The Role of Laparoscopy in Management of Complications Related to the Peritoneal Segment of Ventriculo-Peritoneal Shunts: Feasibility for Salvage.

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ABSTRACT

Background: *Peritoneal complications following cerebrospinal fluid (CSF) diversion by ventriculo-peritoneal (VP) shunts are commonly encountered. In this study, the role of laparoscopy in the management of peritoneal segment complications of VP shunts was evaluated. We hypothesize that it has multiple advantages over open surgery, including enhanced ability to visualize the catheter's situation and address the problem, in addition to decreased morbidity and rapid recovery.* ***Methods:*** *This retrospective study reviewed 11 patients with abdominal domain complications, secondary to VP shunts for CSF diversion, who were all laparoscopically operated upon at a tertiary paediatric surgical referral unit.* ***Results:*** *The peritoneal segment complications encountered were shunt fracture or disconnection and intra-peritoneal catheter migration in 27.3% (3/11); abdominal pseudo-cysts in 18.2% (2/11); CSF ascites in 18.2% (2/11); scrotal position of the tip in 9% (1/11); and abdominal sepsis in 27.3% (3/11). The role of laparoscopy was (a) retrieval of the migrated or disconnected shunt (11/11 – all cases); (b) evacuation, debridement, lavage and drainage for pseudo-cysts, abscesses or peritonitis (5/11 – 45.5%); and (c) repositioning of the peritoneal segment tip and assessment of its function (6/11– 54.5%), either primarily (immediate) or secondarily (delayed). Conversion to laparotomy was needed in 2 cases (2/11 – 18.2%).* ***Conclusion:*** *Abdominal complication following CSF shunts can be successfully, advantageously and safely managed laparoscopically, achieving salvage of the shunt system in more than half the cases or assisting with externalisation.*

Key words: *Laparoscopy, Hydrocephalus, Benign Intracranial Hypertension, Pseudotumor Cerebri, CSF Shunts, Abdominal Pseudocysts and CSF Ascites.*

BACKGROUND

Hydrocephalus and benign intracranial hypertension (BIH) occur when the intracranial pressure (ICP) rises as a result of CSF accumulation and requires prompt management to relieve the pressure. The incidence of hydrocephalus is 0.9-1.8 new cases per 1,000 live births, while the estimated prevalence is 1-1.5% [(1)]. BIH (also known as Pseudotumor Cerebri) occurs in 1-3 per 100,000 individuals [(2)]. CSF diversion is warranted in both conditions. The most widely accepted treatment option is diverting excess CSF to the peritoneal cavity. The most important advantage of peritoneal shunts over venous system shunts is the lower susceptibility to systemic life-threatening infections. In the paediatric and adolescent age group, to overcome the need for repeated lengthening of the shunt in response to longitudinal growth of the patient, excess tubing is left intra-peritoneally [(3)]. It is not uncommon then to encounter complications that are related to the peritoneal segment of CSF shunts culminating to shunt malfunction (impaired drainage), resulting in acute hydrocephalus and signs of increased ICP, a condition that requires urgent intervention. Laparoscopy enables inspecting the

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abdominal cavity; localising and retrieving the catheter; evacuating and draining cysts or abscesses; and repositioning of the peritoneal segment tip while its drainage is being visually assessed, thus the existing shunt is retained and the patient can avoid the potential morbidity of a completely new shunt system operation [(4)]. In this study, we evaluate the role of laparoscopy in managing a wide range of complications related to distal VP shunts' segments.

METHODS

This study is a retrospective review of a cohort of 11 patients who were managed laparoscopically for the abdominal complications related to the peritoneal segment of VP shunting catheters at the department of Paediatric Surgery of a tertiary referral university-based children's hospital. Between September 2014 and January 2018. The mean age was 4.5 years (range: 7-months to 11-years old) and the male to female distribution was 7:4.

We conducted a full clinical assessment of symptoms and signs in all cases. Recurrence of increased ICP was the commonest presentation. Headache, vomiting and disturbed conscious levels were encountered in 8 cases. Fever and abdominal signs of infected ascites, peritonitis or a peritoneal abscess were apparent in 5 cases. Two cases presented with an exposed catheter over the abdominal wall; one had peritonitis and a peritoneal abscess was noted in the other.

Preoperative computed tomography (CT) of the brain and the abdomen were done to all cases. For all cases of pseudo-cyst, CSF ascites, peritonitis or abdominal abscesses, microbiological culture and antibiotic sensitivity of the peritoneal fluid were done. The follow-up period after laparoscopic management ranged between 1.4 years and 4.9 years (median 3.25 years).

