Research Article / Araştırma Makalesi

Abdominal Complications After Ventriculoperitoneal Shunt placement in Pediatric Patients with Hydrocephalus

Hidrosefalili Çocuklarda Ventrikülöperitoneal Şant Yerleştirilmesi Sonrası Abdominal Komplikasyonlar

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Abstract

Background: The insertion of a ventriculoperitoneal shunt is a necessary neurosurgical procedure to treat hydrocephalus. However, the placement of shunts can be associated with rare but significant postoperative abdominal complications, which can subsequently lead to a range of problems.
Materials and Methods: In this study, we reviewed case histories of patients with abdominal complications who previously underwent ventriculoperitoneal shunt insertion for hydrocephalus between 2008 and 2023 at single - institution. Complications related to the abdomen were analysed.
Results: During the 15-years observation period, a total 475 patients had a ventriculoperitoneal shunt placement. 101 (21,19%) patients with abdominal complications after ventriculoperitoneal shunt insertion were examined. Twelve patients (2,52%) who had shunt insertion out of peritoneal cavity and 245 (70,81%) patients with non- abdomen related complications were excluded from the study.
Ninety seven patients (96,04%) required shunt revisions. Obstruction of abdominal end of the ventriculoperitoneal shunt occurred in 63 (62,38%) patients, cerebrospinal fluid pseudocyst of peritoneal cavity occurred in 27 (26,73%) patients. Twenty three patients (22,77%) had a large size of the pseudocyst with a cerebrospinal fluid volume more than 300 mL. Four patients (3,96%) had a pseudocyst with a cerebrospinal fluid volume less than 300 mL.
Four patients (3,96%) had a medical conservative treatment. Risk factors for abdominal cerebrospinal fluid pseudocyst complications were intestinal adhesion and peritoneal thickness, for mechanical dysfunction of ventriculoperitoneal shunt were obstructions of the distal end by fat tissues and for extrusions were long distal end of the shunt. The rates of other rare complications such a spontaneous extrusion of the peritoneal catheter through the anus, urethra, inguinal canal and migration through the abdominal wall were < 1 (0,22%).
Conclusions: All patients who will have treatment with ventriculoperitoneal shunts should be informed about the potential abdominal complications. If there is any suspicion to abdomen related complications after ventriculoperitoneal shunt surgery all patients should be verified through imaging, followed by appropriate treatment. Although these complications are rare, unrecognized and untreated cases can be fatal.

Keywords: Abdominal pseudocyst, Hydrocephalus, Ventriculoperitoneal shunt, Small-bowel obstruction

Öz

Amaç: Hidrosefali tedavisinde ventrikülöperitoneal şant takılması gerekli bir nöroşirürjik işlemdir. Ancak şant yerleştirilmesi sonrası postoperatif abdominal komplikasyonlar gelişebilir ve bu da önemli problemlere yol açabilir.
Materyal ve Metod: Bu çalışmada, 2008-2023 yıllar arasında tek merkezde hidrosefali nedeniyle ventrikülöperitoneal şant takılan hastaların, şantlarla ilgili abdominal komplikasyonlarını retrospektif olarak inceledik.
Bulgular: On beş yılda toplam 475 hastaya ventrikülöperitoneal şant takılmıştır. Ventrikülöperitoneal şant takılması sonrası 101 (%21,19) hasta da abdomen ile alakalı komplikasyonlar gelişmiştir. On iki (%2,52) hastaya şantlar periton dışı takılmıştı ve 245 (%70,81) hastanın şant sonrası gelişmiş komplikasyonları karın boşluğu ile alakalı değildi. Bu hastalar çalışmaya dahil edilmedi.
Doksan yedi (%96,04) hastada şant revizyonuna ihtiyaç duyuldu, Altmış üç (%62,38) hastada ventrikülöperitoneal şantın abdominal ucunda obstrüksiyon, yirmi yedi (%26,73) hastada periton boşluğunda beyin omurilik sıvısı psödokisti gelişmişti. Hastaların yirmi üçünde (%22,77) beyin omurilik sıvısı hacmi 300 mL'den fazlaydı ve dört (%3,96) hastada beyin omurilik sıvısı hacmi 300 mL'den daha azdı. İntestinal yapışıklık ve peritoneal kalınlık bulunması karın serebrospinal sıvı psödokist komplikasyonları için risk faktörlerin arasındaydı, ventrikülöperitoneal şantın mekanik disfonksiyonu için risk faktorler ise distal ucun yağ dokuları tarafından tıkanması veya şantın uzun distal ucuydu. Peritoneal kateterin anüs, üretra, inguinal kanaldan kendiliğinden ekstrüzyonu gibi diğer nadir komplikasyonların görülme oranları < 1 (%0,22) idi.
Sonuç: Ventrikülöperitoneal şant tedavisi görecek tüm hastalar olası abdominal komplikasyonlar hakkında bilgilendirilmelidir. Ventrikülöperitoneal şant ameliyatından sonra karınla ilgili komplikasyonlara dair herhangi bir şüphe varsa görüntüleme yoluyla doğrulanmalı ve ardından uygun tedavi uygulanmalıdır. Bu komplikasyonlar nadir olsa da, tanınmayan ve tedavi edilmeyen vakalarda ölümcül olabilir.

