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Ventriculoperitoneal shunt complications: a local study at Qena University Hospital: a retrospective study

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Abstract

Background: Shunting of cerebrospinal fluid (CSF) has reduced the morbidity and mortality of hydrocephalus. Ventriculoperitoneal (VP) shunt is the most commonly used procedure for shunting, but it has potential complications that may need multiple surgical interventions.

Methods: It is a clinical retrospective observational study that was conducted on 30 patients of both genders with different ages who presented with signs and symptoms of shunt malfunction between 2012 and 2016. A complete clinical assessment was done, a final diagnosis was made, and a treatment of individual patients was planned accordingly. Patients were followed up within 1 week and 1 month post-operatively. Data was analyzed using the SPSS (version 16.0).

Results: VP shunt was inserted for 205 patients. Thirty (14.6%) patients had various forms of complications. Fifteen (50%) patients had complications related to the proximal catheter and the reservoir while 15 (50%) patients had complications related to distal catheter. The most common complications were exposure of the shunt 23.3% (13.3% exposed shunt reservoir and 10% exposed distal catheter) followed by shunt obstruction 13.3% (6.66% proximal and 6.66% distal). Twenty-eight (93.3%) patients were managed surgically, 24 (85%) patients of them showed marked improvement at the end of the first month postoperatively, while four (15%) patients needed another surgical intervention.

Conclusions: Insertion of V-P shunt is routinely done by all neurosurgeons. A great care should be taken during insertion of the shunt system starting from scrubbing to avoid complications. Despite complications, the VP shunt remains the main surgical procedure used for hydrocephalus management.

Keywords: Hydrocephalus, Cerebrospinal fluid shunts, Ventriculoperitoneal shunt, Ventriculoperitoneal shunt complications

Background

Hydrocephalus is an excess of cerebrospinal fluid (CSF) in the ventricular system due to the imbalance between formation and absorption of CSF which is referred to (i) obstruction of the CSF pathways, (ii) over production of CSF, and (iii) impaired venous drainage [1]. Hydrocephalus is the second most common congenital brain malformation [2]. To date, the standard treatment of hydrocephalus is ventriculoperitoneal shunt. The technique of using the peritoneal cavity for CSF absorption in ventriculoperitoneal shunting (VPS) was developed by Kausch in 1908 [3]. Although VPS insertion is a common neurosurgical procedure, complication rates in adults are poorly established with a reported range from 17 to 33% [2, 4–10]. Children demonstrated a higher rate of shunt complications than did adults at 5 years (48 versus 27%, $P < 0.0001$) [11]. The advent of endoscopic third ventriculostomy has gained popularity due to the high complication and failure rates of ventriculoperitoneal shunt [12]. The major disadvantage of VPS is the fact that it constitutes a foreign body and prone to complications such as mechanical blockage, shunt infection, shunt migration, and rarely shunt protrusion [13]. If a shunt system fails to be operated correctly, the patient's life and cognitive functions are placed at risk. Thus, an urgent revision must be done [14]. Although developing countries face the problem of shunt complications more than other countries, much research is ongoing but still remains a common problem [15].

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Methods

This is a retrospective observational study that was conducted at the Department of Neurosurgery, Qena University Hospital, South Valley University for a period of 5 years from January 2012 to December 2016. An informed signed consent was taken from the parents and guardians of patients before enrolling them into the study after the approval of the ethical committee of the Faculty of Medicine, South Valley University. During the study period, a complete clinical assessment including a detailed history and examination with a particular emphasis on neurological examination was done for all patients after admission. A medium-pressure PS medical valve systems were inserted for all patients. Patients with VP shunt complications operated at Qena University Hospital were included while patients operated before the study period were excluded. The investigations performed for all patients were complete blood count (CBC), erythrocyte sedimentation rate (ESR), complete urine analysis, X-ray chest, and brain computed tomography (CT) scan or MRI. Specific investigations such as CSF analysis, CSF culture and sensitivity, blood culture and sensitivity, urine culture and sensitivity, pus culture and sensitivity, ultrasound of abdomen, shunt series X-rays, and MRI of the brain were also performed when indicated. A final diagnosis was made on the basis of clinical findings, and investigations and treatment of individual patients were planned accordingly. All patients with VP shunts who had one or more complications were included in the study.