RESULTS

The preoperative brain CT scans showed signs of ventriculomegaly, periventricular trans-ependymal hypodensity due to CSF permeation and obliteration of the cortical sub-arachnoid CSF spaces. Abdominal imaging showed a dislocated migrated catheter within the abdominal cavity in 3 cases, the catheter's tip located in the scrotum in one case or within a cystic cavity in the abscesses and pseudo-cysts. Otherwise, it revealed the presence of fluid collections, loculations and intestinal distension.

The complications encountered are summarized in **table (1)**. They comprise shunt fracture, disconnection and intra-peritoneal catheter migration in 3 cases (27.3%); scrotal position of the catheter tip in one case (9%); abdominal pseudo-cysts were in 2 cases (18.2%); CSF ascites in 2 cases (18.2%); and abdominal sepsis in 3 cases (27.3%).

The cases with abdominal sepsis included 2 cases of a peritoneal abscess extending into the anterior abdominal wall and one case of perforated bowel leading to peritonitis. CSF ascites when infected, may be considered among this group, making the overall 5 cases.

Laparoscopic exploration of the abdomen was attempted in all cases, adhesions and loculations were safely taken down. Conversion to open exploratory laparotomy was done in 2 cases (18.2%); those who presented with intra-peritoneal abscesses.

The catheter was repositioned intra operatively in 3 cases; two cases that developed a peritoneal pseudo-cyst and one case where the peritoneal catheter's tip was in the scrotum. The peritoneal catheter was substituted, replaced and re-implanted in 2 cases; which were malfunctioning but still within the general peritoneal cavity. In the above 5 cases, the primary shunt system was salvaged laparoscopically (45.5%).

In one patient, the peritoneal segment of the primary shunt was substituted, replaced and re-implanted intra-peritoneally one week after externalization, with laparoscopic guidance to place the tip of the new catheter in a fresh site, relatively distant from the previous one.

The peritoneal catheter was externalized in 5 cases (45.5%) for intervals ranging between 4 and 17 days (mean 9.6 days) until the CSF fluid sample became clear, the white cell count became less than 20/HPF and the systemic manifestations of infection subsided, then conversion to ventriculo-atrial shunt was done later.

Laparoscopy played a key role for peritoneal shunt placement or replacement in an overall of 6 cases (54.5%), primarily (immediate) in 5 cases and secondarily (delayed) in one case. There were no mortalities related to the use of laparoscopy

but there were 2 eventual mortalities (18.2%); one patient with peritonitis died 2 months later due to uncontrolled infection secondary to nutritional debilitation and lowered immunity, and another patient died from a posterior fossa medulloblastoma 15 months after surgery.

DISCUSSION

The imbalance between CSF production and drainage results in increased ICP which is common and occurs either primarily from congenital causes or secondary to obstruction of the CSF pathways. CSF diversion is the treatment of choice for these conditions [(1)].

In this case series, the most common complication caused by the peritoneal segment of the shunting catheter was intra-peritoneal migration due to disconnected or fractured segment of a VP shunt, occurring in 27.3%. Being potentially avoidable, this favourably compares to other series reporting this problem in 47% [(3)]. This is explained by disconnection of the peritoneal catheter from the outlet side of the VP shunt valves in 2 cases, where the connections were sub-optimally secured by a ligature; and in one case by fracture of the shunt at a sub-clavicular site.

The abdominal cavity harbours many spaces where the migrated catheter could be located within, as the para-colic gutters, sub-hepatic space, between small intestinal loupes like in one of our cases or coils into the Douglas pouch (being dependent) like in 2 of our cases. They may erode into the abdominal wall or viscera and even reach the scrotum or mediastinum. The mobility of the distal segment of the catheter and the pulling effect by abdominal contents are the main two factors attributed to catheter migration[(5,6 &7)].

It is speculated that migrated intra-peritoneal catheters can be left in place as long there are no signs of infection [(5)], yet we believe like some authors [(8,9&10)], that it should be removed pre-emptively rather than waiting for further migration and intra-abdominal complications as visceral perforation or bowel entanglement and obstruction to occur. When the peritoneal segment of a VP shunt is disconnected, the patient usually develops recurrence of the symptoms and signs of increased ICP; i.e. acute hydrocephalus.

Peritoneal pseudo-cyst which occurred in 2 cases in this study (18.2%), is known to constitute 1-4.5% of complications related to VP shunts [(11 & 12)]. The underlying cause of its occurrence is not clearly elucidated but is believed to be a peritoneal reaction to localise an occult infection, in response to irritation by the shunt silicone or in cases of hyperproteinnorrachia. Gaskill et al (1989) reported its association with an infected shunt history in 41.6 % [(12)]. Patients who develop peritoneal pseudo-cysts present with manifestations of shunt malfunction and unless there are signs of infection, it could be removed from the cyst and repositioned in another location within the peritoneum [(12)], which is similar to what we did in 2 cases; where the fluid was clear, and the cyst wall was excised or disrupted.