Anahtar Kelimeler: Abdominal psödokisti, Hidrosefali, Ventrikuloperitoneal şant, İntestinal obstrüksyon

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Introduction

Increasing cerebrospinal fluid (CSF) in the brain cavities increases intracranial pressure causing hydrocephalus. This condition may be primary as a congenital hydrocephalus due to brain malformation or spinal dysraphism. Secondary hydrocephalus occurs from post-inflammatory conditions, haemorrhages or brain injuries, leading to an imbalance in the production and absorption of cerebrospinal fluid. Brain tumours can block the circulation pathways of CSF at any location, leading to an increase in intracranial pressure. Ventriculoperitoneal shunt (VPS) surgery involves draining CSF from the ventricles into the intraperitoneal cavity, allowing its absorption. VPS placement steel is commonly used for the treatment of this condition, but shunt placement sometimes may cause various abdomen related problems such as shunt migration, extrusion, disconnection, infection, blockage, excessive drainage or abdominal pseudocyst as a result of intraperitoneal CSF accumulation (1-8).

In this manuscript, we present our experience with rare abdomen related complications of VPS such as abdominal pseudocyst, intestinal strangulation with distal end of VPS catheter, extrusion and disconnection, and our management of patients with these complications.

Materials and Methods

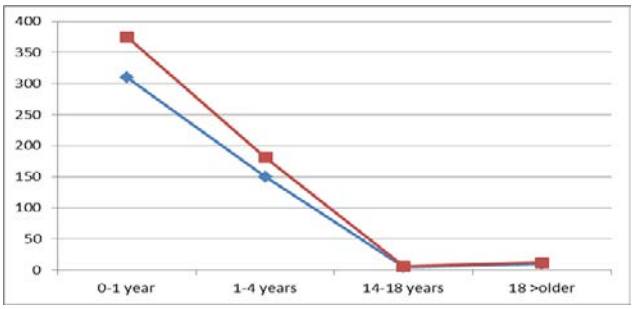
This is a retrospective a single-institution study in patients with hydrocephalus after VPS surgery with abdominal and bowel related complications between 2008 and 2023 at Harran University Hospital. The study was conducted at the departments of neurosurgery and paediatric surgery. Records of all the patients who had VPS insertion and revisions for VPS complications were reviewed. Written informed consent for publication of their details was obtained from the parents of the patients. Complications were categorized into two groups: abdominal and non-abdominal. Cases that were not associated with abdominal complications and where the distal end of the VPS was inserted outside the peritoneal cavity were excluded from this study.

The variables data were: age, sex, demographic details, aetiology of hydrocephalus and indication for VPS, clinical presentation for revisions surgery and outcome. All cases had computed tomography scan (CT) or abdominal shunt X-ray, laboratory tests at admission. We categorized the pseudocyst cases based on cerebrospinal fluid collection volumes more than 300 mL as a large, and cyst sizes of less than 300 mL were classified as a small after puncture. Those patients who had a VPS dysfunction, acute hydrocephalus symptoms and abdominal complaints underwent shunt revision surgery. Four patients without VPS dysfunction and acute hydrocephalus symptoms had a conservative medical treatment. The data was analysed using the statistical program IBM SPSS version 20.

