Extrinsic Compression of the Gastric Wall by a Ventriculoperitoneal Shunt Catheter: Case Report and Literature Review*

Compressão extrínseca de parede gástrica por cateter de derivação ventriculoperitoneal: Relato de caso e revisão de literatura

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Abstract

Introduction Ventriculoperitoneal (VP) shunt is commonly used in the treatment of hydrocephalus and may present complications in up to 30% of patients. The present report addresses an uncommon complication in the abdominal cavity, in which the catheter caused extrinsic compression of the gastric wall.

Case report A 30-year-old man presented a decreased level of consciousness, associated with severe headache and vomiting. He had a history of congenital neurotoxoplasmosis and VP shunt insertion at 7 years of age. Imaging exams demonstrated the formation of an encapsulated retrogastric pseudocyst and extrinsic compression of the gastric wall by a VP shunt catheter. Through videolaparoscopy, decompression of the gastric wall and removal of the pseudocyst were performed, with the reestablishment of the drainage of cerebrospinal fluid. An analysis of the distal fragment of the removed catheter revealed obstruction by fibrotic material. The patient was discharged with a reestablished baseline after four days of hospitalization.

Comments The literature shows that ~ 47% of the complications presented by patients are related to the distal end of the catheter, and 8.2% of these come from

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- hydrocephalus
- ventriculoperitoneal shunt
- complications
- extrinsic compression
- gastric wall

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migration to the abdominal cavity. However, there is an extreme paucity of studies that demonstrate extrinsic compression of the gastric wall by a VP shunt catheter. Therefore, we suggest that further studies on complications involving the VP shunt be performed to improve diagnostic and therapeutic results, in addition to complementing the literature on this complication.

Resumo

Introdução A derivação ventriculoperitoneal (DVP) é comumente empregada no tratamento da hidrocefalia, e pode apresentar complicações em até 30% dos pacientes. Este relato aborda uma complicação incomum na cavidade abdominal, em que o cateter promoveu compressão extrínseca da parede gástrica.

Relato de caso Um homem de 30 anos apresentou rebaixamento do nível de consciência associado a cefaleia de forte intensidade e vômitos. O paciente tinha histórico de neurotoxoplasmose congênita e inserção de DVP aos 7 anos. Os exames de imagem demonstraram formação de pseudocisto encapsulado retrogástrico e compressão extrínseca de parede gástrica por cateter de DVP. Por meio de videolaparoscopia, foram realizadas a descompressão da parede gástrica e a remoção do pseudocisto, com o restabelecimento da drenagem de líquido cefalorraquidiano. Uma análise do fragmento distal do cateter removido revelou obstrução por material fibrótico. O paciente recebeu alta com quadro basal reestabelecido após quatro dias de internação.

Comentários A literatura mostra que ∼ 47% das complicações apresentadas pelos pacientes relacionam-se com a extremidade distal do cateter, sendo que 8,2% destas são oriundas de migração para a cavidade abdominal. Entretanto, há extrema escassez de estudos que demonstrem a compressão extrínseca da parede gástrica por cateter de DVP. Portanto, sugerimos que novos estudos envolvendo complicações de DVP sejam realizados, a fim de melhorar os resultados diagnósticos e terapêuticos, além de complementar a literatura acerca dessa complicação.

Palavras-chave
- hidrocefalia
- derivação ventriculoperitoneal
- complicações
- compressão extrínseca
- parede gástrica

Introduction

Hydrocephalus is a condition in which there is an accumulation of cerebrospinal fluid (CSF) in the cranial cavity, whose pathophysiology is disorders related to its production, circulation or reabsorption, which enables its classification into obstructive and non-obstructive.[1,2] The understanding of the mechanisms that lead to this condition has been sought since the time of great scholars, such as Hippocrates, Galen and medieval Arab doctors.[3] Thus, the understanding of these processes enabled the development of procedures that would reduce the excess of CSF in the cranial box, such as the insertion of catheters inside the cerebral ventricular system.[2–4] This technique is called ventricular bypass, and its principle is the drainage of excess CSF from the skull to places such as the peritoneal cavity, the pleural space, or the atrium.[2,4,5] The peritoneal cavity, however, is the most common drainage site, and the procedure is called ventriculoperitoneal (VP) shunt.[1–5] Nevertheless, complications are observed in the long term in some of these surgeries, and the most frequent are obstructions of the VP shunt catheter, formation of pseudocysts in the abdominal cavity, intestinal perforations, migration of the distal extremity, torsions, catheter breakage, infections, or even subdural hematoma.[2–5]