Statistical analysis

Data was recorded and analyzed using the Statistical Package of Social Sciences (SPSS) version 16. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations.

Results

Two hundred and five patients for whom VP shunt was inserted by consultant and senior neurosurgeons, thirty (14.6%) patients had complications. Both genders were included [22 (73.3%) males and 8 (26.6%) females]. All ages were also included [22 (73.3%) infants, 6 (20%) children, and 2 (6.6%) adults] with a mean age (3.60 ± 6.64) as shown in Table 1. Clinically, 22 (73.3%) patients presented with bulged anterior fontanelle, 21 (70%) with sleepiness, 20 (66.7%) patients with frequent vomiting, 17 (56.66%) patients with enlarged head, 12 (40%) patients with tense anterior fontanelle, 11 (36.7%) patients with agitations and irritability, nine (30%) patients with inflammation around distal tube, seven (23.33%) patients with headache, six (20%) patients with fever, four (13.66%) patients with exposure of the shunt reservoir, three (10%) patients with CSF leak from the distal wound, two (6.66%) patients with swelling around the reservoir,

Table 1 Demographic data, clinical presentations, frequencies, and classifications of complications of ventriculoperitoneal shunts

Item	Frequency	Percentage
Age groups		
Infant	22	73.3
Child	6	20
Adult	2	6.66
Age (years), mean (standard deviation) 3.6 ± 6.64		
Sex		
Female	8	26.6
Male	22	73.3
Clinical presentations		
Bulged anterior fontanelle	22	73.3
Sleepiness	21	70
Frequent vomiting	20	66.7
Enlarged head	17	56.66
Tense anterior fontanelle	12	40
Agitation and irritability	11	36.7
Inflammation around distal tube	9	30
Fever	6	20
Headache	7	23.33
Exposure of shunt reservoir	4	13.66
CSF leak from distal wound	3	10
Swelling around reservoir	2	6.66
Swelling around distal tube	2	6.66
Scrotal swelling	1	3.33
Complications		
A Related to proximal catheter and reservoir	15	50
Exposure of the reservoir	4	13.33
Misplaced catheter	3	10
Ventriculitis	2	6.66
Proximal obstruction by debris	2	6.66
CSF collection around reservoir	2	6.66
CSF overdrainage (CSDH)	2	6.66
B Related to distal catheter	15	50
Exposure of skin overlying the tube	3	10
Infection around the tube	2	6.66
CSF collection around distal tube	2	6.66
Fracture of the tube	2	6.66
Extrusion through anus	2	6.66
Obstruction by pseudocyst	2	6.66
Extra peritoneal placement	2	6.66
Hydrocele	1	3.33

two (6.66%) patients with swelling around distal tube, and one (3.33%) patient with scrotal swelling as shown in Fig. 1 and Table 1.