Results

During the 2008 to 2023 surveillance period, a total of 475 patients were treated surgically for hydrocephalus. Indications for VPS placement were: 1) congenital hydrocephalus (CH) 419 (88,21%), 2) secondary hydrocephalus after intracerebral haemorrhage, atrophy of the brain parenchyma or non-communicant / obstructive hydrocephalus as a result of previous meningitis, surgery or tumour 56 (11,79%).

The distribution between the sex of the patients was approximately equal: boys 237 (49,89%) and girls 238 (50,11%). During the above period the majority of patients had a shunt placement procedure at age 0-1 years old 310 (65,26%), 150 (31,58%) at age 1-14 years old and 15 (3,16%) patients at age 15 or older. Figure 1 shows a distribution between the age groups of the patients who had VPS insertion.



Fugure 1. The distribution between different age groups: red line represents the number of female patients and blue line indicates the number of male patients.

Table1. A summary of the inclusion and exclusion criteria of the patients in this study.

Records between 2008-2023 screened total *n* = 475	
Congenital hydrocephalus *n* = 419 (88,21%)	
Secondary hydrocephalus *n* = 56 (11,79%)	
Patients included in the study	**Patients excluded from the study**
Intraperitoneal *n* = 463 (97, 48%)	Intrapleural *n* = 5 (1,05%) Intraatrial *n* = 6 (1,26%) Intravesical *n* = 1 (0,21%)
Abdomen related complications *n* = 101 (21,19%)	Non-abdominal complications *n* = 245 (70,81%)

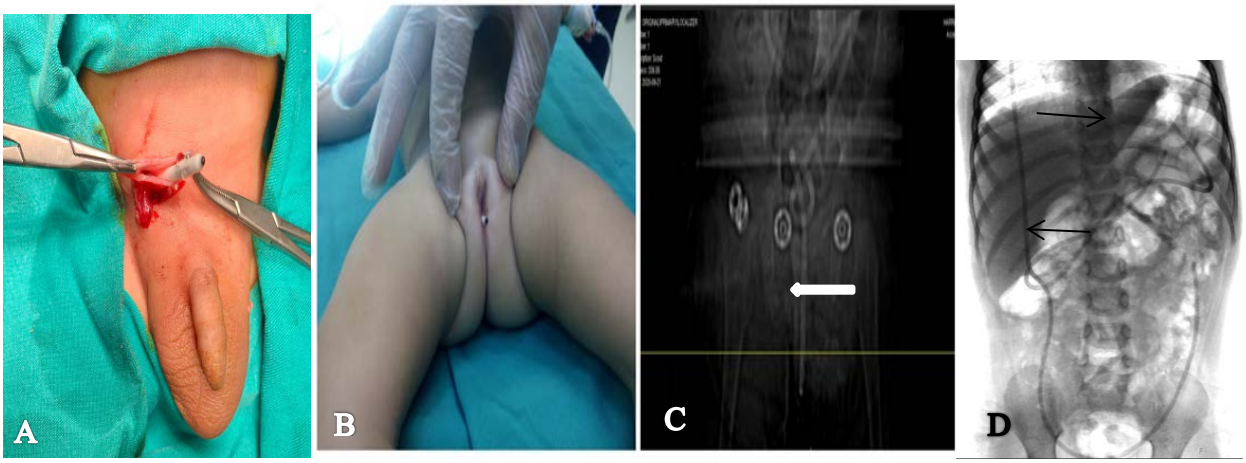


Figure 2. A-spontaneous extrusion of the distal end of the VPS through the inguinal canal, B- uretra, C- X-ray shows that the distal end (white arrow) has passed through the abdominal wall into the bladder, formed a knot, and protruded outward through the urethra, D- complete detachment of the distal end of the VPS within the peritoneal cavity (black arrow).

