Abnormal Migration of Distal End of Ventriculoperitoneal Shunt: A Retrospective Case Series at Sohag University

Ahmed Kamal Abdelhameid[a*], Khaled Nasser Fadle[a], Bahaa Ghareeb Hassanin[a]
[a]Department of Neurosurgery, Faculty of Medicine, Sohag University, Sohag, Egypt

Abstract

Background: Treatment for hydrocephalus often involves the installation of a ventriculoperitoneal (VP) shunt. Relatively uncommon problems include migration and extrusion of the VP shunt's distal end. Once the distal end of the VP shunt extruded to the external environment or imbedded in unclean media the risk of CNS infection associated with morbidity and mortality will increase. Periodic follow for the VP shunt and early management of the complications is a goal to all neurosurgeons nowadays.

Objectives: to outline the serious rare complications of the ventriculoperitoneal shunt that may happen due to ignorance of the periodic follow up, and the value of early intervention to decrease the morbidity and mortality of these cases. .

Patient and methods: A retrospective study conducted at Sohag University Hospitals on twelve hydrocephalic patients treated with ventriculoperitoneal shunt, during the period from April 2021 to January 2024.

Under general anesthesia, our patients treated with VP shunt extraction then a new shunt applied or revision of the same distal tube of the VP shunt.

Results: We included twelve patients with median age 12.5 months and male to female ratio (3:1) manifested by ventriculoperitoneal shunt complication: extrusion through the anus (4 cases 33.3%), scrotum (two patients 16.7%) other sites(6 patients 50%) like: coiling of the distal end around the flusher, migration to the urinary bladder or flanks, myelomeningocele wound, and an exploratory wound. The main complaint was the fever (100%), early meningeal symptoms (50%). Ten patients treated with new distal tube insertion (83.3%) and 2 patients revision of the same distal end done (16.7%). Demographic data, site of migration, treatment protocol and subsequent related morbidity and mortality and outcome on follow up recorded.

Conclusion: Close follow up with early detection of the shunt complication may secure us for going to abnormal rare complications.

Keywords: Ventriculoperitoneal shunt; Abdominal end migration; Extrusion; Shunt complications.

DOI: 10.21608/SVUIJM.2024.313513.1967

***Correspondence**: a.kamal_neuro@yahoo.com

Received: 15 August,2024.
Revised: 8 September,2024.
Accepted: 9 September,2024.
Published: 29 September, 2024

Cite this article as: Ahmed Kamal Abdelhameid, Khaled Nasser Fadle[a], Bahaa Ghareeb Hassanin.(2024). Abnormal Migration of Distal End of Ventriculoperitoneal Shunt: A Retrospective Case Series at Sohag University. *SVU-International Journal of Medical Sciences*. Vol.7, Issue 2, pp: 579-593.

Introduction

One of the most popular methods for treating hydrocephalus is the VP shunt. Complications may arise during the immediate post-operative phase or throughout the follow-up period **(Borkar et al., 2008).** Although the ventriculoperitoneal shunt has been the proper management for the hydrocephalus for more than 5 decades with the subsequent advancement in the valve and the design of the catheter, complications still occurred **(Broggi et al., 2020)**

Obstruction of the distal peritoneal end can occur because of breakage in the tubing or withdrawal from the peritoneal cavity with the growing up of the child **(Robert et al., 2018).** The development of an abdominal pseudo-cyst, spontaneous bowel perforation, intestinal blockage, inguinal hernia, liver abscess, and mechanical obstruction of the distal peritoneal catheter by the omentum or other structures resulting in shunt malfunction are among the frequently occurring complications **(Çelik et al., 2005**).

There have been reports of an uncommon consequence of peritoneal shunt extrusion in the diaphragm, bowel, colon, stomach, gallbladder, urine bladder, vagina, liver, and scrotum **(Frazier et al., 2002)**. There have been documented cases of distal end extrusion of shunt via healed incisions on the neck and abdomen in the literature (**DeSousa and Worth 1979; Whittle and Johnston 1983)**. Abdominal problems have a reported incidence of 10–30% (**Bryant et al., 1988)**.