The documented complications were classified according to site into two categories: (i) complications related to proximal catheter and reservoir and (ii) complications related to distal catheter as presented in Table 1. Concerning proximal catheter and reservoir complications, they appeared in 15 patients. The skin erosion over the shunt reservoir was the most common complication which was documented in four (13.3%) patients as shown in Fig. 2. Misplaced catheter was noted in three (10%) patients; ventriculitis was presented in two (6.7%) patients as shown in Fig. 3. Obstruction of proximal catheter by debris was noted in two (6.7%) patients, and CSF leak making collection around the reservoir was documented in two (6.7%) patients as shown in Fig. 4. Overdrainage of the ventricles may lead to unilateral or bilateral chronic subdural hematoma (CSDH), and this was presented in two (6.7%) patients as shown in Fig. 5. Regarding distal catheter complications, they also occurred in15 patients. Exposure of skin overlying the tube occurred in three (10%) patients (hyperemia with superficial ulceration or complete exposure) as shown in Fig. 6. Infection around the distal catheter was reported in two (6.7%) patients. Two (6.66%) patients showed poor peritoneal absorption which leaded to distal failure and CSF collection under the skin surrounding the distal catheter as shown in Fig. 7. Fracture can occur at any site along the course of the distal tube especially near bony prominences. In our study, two (6.66%) patients were documented to have a fracture and, hence, distal tube migration as shown in Fig. 8. Extrusion of the distal end of distal catheter through anus was also reported in two (6.66%) patients as shown in Fig. 9. Two (6.66%) patients had a distal failure due to obstruction of the distal end of the distal catheter by pseudo cyst causing closed narrow space for CSF drainage causing VP shunt malfunctioning as shown in Fig. 10. Other complications were noted as extraperitoneal placement of the distal catheter and hydrocele, each of them noted in only one patient for each (3.33%). It was noted that complications tend to occur more frequently in case of proximal catheter insertion in occipital horn (posterior parietal shunt) than in frontal horn (frontal VP shunts). Such complications occurred within 26 out of 162 patients for whom occipitoparietal

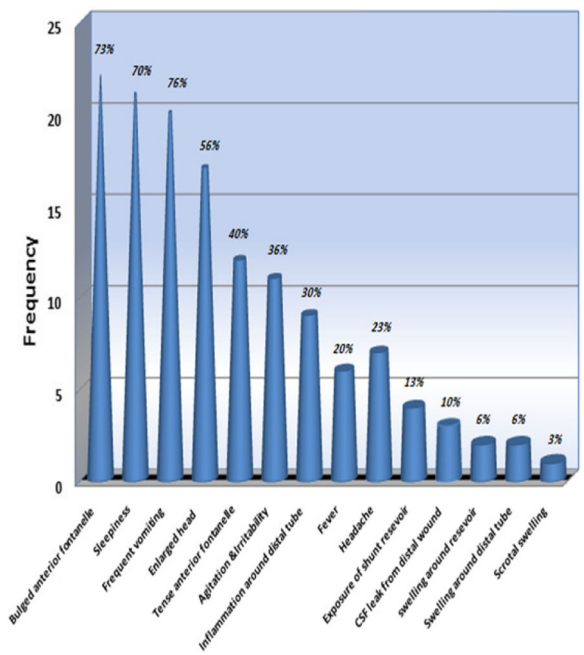

Fig. 1 Clinical presentations of shunt complications

Fig. 2 Photograph of a 6-month-old infant showing complete exposure of the shunt reservoir

Fig. 3 CT brain axial view of a 16-month-old female patient showing left-sided VP shunt causing picture of ventriculitis

Fig. 4 Photograph of an 8-month-old infant showing CSF collection around the shunt reservoir

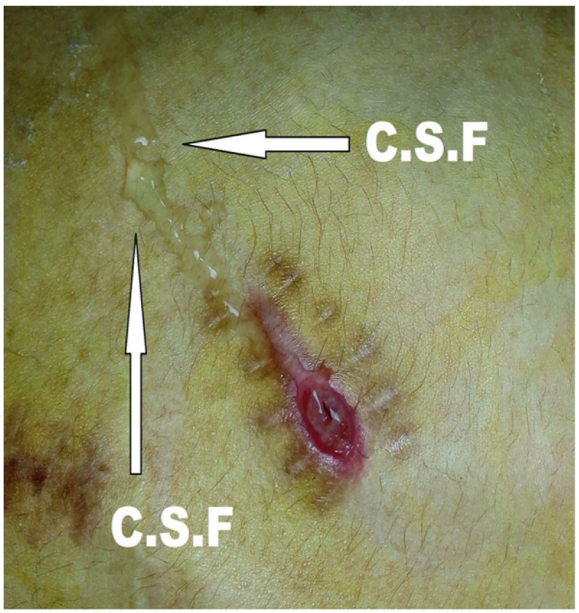

Fig. 6 Photograph of a 16-year-old male patient showing CSF leak (white arrows) through ulceration of the skin over the distal catheter of left VP shunt at the abdomen