The literature estimates that approximately 30% of patients undergoing this treatment will experience procedural failure, with patients free from other complications being restricted to 15% over 10 years. In addition, it is estimated that around 8,17% of patients will experience migration of the catheter to the abdominal wall, with extrinsic compression by the catheter into an abdominal organ being less frequent.[5,6] In this scenario, the present report addresses an unusual form of complication of the VP shunt in the abdominal cavity, in which the distal catheter remained tied around the stomach due to migration, with the respective extrinsic compression of this organ.

Case Report

A 30-year-old man weighing ∼ 70 kg was admitted to the emergency department with a lowered level of consciousness, associated with severe headache and vomiting. He had a history of cognitive sequelae caused by congenital neurotoxoplasmosis, and prior hospitalization at the age of 7 years for acute hydrocephalus, which was then treated with a VP shunt. The neurological examination yielded a score of 10 on the Glasgow Coma Scale (eye opening: 3; verbal response: 2; motor response: 5), in addition to showing severe

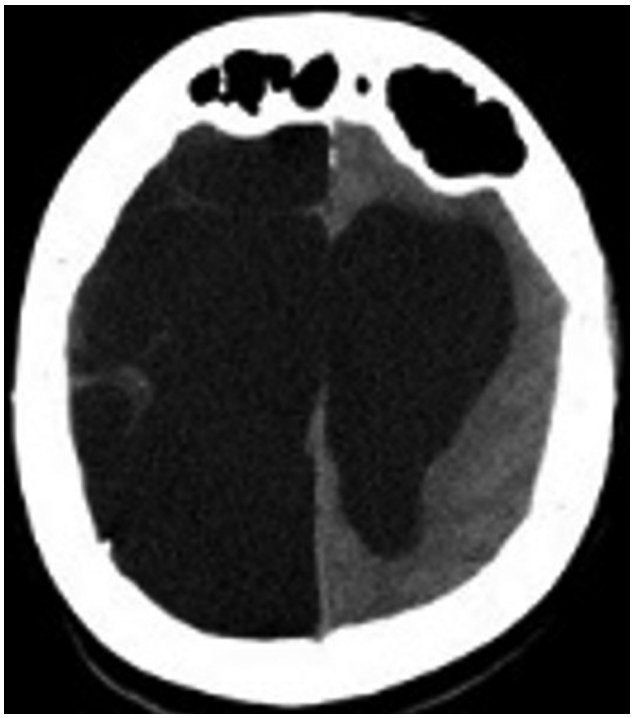

Fig. 1 Cranial computed tomography (CT) showing supratentorial ventriculomegaly

neurotoxoplasmosis sequelae, with atrophy of the lower limbs. The examination maneuver of the VP shunt device revealed normal functionality proximal to the valve. A computed tomography (CT) scan of the skull was then performed, which revealed an important cerebral malformation, with areas of encephalomalacia in the right hemisphere, in addition to supratentorial ventriculomegaly (►**Fig. 1**).

The patient underwent lumbar puncture, and the analysis of the CSF showed normal biochemistry and negative culture for bacteria. During hospitalization, an ultrasound (US) of the abdomen showed the formation of a peritoneal pseudocyst encapsulated in the left flank, which might be associated with the distal end of the VP shunt catheter. The follow-up of the case was performed with investigation by means of radiography (XR), which suggested invasion of a distal catheter into the stomach (►**Fig. 2**). An abdominal CT scan showed proximity of the catheter to the gastric walls (►**Fig. 3**), while the complementary report of the upper digestive endoscopy concluded that the catheter had caused bulging of the gastric wall, as it surrounded part of this organ with the respective extrinsic compression.