Ten percent is the documented occurrence of distal shunt extrusion (**Kast et al., 1994)**. One uncommon and little-known consequence is the extrusion of the distal end of the VP shunt via an anal hole (**Akcora et al., 2006)**. In this research, twelve patients with aberrant migration and extrusion of the VP shunt's distal end are reported. We aimed in our study to clarify that periodic follow up of our patient with VP shunt clinically and radiologically is important issue to avoid distal end complications with its subsequent mortality and morbidity, however if complications occurred rapid intervention and dealing with immediately is a must.

Patient and methods

Under the general ethical committee with a registration number Soh-Med24-07-08PD with written consents for all patients to approve the publication of their cases and pictures. Case series for a retrospective study conducted on 12 patients presented to our department of neurosurgery Sohag University Hospital with abnormal migration of the distal end of previously operated ventriculoperitoneal shunt, between April 2021 to January 2024. We include in our series all patients with abnormal presentation of distal end complications of the VP shunt

Patients with hardware failure or proximal shunt obstruction, were excluded from our study.

Case presentation

A total of 12 shunt migration cases were included, most of them 9 (75%) were males, and their ages ranged from 4 months to 22 years. Ten cases had VP shunt insertion for congenital causes, one was post-traumatic, and one was post-meningitis. Four cases had shunt migration to the anus, two to the scrotum, one to the urinary bladder, one to an exploratory wound, one to the chest wall, one to a myelomeningocele wound, one had backward proximal coiling around the flasher, and one slipped from flasher and downward migrated. All cases were managed by revision of the distal tube or extraction and insertion of a new distal tube. All cases showed good outcomes and complete recovery. This data is presented in **Table (1).**

Table 1. Clinical data of the included cases

ID	Age	Sex	Shunt insertion timing	Cause of hydrocephalous	Migration site	Management	Outcome
1	20 (years)	Male	5 years before the presentation, a left shunt for treatment of extracted malfunctioning right shunt	Post-traumatic	Urinary bladder with obstruction of tiny stone	Revision of the same distal tube with urinary catheter insertion for a few days	Good
2	4 months	Male	Left shunt 3 months before the presentation (1 month)	Congenital	Backward proximal coiling around the flasher	Revision the distal tube	Good
3	18 months	Male	Right shunt insertion.6 months before the presentation (at the age of 1 year)	Congenital	Anus	Extraction and insertion of a new distal tube	Good
4	24 months	Female	Neonate (1 month age)	Congenital	Anus	Extraction and insertion of a new distal tube	Good
5	6 months	Male	Right shunt inserted 6 months before the presentation (at age 2 weeks)	Congenital	Chest wall	Extraction and insertion of a new distal tube	Good
6	18 (years)	Male	Right shunt inserted 5 years before the presentation (at the age 13 years)	Post-meningitis	Exploration wound	Extraction and insertion of a new distal tube	Good
7	10 months	Female	10 months before the presentation (at birth)	Congenital	Anus	Extraction and insertion of a new distal tube	Good
8	12 months	Female	Right shunt was inserted 12 months before the presentation (since birth)	Congenital	Anus	Extraction and insertion of a new distal tube	Good
9	9 months	Male	Right shunt was inserted 9 months before	Congenital	Scrotum	Extraction and insertion of a new	Good

ID	Age	Sex	Shunt insertion timing	Cause of hydrocephalous	Migration site	Management	Outcome
			the presentation (since birth)			distal tube	
10	5 months	Male	Right shunt was inserted 5 months before the presentation (since birth)	Congenital	Myelomeningocele wound	Extraction and insertion of a new distal tube	Good
11	13 months	male	Right shunt was inserted 13 months before the presentation (since birth)	Congenital	Scrotum	Extraction and insertion of a new distal tube	Good
12	7years	male	Right shunt was inserted 7 years before the presentation (since birth)	Congenital	Slipped from flasher and downward migrated	A new distal tube insertion	Good

Case 1

A 20-year-old male patient presented with a DCL. He has a history of road traffic accident (RTA) at the age of 4 years. One month after the accident he was presented with blurred vision and secondary hydrocephalus. He was operated and an RT VP shunt was inserted, five years ago, the distal end was exposed at the abdomen and then extraction of the distal tube and a new LT shunt were inserted.

Abdominal ultrasonography and X-ray showed that the Lt VP shunt is seen at the left side of the anterior chest wall then, seen intraperitoneal at the left upper abdomen, and its tip is seen at the urinary bladder. **(Fig.1)**.