VP shunt was done. The remaining 43 patients for whom frontal VP shunt was done showed complications related to four patients only. Thus, the incidence of complications with occipitoparietal VP shunt is 86.67 and 13.33% with the frontal type out of the total number of complications. VP shunts were inserted for treatment of hydrocephalus caused by any etiology such as congenital, post meningitic, post subarachnoid hemorrhage, and tumor obstructing CSF pathway. In the current study, out of 205 patients operated with VP shunt, 188 patients were congenital, 10 patients were post meningitic, four patients were post subarachnoid hemorrhage, and three patients were tumor-induced hydrocephalus. Out of 30 patients who had various types of VP shunt complications, 28 (93. 33%) patients complained of congenital hydrocephalus, one (3.33%) patient complained of post meningitic

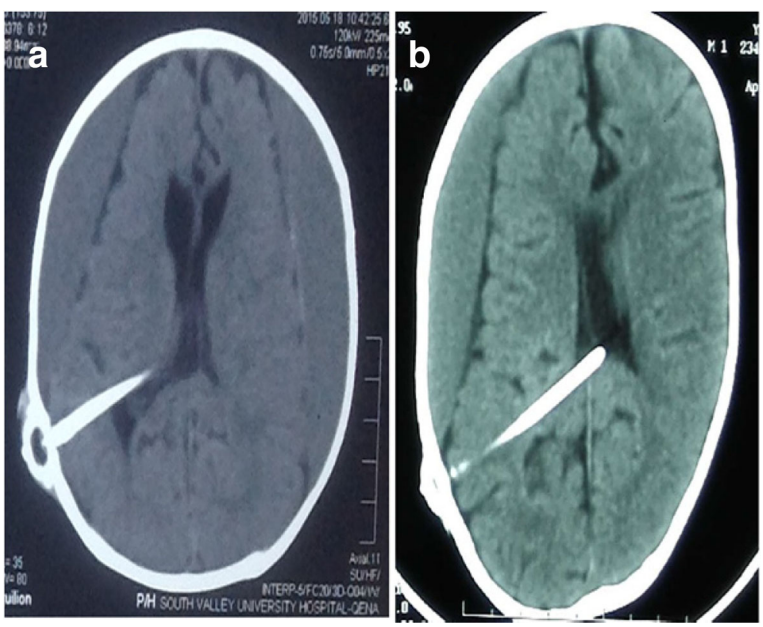

Fig. 5 a Plain CT brain of an 18-month-old infant showing bilateral chronic subdural hematoma due to right-sided VP shunt overdrainage. **b** Plain CT brain of a 1-year-old infant showing right-sided chronic subdural hematoma due to right-sided VP shunt overdrainage

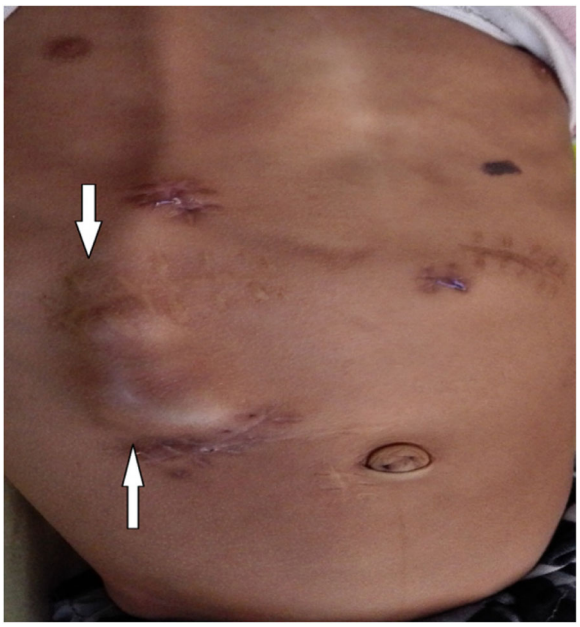

Fig. 7 Photograph of a 30-month-old male child showing CSF subcutaneous collection surrounding the distal catheter near its insertion at the abdomen

Fig. 9 Photograph of a 13-month-old male infant showing extrusion of the distal end of the distal catheter through the anus with CSF drainage out

hydrocephalus, and one (3.33%) patient complained of post subarachnoid hydrocephalus. No patient who had tumor-induced hydrocephalus complained of shunt complications (see Table 2).