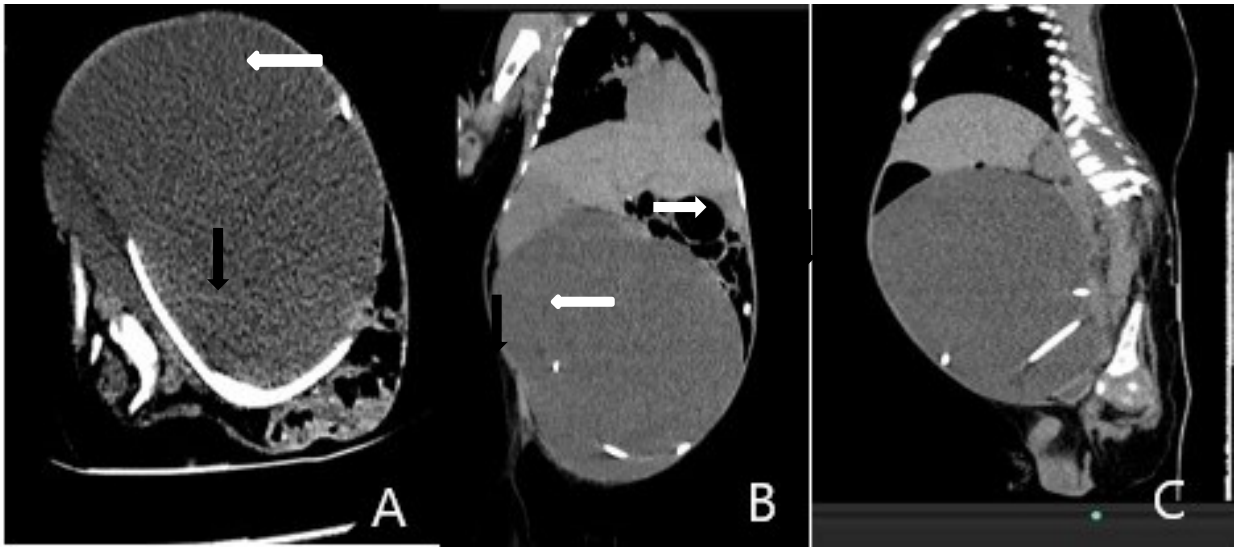


Figure 3. A-Axial, B-frontal and C-sagittal views of a large peritoneal pseudocyst (white arrow) and one of the silicone catheter of VPS was located inside the peritoneal pseudocyst (black arrow).

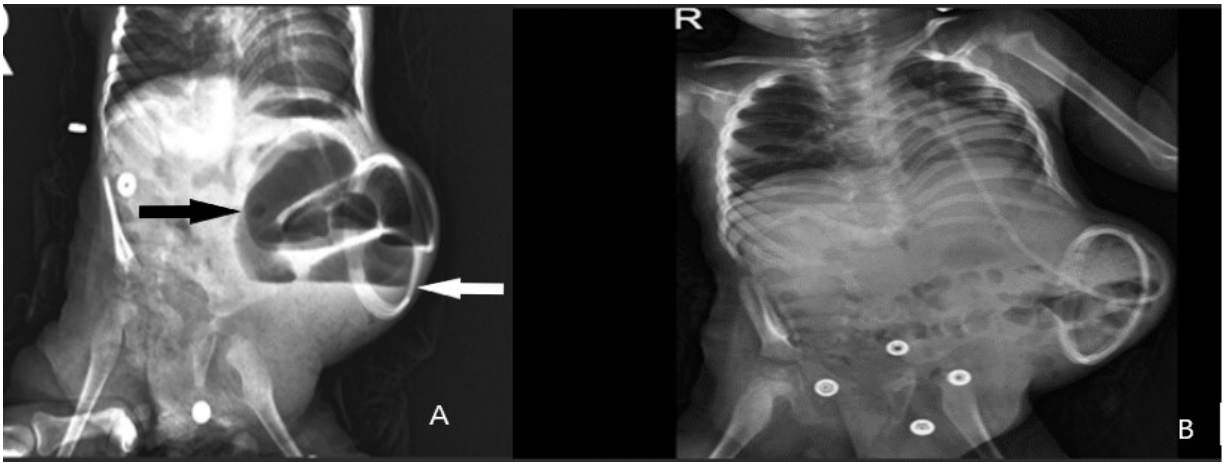


Figure 4. A- Direct abdominal radiography before treatment: mechanical obstruction of small bowel from distal peritoneal catheter (white arrow) wrapped around the loop of ileum. Abdominal distention, intestine dilatation, air-liquid levels (black arrow). B- Direct abdominal radiography after conservative treatment, obstruction was resolved.