His CSF report was within normal parameters. This patient underwent revision of the same distal tube, the distal end was obstructed with urinary gravels, a urinary catheter was inserted for a few days and the patient showed good outcomes in the short and long terms **(Fig.2).**

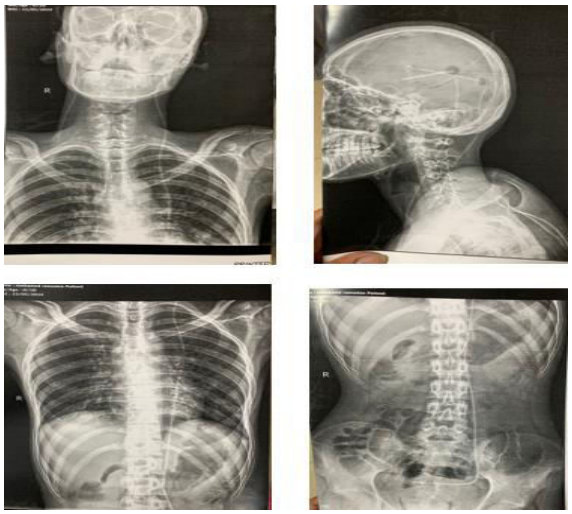

Fig.1. X-rays showed a jumbled distal end of the Lt VP shunt in the urinary bladder.

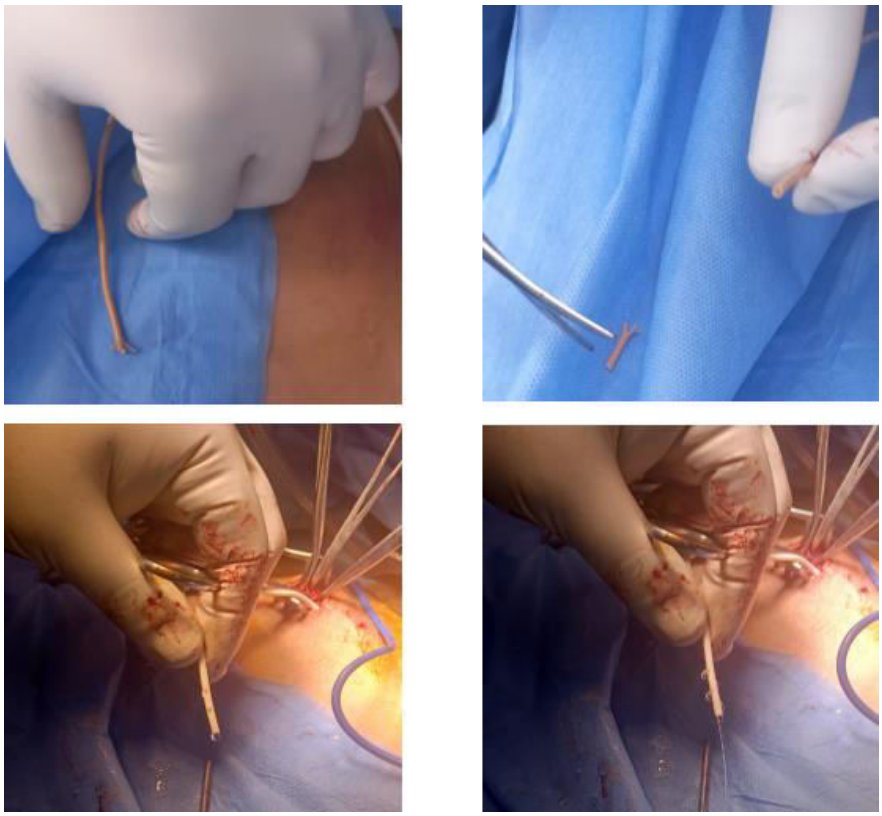

Fig.2. Intra OP, obstruction of the distal end with gravels, and subsequent revision.

Case 2

A 4-month-old male child was operated on since birth using a Lt VP shunt for congenital hydrocephalus and few months later presented with swelling around the flasher, and signs of increased intracranial tension. X-rays showed backward proximal coiling around the flasher. The patient underwent revision of the distal tube and showed good outcomes **(Fig. 3 & 4)**.