Patients were followed up after 1 week and 1 month postoperatively. Two (6.66%) patients were managed conservatively while 28 (93.3%) patients were managed surgically. Surgeries included proximal revision, distal revision, debridement, redirection of misdirected catheter, repositioning of the distal catheter, new VP shunt on the other side, changing the shunt pressure to higher one in case of CSDH, or closure of hernia sac as shown in

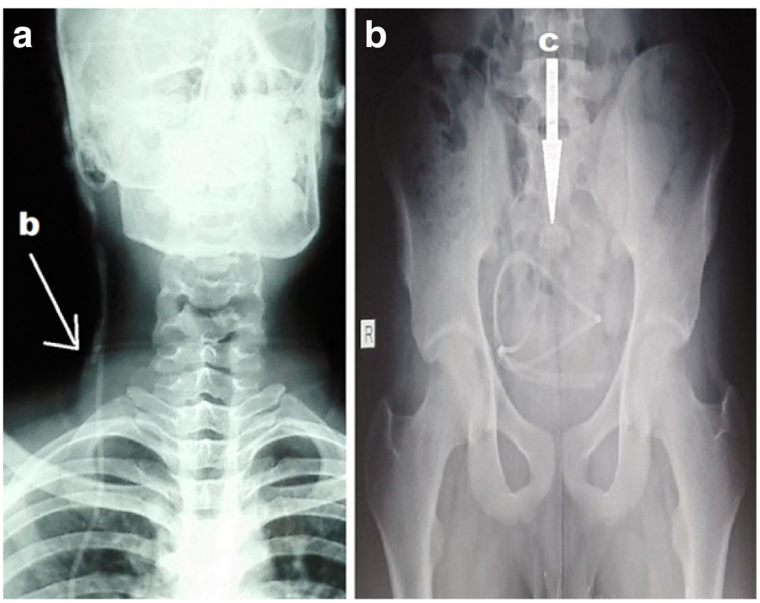

Fig. 8 a Plain X-ray AP view on the skull and upper chest of a 17-year-male patient showing a fracture of distal tube of right VP shunt at the neck region (b arrow). **b** Plain X-rays AP view on the pelvis migrated disconnected distal catheter (c arrow)

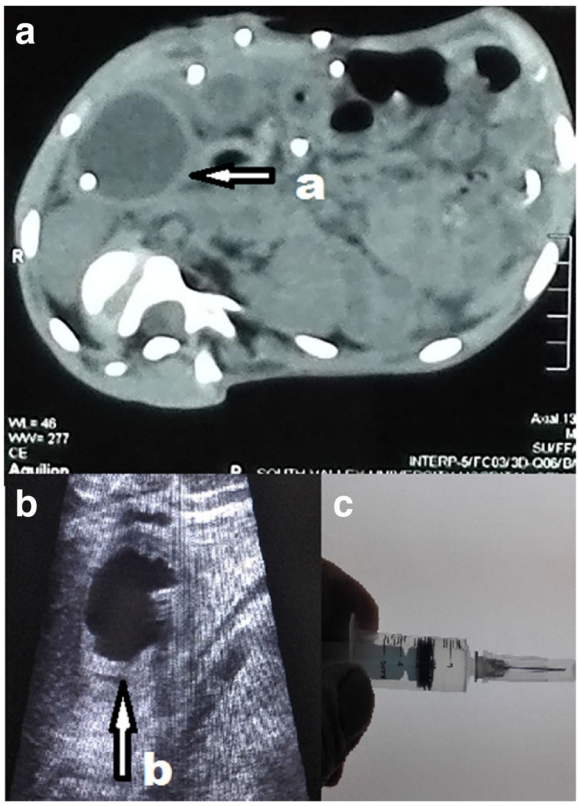

Fig. 10 **a** CT abdomen axial view of a 13-year-old male patient showing right hypochondrial cyst (a arrow). **b** Abdominal ultrasonography done for the same patient, and right hypochondrial cyst was found (b arrow). **c** Ultrasonic-guided aspiration was done from this cyst, and the aspirate was clear CSF