Complications related to postoperative VPS insertion were experienced by 346 (100%) patients during the follow-up period. Twelve patients with a history of abdominal issues, were excluded from this study as they had undergone a procedure where the distal end of a VPS was inserted outside the peritoneal cavity. Two hundred forty five (70,81%) of the cases had non-abdominal issues such as a shunt infection or VPS dysfunction as a result of cranial end of VPS catheter or valve blockages. These patients were also excluded from this study, because we would like discuss only abdominal related complications in this article and these were presented in table 1.

Complications relating to the abdominal cavity were observed in 101 (21,19%) of patients. The complaints were evident within the 5-6 months after the VPS placement. The patients at admission had some various complaints such a sliding in the eyes, inability to feed, increased head circumference, nausea and vomiting, abdominal pain, absolute constipation and distention for 1 week. Clinical characteristics of complaints at admission of abdominal complications of VPS are detailed in table 2.

Table 2. Clinical characteristics of complaints of abdominal complications after VPS placement.

Complaints	*n*	Frequency
Sliding in the eyes	44	43,56
Inability to feed	95	93,07
Increased head circumference	28	27,72
Nausea and vomiting	96	95,05
Abdominal pain	37	36,63
Constipation	33	32,67
Distention	32	31,68

In the physical examination, all patients were conscious. The most of the patients had nausea with vomiting 96 (95,05%) followed by inability to feed 95 (93,07%). About half of patients with symptoms of intracranial hypertension (IHT) had a sliding in the eyes 44 (43,56%) and patients under 1 year of age were macrocephalic 28 (27,72%). Patients with bowel related complications such an abdominal CSF pseudocyst or volvulus had a big abdomens and intestinal sounds were not heard. The main presented symptoms with these patients were abdominal pain 37 (36,63%), constipation 33 (32,67%) and distention 32 (31,68%).

Approximate two-thirds of the patients with complications related to the abdominal cavity had an obstruction of the distal end of VPS by fat tissue. The amount of abdomen related complications after VPS insertion are presented in table 3.

Ninety seven (96,04%) patients required a VPS revision surgery. The majority of the patients had an obstruction of abdominal end of the VPS 63 (62,38%), followed by CSF pseudocyst of peritoneal cavity 27 (26,73%), and other each patient had different rare complications such a spontaneous extrusion of the peritoneal catheter of the VPS through the anus, urethra, inguinal canal, migration through the abdominal wall to the scrotal sac and total disconnection (Figure 2). The rate of this rare complications was < 1 (0,22%).

Table 3. Distribution of the patients with abdomen related complications after ventriculoperitoneal shunt placement *n*=101 (100%).

Complication	*n*	Frequency
CSF pseudocyst of peritoneal cavity	27	26,73
Trans-anal extrusion	3	2,97
Trans-inguinal extrusion	1	0,99
Trans-uretral extrusion	1	0,99
Migration to the scrotal sac	1	0,99
Total disconnection	1	0,99
Volvulus	4	3,96
Obstruction of distal end of VPS	63	62,38

Brain CT revealed that the cranial end of the VPS was in the ventricle in all patients and that in 31 (30,69%) of these patients were no signs of acute hydrocephalus or brain compression. There was no significant change in the blood tests, with the exception of hyponatremia, on average sodium count of 119 mEq/L in 23 (22,77%) patients with a large peritoneal pseudocyst. In patients with an abdominal pseudocyst containing less than 300 mL of CSF 4 (3,96%) no decrease in blood sodium levels was noted. Abdominal direct x-ray and abdominal non-contrast axial CT showed that intestines were shifted and we observed a large peritoneal pseudocyst filled with the fluid, and we also saw that one of the silicone catheter of VPS was located inside the peritoneal pseudocyst (Figure 3). Abdominal X-Ray examination in patients with volvulus demonstrated mechanical obstruction of small bowel by distal end of VPS catheter, abdominal distention, intestine dilatation, air-liquid levels (Figure 4 A).

Before the shunt revision in patients with a pseudocyst more than 300 mL of CSF, cyst was punctured and average of 500 mL light coloured liquid was taken from the cyst. The largest pseudocyst had 3500 mL of content while the smallest pseudocyst had 100 mL. When supraumbilical laparotomy was performed, we observed in these patients intestinal adhesion and peritoneal thickness. The peritoneal catheter was carefully freed from intestines and the peritoneal catheter was placed back. After the operation, patients did not have any problems; abdominal weakness and constipation decreased.