After the diagnosis of extrinsic compression, the patient was submitted to videolaparoscopy for drainage of the retrogastric cyst and distal section of the obstruction point of the VP shunt catheter. During the surgical procedure, in addition to multiple adhesions, with the mesocolon adhered to the abdominal wall, we found that the obstructed VP shunt catheter was compressing the gastric wall. With the section $\sim$ 2 cm proximal to the point of obstruction, spontaneous drainage of the CSF was evidenced. The fragment of the VP shunt catheter (►**Fig. 4**) was submitted to an anatomopathological examination, and the analysis of the specimen that

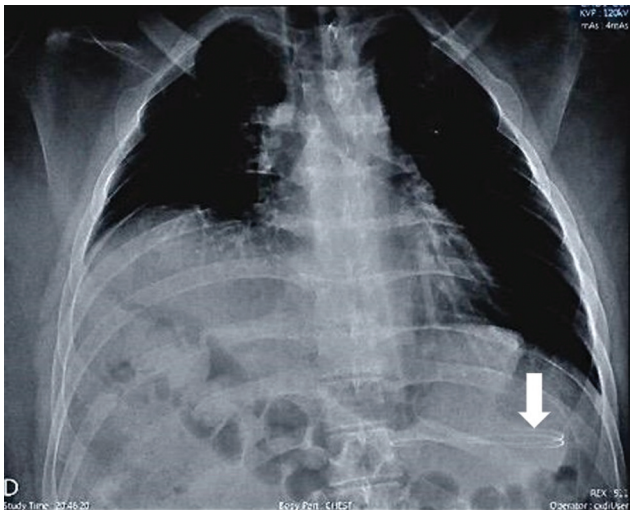

Fig. 2 Chest X-ray showing a ventriculoperitoneal (VP) shunt catheter in the gastric region

obstructed it revealed that it was composed of fibroadipose tissue, with a moderate chronic inflammatory process.

Postoperative control examinations confirmed a reduction in ventricular volume and correct positioning of the VP shunt catheter, which enabled us to discharge the patient from the hospital with a reestablished baseline after four days of hospitalization.

Discussion

The first description of the VP shunt was made by Kaush in 1908.[2] Since then, this has been the procedure most commonly performed by neurosurgeons for the treatment of hydrocephalus.[1,2] The technique basically consists in connecting the catheter proximal to a VP shunt valve, while the distal catheter is connected to the distal end of the same valve, and is then tunneled through the subcutaneous tissue until it is inserted into the peritoneal cavity.[2,3] With the dissemination of this technique, catheters made from silicone emerged in the 1990, a material that proved to be a predisposing factor to allergic reactions, which would

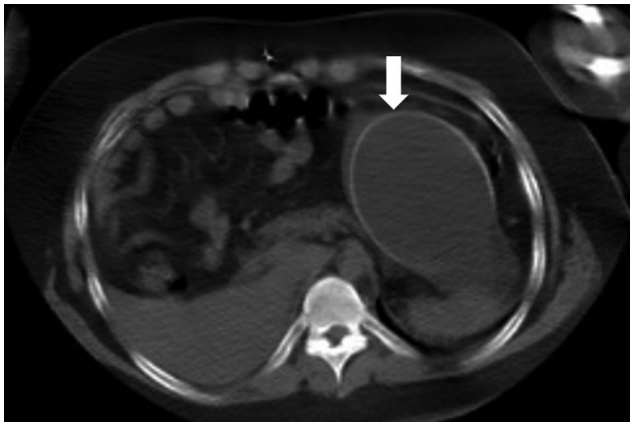

Fig. 3 Abdominal CT showing the distal end of the VP shunt catheter in contact with the stomach walls