Fig. 11. At the end of the first month, two (6.66%) patients with infection around the distal tube were managed conservatively by good antiseptics and highly sensitive antibiotics according to culture and sensitivity tests showing marked improvement. Out of the 28 surgically treated patients, 24 (85%) patients showed marked improvement while four (15%) patients needed other surgical interventions.

Discussion

Although VP shunt is an effective treatment of hydrocephalus, it is plagued by shunt-related complications [16]. As VP shunt is lifelong commitment, multiple surgical procedures may be required during life time [17]. The incidence of VP shunt complications was reported by most studies to be slightly higher in males than females [18], which was consistent with the current study as males represent 73.3%. Among 30 patients who were operated by ventriculoperitoneal shunt, infants and children represented 93.3% whereas adults represented 6.6%. This is consistent with Abdul Munam et al. who conducted their study on 40 VP shunt complicated patients where children represented 85% [19]. In neonates, scalp necrosis is actually a common complication associated with VP shunts which is due to the inherent skin fragility and the superficial nature of the shunt [20, 21]. In agreement with this current study scalp, necrosis was presented in four (13.3%) patients. Lee et al. found shunt blockage in 12.2% of 246 shunt procedures in Seoul, Korea, and their infection rate was 4.1%. Shunt infection was found together with blockage in most instances in their series indicating that shunt malfunction could have been caused by infection in these patients [22]. Vanaclocha et al. observed that shunt malfunction occurred in infected shunts where some of which were clinically undetectable. They argued that the incidence of shunt infection might be higher than generally reported and that negative cultures of CSF taps did not exclude shunt infection in malfunctioning shunts [23]. Peacock and Currer found shunt blockage to be 20% in their series of 440 patients [24]. Mwan'gombe and Omulo reported an infection rate of 24.6% among children operated for non-tumor hydrocephalus in Nairobi [25]. In the current study, shunt obstruction was reported in approximately 13.4% of patients (6.7% proximal obstruction by debris and 6.7% distal obstruction by pseudo cyst). Infection was also reported in 13.4% of patients. Hamada and Abou Zeid found that misdirection of proximal catheter was founded in two (7.1%) patients of their shunt malfunction series which is approximately near to the result of this current

Table 2 Incidence of VP shunt complications in relation to site and etiology

Site of VP shunt patients	No. of VP shunt (total = 205)	No. of complicated shunts (total = 30)	Percentage of complicated shunts
Occipitoparietal	162	26	86.67
Frontal	43	4	13.33
Etiology	No. of patient's shunts (total = 205)	Complicated shunt No. of patients	Percentage of complicated shunts
Congenital	188	28	93.33
Post meningitic	10	1	3.33
Post S.A.H	4	1	3.33
Tumors	3	0	0

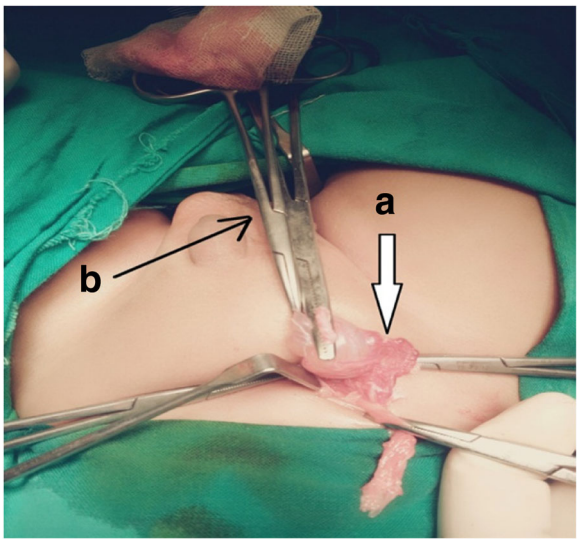

Fig. 11 Photograph of a 9-month-old male infant showing hydrocele (b arrow) who was operated to close surgically the hernia sac (arrow a)