Four patients with partial small- bowel obstruction by long distal end of VPS had a conservative treatment. No decline in the overall condition or reported symptoms of these patients was noted during conservative treatment, which involved intravenous fluid and electrolyte replacement, gastrointestinal decompression, and prophylactic antibiotics. A follow-up was conducted using direct abdominal radiography, and no notable changes were detected in the blood tests. All of these patients recovered dramatically within 48 hours after conservative treatment (Figure 4 B). The management strategies for these cases with abdominal complications are depicted in figure 5.

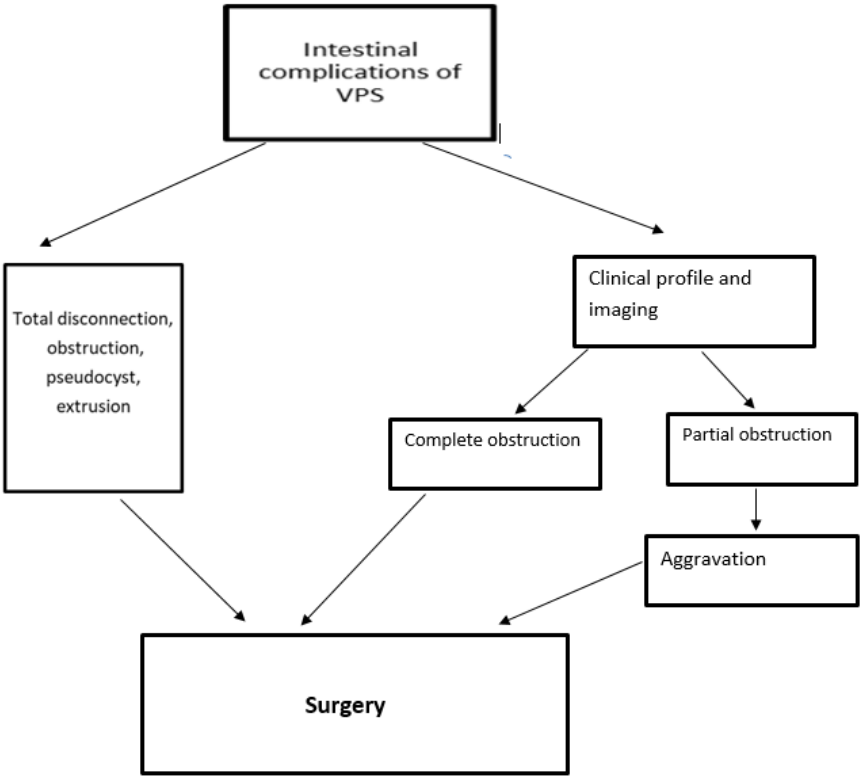


Figure 5. Algorithm of the treatment of the patients with an abdominal complication of VPS.

Discussion

VPS surgery is a common procedure to treat a congenital hydrocephalus as well as hydrocephalus associated after trauma, infection or tumour. Despite the development of new techniques in patients with hydrocephalus, VPS is still the most preferred treatment, because the peritoneal cavity provides a good absorptive surface for CSF, and VPS is easily chased by X-Ray. But complications of VPS have been frequently reported in the literature. All VPS complications can be classified into two groups: group A- abdomen related complications and group, B- others (dysfunction of ventricular catheter, shunt infection or intracranial complications). Also shunt complications may occur as a result of obstruction of proximal and distal ends of VPS or from pump malfunctions. Abdomen related complications were defined as shunt migration to the scrotal sac, extrusion trough anus or urethra, disconnection and completely fall into abdominal cavity, excessive drainage with abdominal pseudocyst, intestinal volvulus or perforation, intestinal adhesions.

The most common complications are shunt dysfunction and shunt tip, infection intracranial shunt migration, abdominal migration, extrusion through anus, urethral or scrotal extrusion, extrusion through chest wall, pneumothorax, abdominal pseudocyst, bowel perforation with subcutaneous emphysema, small bowel obstruction with abdominal end of VPS with secondary ischemia and necrosis (9-17).