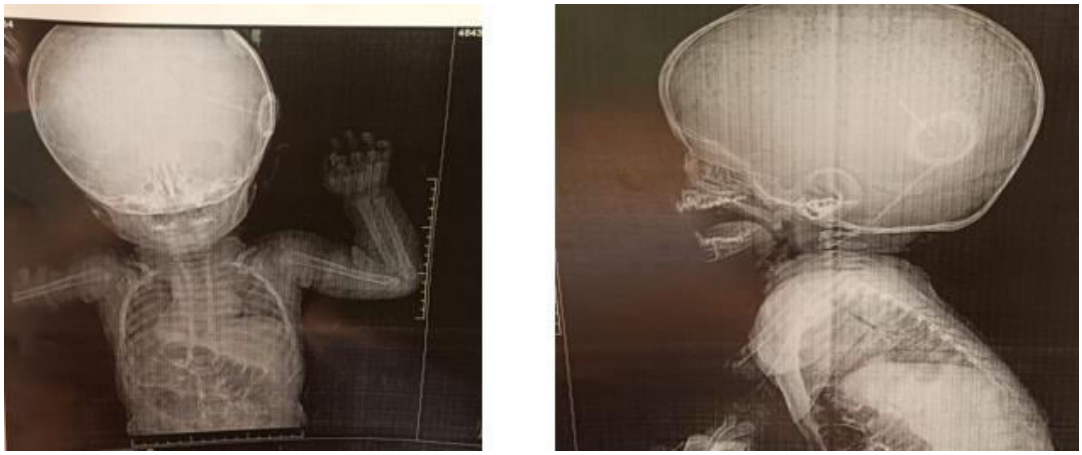

Fig.3.Posteroanterior and lateral views of the skull showing shunt coiling around the flasher.

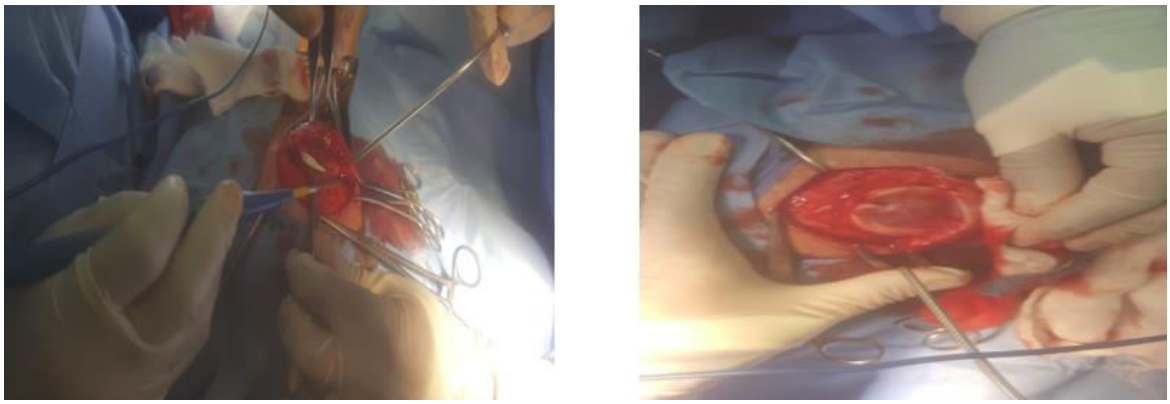

Fig.4. Intraoperative view of shunt migration and coiling.

Case 3

An 18-month-old male child was operated on since birth using a right VP shunt for congenital hydrocephalus and 18 months later presented with a pointing tube from the anus **(Fig. 5).** This patient underwent extraction and insertion of a new distal tube and showed good outcomes on follow up.

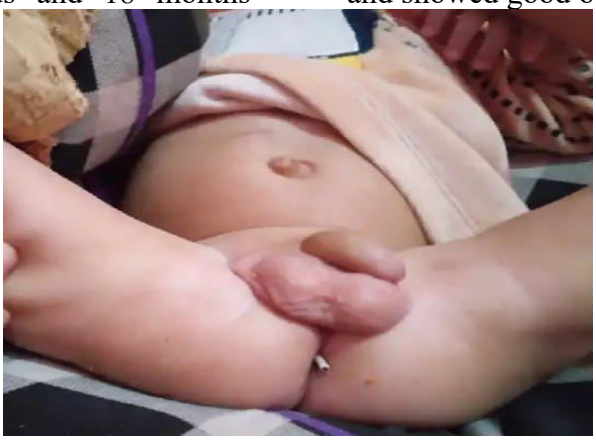

Fig.5. VP shunt migrated and extruded from the anus.