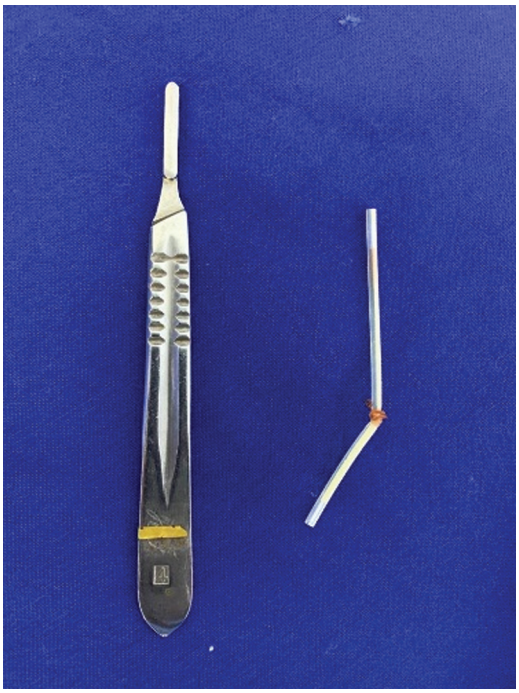

Fig. 4 Fragment of a VP shunt catheter with the fibrotic material that obstructed it

culminate in chronic inflammatory processes around it, with the formation of fibrosis.[1,5,6] Thus, based on the scenario in which distal-end malfunction corresponds to 47% of VP shunt complications, it would be possible to obtain a plausible explanation for the development of obstruction of the distal catheter, which represents up to 15.3% of the total of complications.[6] In addition, other postoperative complications, such as infection, cerebrospinal pseudocyst, perforations of abdominal organs and migration of distal catheter to the abdominal cavity, mediastinum or heart are also described.[1,3,4,6]

The present is a report of a complication not often described in the literature, considering that studies[5,6] indicate that, in the event of migration, the catheter is restricted in up to 8.2% to the abdominal wall, with an association with the stomach being infrequent. However, when in contact with this organ, there is a higher incidence of gastric perforation, with protrusion of the catheter into the lumen of the organ, which often does not generate significant clinical changes.[3–6] Cohen-Addad et al.[3] suggest what would be the pathophysiological mechanism related to this finding, which is based on the interaction of the catheter with the organ wall, either at the time of insertion or later, which leads to local inflammation, tissue changes, and fibrosis, which may generate organ adhesion or even delayed perforation.[3,5,6] However, perforation was not observed in the case herein reported, but extrinsic compression of the stomach by a VP shunt catheter was observed.

In their retrospective review, Abode-Iyamah et al.[2] evaluated the risks of developing VP-shunt complications regarding different age groups and catheter insertion techniques, and they also made a subsequent postinsertion analysis of the VP shunt. As a technique, the conventional insertion in the peritoneal cavity was established.[3,5] Imaging exams were used to verify the correct positioning of the catheter in the peritoneum throughout the years, which made it possible to establish that the incidence of complications increased with advancing age.[2–4] In the present study, we inferred that age and, consequently, the patient's growth was shown to be a predisposing factor for catheter migration. Alonso-Vanegas et al.[4] reported that the patient's position, postprandial gastric distension, and diaphragm movements are other risk factors for chronic irritation in the region of contact with the stomach, which could lead to perforation.[4,5] In the case herein reported, intraoperatively, it was possible to visualize areas of chronic inflammation and the respective fibrosis around the catheter, as was found in most studies[2–8] in which there was perforation of abdominal organs; however, no perforation of the gastric wall was evidenced through the VP shunt catheter. Moreover, in other studies,[5–7] CSF culture revealed infection by *Staphylococcus capitis* and *Enterobacter cloacae*, which was linked to distal catheter migration in the stomach. In the present report, however, no positive cultures for any microorganisms were found in the respective analysis.

The diagnosis of these complications can be made through US, XR, CT, or even with the study of radioisotope elements by fluoroscopy; however, the CT and XR are the most requested exams by the services.[5–7,9] Another study[3] suggests that upper digestive endoscopy can also help in the diagnosis and treatment, which is useful in cases of gastric perforation without peritoneal irritation. Therefore, to study the cause of obstruction in the case herein reported, we used US, XR and CT. The CT allowed us to assess the relationship of the catheter with the gastric walls, for correct surgical management, while the US helped us detect the pseudocyst in the gastric wall. The RX, however, was not sufficiently accurate to differentiate the possible perforation from the involvement of the catheter in the abdominal wall.