There are limited cases of abdominal pseudocyst and intestinal obstruction as an intra-abdominal complications of VPS (19-22). Abdominal symptoms can develop at any time after the shunting procedure. In our study, abdominal complications developed in average in 5,5 months after VPS implementation. In the aetiology of abdominal pseudocyst formation, we believe that there are a few factors. First of all, intestinal adhesions may have been caused by sterile inflammation of cerebrospinal fluid (23). CSF pseudocyst infection usually associated with Staphylococcus epidermis, Staphylococcus aureus, and Streptococcus (24). Abdominal infection followed by fibrosis may have thickened peritoneum and reduced absorption of SCF. Secondly, adhesions and fibrosis may reduce peristaltic movements of the bowel. In our presentation bacteriological cultures of cyst collection were sterile. All 27 cases with pseudocyt collection had abdominal adhesions which decreased peritoneal absorption of CSF. Some pseudocysts may have been due to silicone allergy (25).

The size and volume of the abdominal pseudocysts may vary from 10 mL to 1000 mL and abdominal symptoms are related to their pressure on abdominal organs (8, 15, 16, 26). In our study of abdominal pseudocysts, the largest cyst had a volume of CSF 3500 mL, while the smallest were measured 100 mL. The literature review did not reveal any classification of SCF pseudocyst that occur after intraperitoneal shunt insertion based on their intra-abdominal size. The literature

review did not reveal any classification of SCF fistulas that occur after intraperitoneal shunt insertion based on their intra-abdominal size. In our cases, in large pseudocysts bigger than 300 mL, we observed hyponatremia. Consequently, if the cyst is large, it is important to consider the potential for hyponatremia, even if the shunt is functioning properly. In previously reported cases, hyponatremia was associated with ventricular drainage and CSF loss and huge pseudocyst accumulated CSF or the low of dietary daily sodium intake because of nausea and vomiting (27-29). This is similar to our patients who experienced abdominal issues, which may have contributed to sodium depletion. All of our cases had a cyst drainage followed by open laparotomy. An alternative approach is laparoscopic cyst drainage, which involves repositioning the abdominal catheter of the shunt (30).

Other cases had some factors to consider, such as twisting distal catheter of VPS around a bowel and causing mechanical obstruction in the intestine. The causes of aetiology are not clear but based on previously reported cases, long length abdominal catheter end and bowel movements may have caused spontaneous knotting between bowel and VPS (31). Spontaneous knotting of an agitated string experiments has shown that knots depend on agitation time and string length (32). The small bowel obstruction was due to adhesions at the VP shunt (20, 22).

There are different views in the treatment of abdominal pseudocyst and bowel strangulation, such as excision of the cyst by laparotomy or aspiration; change of VPS to lumboperitoneal (LP) or ventriculoarterial (VA) shunts (1, 14, 18, 20).

Selecting the type of treatment requires careful attention, taking into account the potential complications that could rise after the insertion of a VPS. Even if patients with obstructive hydrocephalus treated with endoscopic third ventriculostomy (ETV), recurrent shunting was required in 20% (33). In our study surgical intervention was required for 97 patients with rapidly progressing clinical course. Four patients with a partial bowel obstruction had a conservative treatment.

Conclusion

Due to the increasing incidence of abdominal complications after VPS surgery, it is important to classify complications such as abdominal pseudocysts based on the volume of CSF accumulation or the size of the cysts. In conclusion, abdominal pseudocyst and bowel strangulation with intestinal obstruction are rare but have serious potential complications of a VP shunt. Patients who had VP shunt placement may have nonspecific gastrointestinal complaints. Increased abdominal symptoms in addition to clinical symptoms must be carefully investigated and necessary treatment should be given.

Abbreviations

CSF - Cerebrospinal fluid
CH - Congenital hydrocephalus
ICH - Intracranial hypertension
EVT - Third ventriculostomy
LP - Lumboperitoneal shunt
VA - Ventriculoarterial shunt
VPS - Ventriculoperitoneal shunt

Ethical Approval: *Ethical approval for the study was obtained from the Harran University Ethics Committee (date: 16/10/2023, decision no: HRU/23.19.36). Our study was planned in accordance with the ethical standards stated in the Helsinki Declaration.*

Author Contributions:
Concept: G.C.
Literature Review: G.C., M.E.B.
Design : G.C., M.E.B.
Data acquisition: -
Analysis and interpretation: G.C.
Writing manuscript: G.C.
Critical revision of manuscript: M.E.B.

Conflict of Interest: *The authors have no conflicts of interest to declare.*

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