Case 4

A 2-year-old female child was operated on using a right VP shunt 2 years ago for congenital hydrocephalus. 2 months later she underwent a proximal revision. Then, at the age of 2, she presented with a pointing tube from the anus **(Fig. 6).** She underwent extraction and insertion of a new distal tube and showed good outcomes.

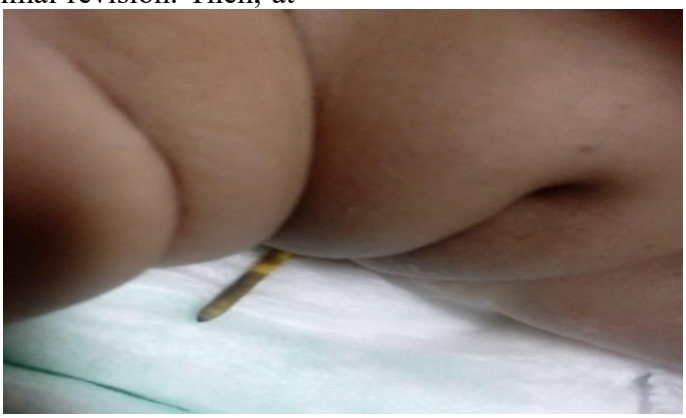

Fig.6. VP shunt migrated and extruded from the anus.

Case 5

A 9-month-old male child was operated on using a right VP shunt for congenital hydrocephalus since birth and presented with the distal end point from the right side of the scrotum **(Fig. 7 & 8)**. He underwent extraction and insertion of a new distal tube and showed good outcomes

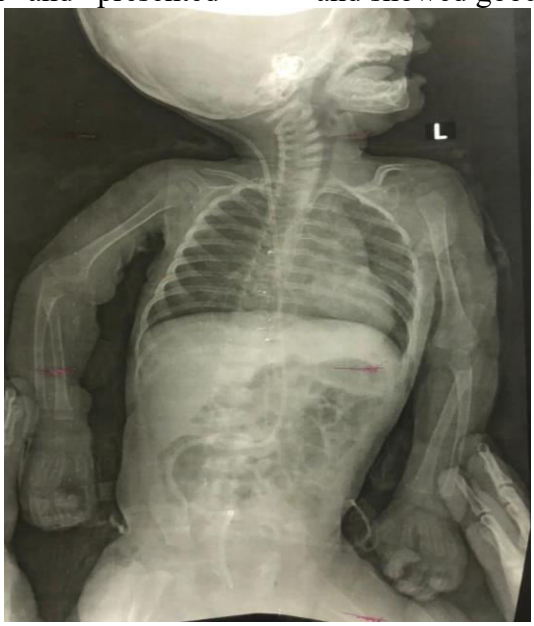

Fig.7. Anteroposterior X-ray showing a jumbled distal end of the VP shunt in the lower abdomen.

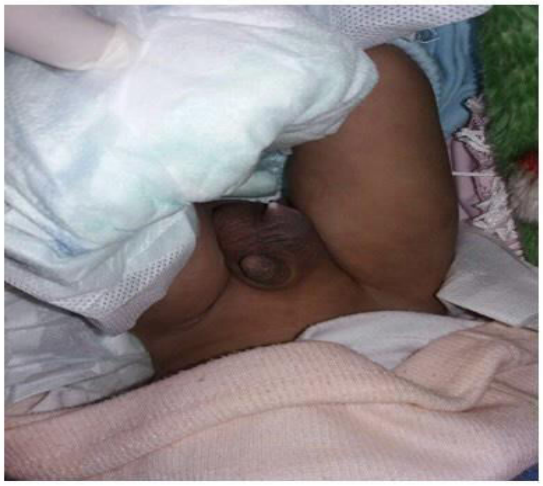

Fig.8. VP shunt migrated and extruded from the left side of the scrotum.

Case 6

A 6-month-old male child was operated on using a Rt VP shunt for congenital hydrocephalus and presented with the distal end pointing from the right flank **(Fig.9).** He underwent extraction and insertion of a new distal tube and showed good outcomes.

Fig.9.VP shunt migrated and extruded from the right chest wall.

Case 7

An 18-year-old male patient was operated on using a VP shunt 5 years ago for post meningitis hydrocephalous and then he presented with intestinal obstruction abdominal exploration was done about 1.5y ago **(Fig.10).** The patient presented by the distal end of the tube pointing from the exploratory wound, he underwent extraction and insertion of a new distal tube and showed good outcomes.