As for the treatment, the literature[9,10] shows a different kinds of management for each type of complication. The procedures of choice include infection control with antibiotics, section of the point of obstruction, external proximal drainage, repositioning of the catheter, and a new procedure to remove the current catheter and insert another VP shunt on the contralateral side.[3,8–11] Therefore, the treatment chosen for our patient was the removal of the obstructed part of the catheter, without the need to insert a new VP shunt. However, the access route for catheter removal was not through exploratory laparotomy, as usual, but through videolaparoscopy, given that no signs of peritoneal irritation were found.[1–11] Furthermore, the advent of the minimally-invasive technique enabled the treatment of this complication without significantly increasing the patient's morbidity and mortality rates, in addition to ensuring a shorter hospital stay. The anatomopathological analysis in the postoperative period was suggestive of fibrosis around the catheter, which led to obstruction of the CSF drainage, while promoting extrinsic compression of the gastric wall. Thus, as in other studies,[1,3,6,10,11] fibrosis around the VP shunt catheter

proved to be a plausible explanation for the finding of drainage obstruction in our patient.

Therefore, when analyzing the conditions related to complications, diagnosis and treatment found in the literature, we inferred that some of these characteristics had some degree of similarity in relation to those of our patient. Millward et al.[1] described the case of a foreign body granuloma around the valve and the VP shunt catheter in a patient who underwent multiple VP shunt replacements, with the CSF presenting eosinophilia. Furthermore, the correlation between perforation of the gastric wall and the formation of fibrosis around the VP shunt catheter has also been observed and reported by Alonso-Vanegas et al.,[4] Masuoka et al.[5] and Cheng et al.[7] Moreover, there are reports of the incidental finding of a VP shunt catheter in the gastric fundus in an asymptomatic patient, migration of the VP shunt catheter to the mediastinum, and spontaneous knot formation at the distal end of the VP shunt catheter, which were published by Cohen-Addad et al.,[3] Fukamachi et al.[8] and Borcek et al.[6] respectively. In addition, Fukamachi et al.[8] also described two other cases of complications associated with the VP shunt catheter: extrusion of a VP shunt catheter through a healed abdominal incision, and migration of a subdural catheter to the brain parenchyma. ►**Table 1** summarizes the main characteristics of the aforementioned cases of VP shunt complications.

We included in ►**Table 1** other studies, which are not specifically case reports, but which contribute to the understanding of the risk factors and diagnosis of the complications. Thus, Abode-Iyamah et al.[2] observed that obesity and the number of previous procedures are closely associated with complications involving the distal end of the VP shunt catheter. In addition, Ezzat et al.[11] identified other risk factors for the development of these complications, such as peristaltic activity, shunt characteristics, and insertion technique, while Grosfeld et al.[10] and Goeser et al.[9] pointed out that the high rate of suspicion, followed by the early treatment of these complications, reduces the risks to the patient. In our case, fibrosis around the catheter, the diagnostic and therapeutic methods were similar to the data found in the literature, with extrinsic compression of the gastric wall without its perforation by the VP shunt catheter, the unique characteristic of the case herein reported.

Thus, we suggest that further studies on the prognosis and recurrence of migration of the VP shunt catheter are needed to improve the therapeutic results and complement the literature on this subject.

Table 1 Summary with the main findings of the literature review

Author (year)	Patients	Findings	Treatment	Results
Millward et al.[1] (2013)	Male/14 years old	Foreign body granuloma around the valve and VP shunt catheter in a patient with multiple changes of VP shunt and CSF with eosinophilia.	Removal of the VP shunt catheter and insertion of a hypoallergenic catheter.	The patient was asymptomatic after the intervention.
Abode-Iyamah et al.[2] (2016)	137 patients, with a mean age of 57.7 years	Retrospective study evaluating the risk factors involved in VP shunt complications.	Identification of the occurrence of migration of the distal end of the VP shunt catheter in 16 patients.	It was observed that obesity and the number of previous VP shunt procedures were associated with the occurrence of complications with the distal end of the catheter.
Cohen-Addad et al.[3] (2018)	Male/72 years old	Incidental finding of a VP shunt catheter in the gastric fundus during percutaneous endoscopic gastrostomy.	No surgical treatment was performed to change the VP shunt.	The baseline was restored after the intervention.
Alonso-Vanegas et al.[4] (1994)	Female/4 months old	Gastric perforation and fibrosis around the VP shunt catheter, associated with signs and symptoms of intracranial hypertension.	Removal of the fibrosis, suture of the stomach, removal of the VP shunt, and replacement by the left ventricle-atrial system.	The patient was asymptomatic after the intervention.
Masuoka et al.[5] (2005)	Male/47 years old	Gastric perforation and fibrosis around the VP shunt catheter.	Extraction of the VP shunt catheter through a scalp incision.	The patient was asymptomatic after the intervention.

