 152 had shunt placement, and concluded that a shunt, regardless of the type, location, revision rate, or filter insertion, did not seem to predispose those patients to extraneural metastasis.

In conclusion, intestinal obstruction is a rare complication of a VP shunt. Based on our cases and the literature review, volvulus, twisting of the catheter, and adhesions appear to be the most common causes of intestinal obstruction. More studies and cases, however, are needed to confirm this observation. Although intestinal obstruction is a rare complication of a VP shunt, it should be considered in the presence of abdominal symptoms as it can lead to serious consequences and prompt treatment should be given.

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