study as proximal catheter misdirection was founded in three (10%) patients [26]. Aldrich and Harmann found that shunt disconnection and fracture accounted for 15% of their shunt malfunctions and that occipitally placed shunts had a higher tendency to dislocate than frontally placed shunts [27]. In agreement with this study, Shunt fracture was noted in 6.66% of shunt complication for occipitally placed shunts. Bierbauer et al. found no advantage of anteriorly placed shunts over posteriorly placed shunts in terms of shunt malfunction or infection [28]. However, in the current study, there was an advantage of anteriorly placed VP shunts over posteriorly placed shunts in terms of malfunction and infection. It was also noted that complications tend to occur more with occipitoparietal than with frontal VP shunts. In more details, incidence of complications with occipitoparietal VP shunt was 10.4% and with frontal type was 6%.

Abdominal complications of VP shunt are not rare and the main causes of distal catheter failure are related to extra peritoneal retraction of the catheter and subcutaneous or intra-abdominal cerebrospinal fluid (CSF) collections [29]. In the current study, intra-abdominal pseudo cyst was reported in two (6.66%) patients and extra peritoneal catheter in one (3.33%) patient.

A higher incidence of unobliterated processus vaginalis in pediatric patients than in adult patients leads to a higher likelihood of VP shunt distal catheter migration into the scrotum [30]. In the current study, one infant presented with scrotal swelling due to patent processus vaginalis (see Fig. 11) and this is consistent with the previous study. Sathyanarayana et al. documented a protrusion of distal catheter per anus without any complications such as obstruction or peritonitis [31]. This agrees with the current study where two patients were reported with a VP shunt distal catheter per rectum without any complications in the form of obstruction or peritonitis. Previous studies reported that age and principal diagnosis (etiology) are independent contributors to the risk of initial shunt failure [32–34]. In agreement with these studies, the current study demonstrated that age and etiology were significantly associated with shunt revision where 28 (93.33%) patients with VP shunt complications were congenital. Accordingly, there was a higher rate of complications related to congenital etiology.

Conclusions

Insertion of VP shunt is routinely done by all neurosurgeons. Great care and precautions should be taken during insertion of the shunt system starting from scrubbing to avoid complications such as infection. Implantation of VP shunt system should be done by well-qualified neurosurgeons in order to limit or avoid shunt complications. Despite complications, the VP shunt remains the main surgical procedure used for hydrocephalus management.

Abbreviations

CBC: Complete blood count; CSDH: Chronic subdural hematoma; CSF: Cerebrospinal fluid; CT: Computed tomography; ESR: Erythrocyte sedimentation rate; MRI: Magnetic resonance imaging; No: Number; S.A.H: Subarachnoid hemorrhage; SPSS: Statistical Package of Social Sciences; VP: Ventriculoperitoneal; VPS: Ventriculoperitoneal shunt

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Availability of data and materials

The data and materials of this manuscript are available for sharing.

Author's contributions

The data collection and the scientific writing were done by the corresponding author himself. The author read and approved the final manuscript.

Ethics approval and consent to participate

An informed signed consent was taken from all the patients and guardians of patients before enrolling them into the study after approval of the ethical committee of the Faculty of Medicine, South Valley University.
The present study has been performed in accordance with the Declaration of Helsinki and after approval of Ethical Committee, Qena Faculty of Medicine, South Valley University.

Consent for publication

A written consent has been obtained from every included patients and guardians of the patients regarding publishing their details and images.

Competing interests

The author declares that he has no competing interests.

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