(*Continued*)

Table 1 (*Continued*)

Author (year)	Patients	Findings	Treatment	Results
Borcek et al.[6] (2012)	Male/5 years old	Spontaneous knot formation at the distal end of the VP shunt catheter in a patient with signs and symptoms of intracranial hypertension.	Node clearance and revision of the derivation system.	The baseline was restored after the intervention.
Cheng et al.[7] (2007)	Male/87 years old	Gastric perforation and fibrosis around the VP shunt catheter in a patient with upper gastrointestinal bleeding due to associated gastric ulceration.	Removal of the fibrosis stitch and suturing of the gastric wall through laparotomy.	The patient was asymptomatic after the intervention.
Fukamachi et al.[8] (1982)	Female/7 months old	Migration of the VP shunt catheter to the mediastinum on two occasions.	Removal of the VP shunt catheter from the chest and fixation of the distal end to the peritoneum and abdominal fascia through laparotomy.	The patient was asymptomatic after the intervention.
	Male/49 years old	Extrusion of the VP shunt catheter through the healed abdominal incision.	Fixation of the VP shunt catheter to the peritoneum and reinforcement of the sutures in the muscle layers.	The baseline was restored after the intervention.
	Male/1 year old	Migration of the subdural catheter to the brain parenchyma after a subdural-peritoneal shunt procedure to treat hygroma after traumatic subdural hematoma.	Complete shunt removal.	Progressive improvement was observed during the follow-up.
Goeser et al.[9] (1998)	Pediatric patients with VP shunt catheter.	Correlation between imaging exams with signs and symptoms of acute hydrocephalus.	Use of imaging exams for the early diagnosis of the complications associated with the VP shunt and to guide the treatment.	The early identification, through imaging exams, of VP shunt complications is essential to guide the treatment and minimize the risks to the patient.
Grosfeld et al.[10] (1974)	185 pediatric patients with VP shunt catheter.	Retrospective study with 45 cases presenting intra-abdominal complications associated with the distal end of the VP shunt.	Treatment of the intra-abdominal complications, followed by serial follow-up of the patients.	The high level of suspicion for complications and postoperative follow-up is essential for these conditions to be identified and treated early.
Ezzat et al.[11] (2018)	1,092 patients, under the age of 12 years	Retrospective study with complications involving the distal end of the VP shunt catheter in 15 patients with a mean age of 1,5 years.	Early treatment of the complications and postoperative follow-up and identification of the risk factors for these conditions.	Peristaltic activity, shunt characteristics and the technique for the insertion of the catheter were the main risk factors for these complications.
Present case report	Male/30 years old	Extrinsic compression of the gastric wall.	Decompression of the gastric wall, removal of the pseudocyst, and sectioning of the distal end through videolaparoscopy.	Restoration of the basal state.

Abbreviations: CSF, cerebrospinal fluid; VP, ventriculoperitoneal.

Conclusion

Extrinsic compression of the gastric wall by a VP shunt is rare and requires a high index of suspicion to establish the diagnosis. The treatment includes changing the VP shunt, or sectioning in cases of associated obstruction, preferably in specialized centers and with an experienced multidisciplinary team.

Ethics Statement

The present study complied with all institutional guidelines for research in human beings. Informed consent was obtained from the person responsible for the patient.

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Conflict of Interests

The authors have no conflict of interests to declare.

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