CSF ascites is a rare complication of shunts [(13)], in our series it was encountered in 2 cases (18.2%). The pathogenesis of CSF ascites could be due to impaired absorptive power of the peritoneum, hyperprotiennorrachia or shunt infection. Our 2 cases who developed this problem were patients who underwent repeated shunt revisions due to shunt infections. It is assumed that their peritoneal absorptive power was greatly affected owing to the subsequent adhesions following each attempt. Unlike CSF pseudo-cyst, which is usually non-infected, in ascites the shunt has to be externalized and possibly converted to another drainage modality in a subsequent operation as followed in our cases. In this context, laparoscopy was used to visualize the abdominal cavity for relevant pathologies as adhesions. Urgent intervention to manage peritoneal CSF ascites is highly advised because it may constitute a life-threatening condition either due to shunt malfunction or respiratory compromise.

Scrotal migration of the catheter or catheter tip may be due to a combination of a patent processus vaginalis (PPV) together with positive abdominal pressure [(14 & 15)]. The catheter may also migrate through other non-obliterated peritoneal defects, for example into an umbilical hernia [(5)]. In our case, laparoscopy was used to pull the catheter out of the scrotum and reposition it in the general peritoneal cavity and to repair the associated hernial defect or PPV by dissection of the hernial sac from the vas and vessels and intracorporeally placing a purse-string suture around the dissected peritoneum.

Peritonitis and peritoneal abscesses are the most fraught complications associated with shunt infection, occurring in up to 30% or more in some series [6 & 7]. Predisposing factors for the occurrence of peritonitis and peritoneal abscesses also include immunocompromised children, preterm babies and small infants, ventriculitis, intra-ventricular haemorrhage, multiple shunt revisions and neural tube defects as meningomyelocele due to their friable visceral wall and low mobility [3, 8 & 16].

In this series, peritonitis occurred in one patient (9%) after exposure of a segment of the shunting catheter through the skin along its course over the chest wall allowing for infection. A peritoneal abscess occurred in 2 patients (18.2%), in one case because of perforation of the abdominal wall and the other because of perforation of an intestinal loupe, 3 years after primary implantation of the shunt. All 3 cases had their catheters externalized for variable periods of time and samples were sent for cultures during laparoscopic exploration. The 2 cases with abscesses required conversion to an open surgery for adequate exploration and lavage of peritoneal cavity, as well as repair of friable bowel. In all 3 cases, and the 2 cases with CSF ascites, the shunt was converted into a VA shunt after externalization and clearing of the CSF.

Fluid samples grew Staphylococcus epidermidis in the case of peritonitis and Enterococci in the 2 cases of abscesses. Staphylococcus epidermidis and aureus are usually the causative organisms in early shunt infection due to contamination from skin organisms during shunt implantation. On the other hand, enterococci are the pathogen in cases of late shunt infections since this is commonly associated with viscus perforation by the tip of the catheter and contamination with intestinal flora [16].

CONCLUSION

Abdominal complications caused by the peritoneal segment of CSF shunts could be safely managed laparoscopically, with the intention to salvage the system or achieve externalisation. When externalised, laparoscopy may facilitate subsequent utilisation of the peritoneum to harbour the distal shunt, otherwise conversion to another draining site as a ventriculo-atrial shunt is necessary. Laparoscopy in this case series was beneficial for minimally invasive exploration of the peritoneal cavity, retrieval of migrated shunts, fluid and tissue sampling and dealing with ongoing pathology as pseudocyst evacuation and/or excision, as well as upfront or delayed purposeful re-positioning of the tip of the peritoneal segment.

Abbreviations

CSF: cerebrospinal fluid
VP: ventriculo-peritoneal
BIH: benign intracranial hypertension
ICP: intracranial pressure
VA: Venticulo-Atrial Shunt
EVD: External Ventricular Drain/Drainage

Declarations

The authors declare that they have no competing interests. ***Ethics approval and consent to participate***: Ethical approval was obtained via the departmental research ethics and scientific committee. This study is a retrospective review and is neither prospective nor experimental, thus consent for participation is not applicable. However, consent for any clinically indicated surgical procedure or medical intervention followed the standard informed and written documentation. ***Consent for publication***: This study was conducted in a tertiary university hospital (teaching) centre which operates under directives allowing retrospective utilization of non-identifiable clinical data with no written consent. Verbal consent for publication was obtained by telephone from the parents of all cases included. ***Availability of data and material***: The data and material for this study is available and stored confidentially. ***Funding***: There are no funding sources to declare.

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