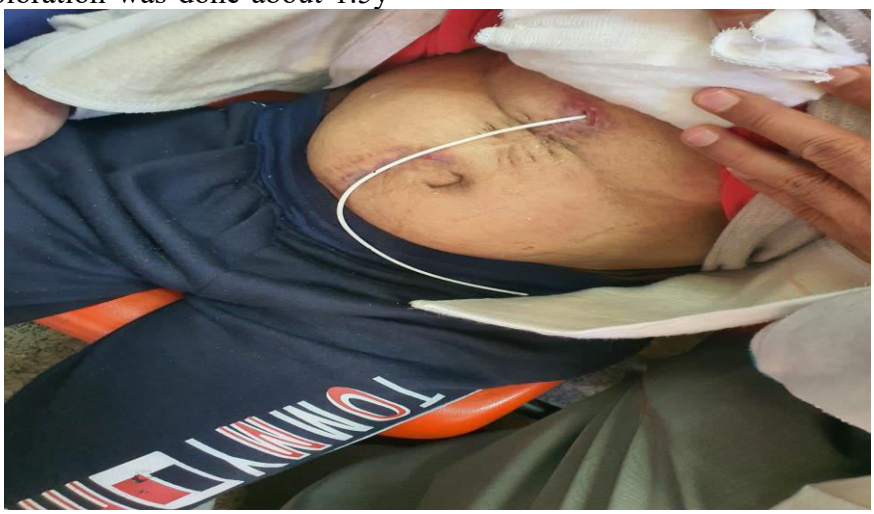

Fig.10. VP shunt migrated and extruded from an exploratory wound.

Case 8

A 5-month-old male child underwent right VP shunt insertion and myelomeningocele repair since birth and presented with the distal end of the tube pointing from a myelomeningocele wound (**Fig. 11 & 12).** He underwent extraction and insertion of a new distal tube.

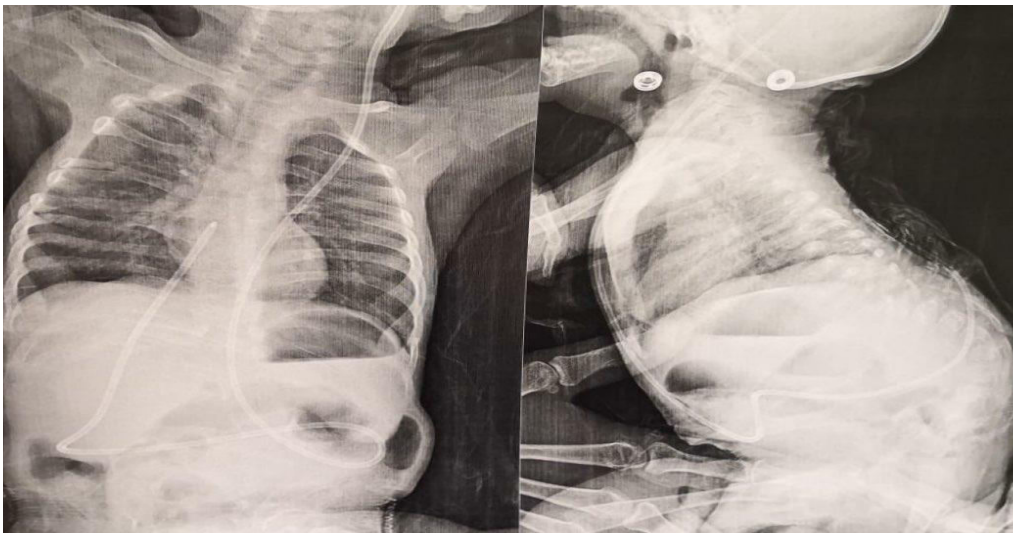

Fig.11. Anteroposterior and lateral X-ray showing a jumbled distal end of the VP shunt in the myelomeningocele wound.

Fig.12.VP shunt migrated and extruded from a myelomeningocele wound.

Case 9

A 7-year-old male child underwent right VP shunt since birth for congenital hydrocephalus. He presented with headache and swelling around the flasher, radiographic investigation showed distal tube disconnection and distal migration from the flasher **(Fig. 13 & 14).** He underwent a new distal tube insertion.

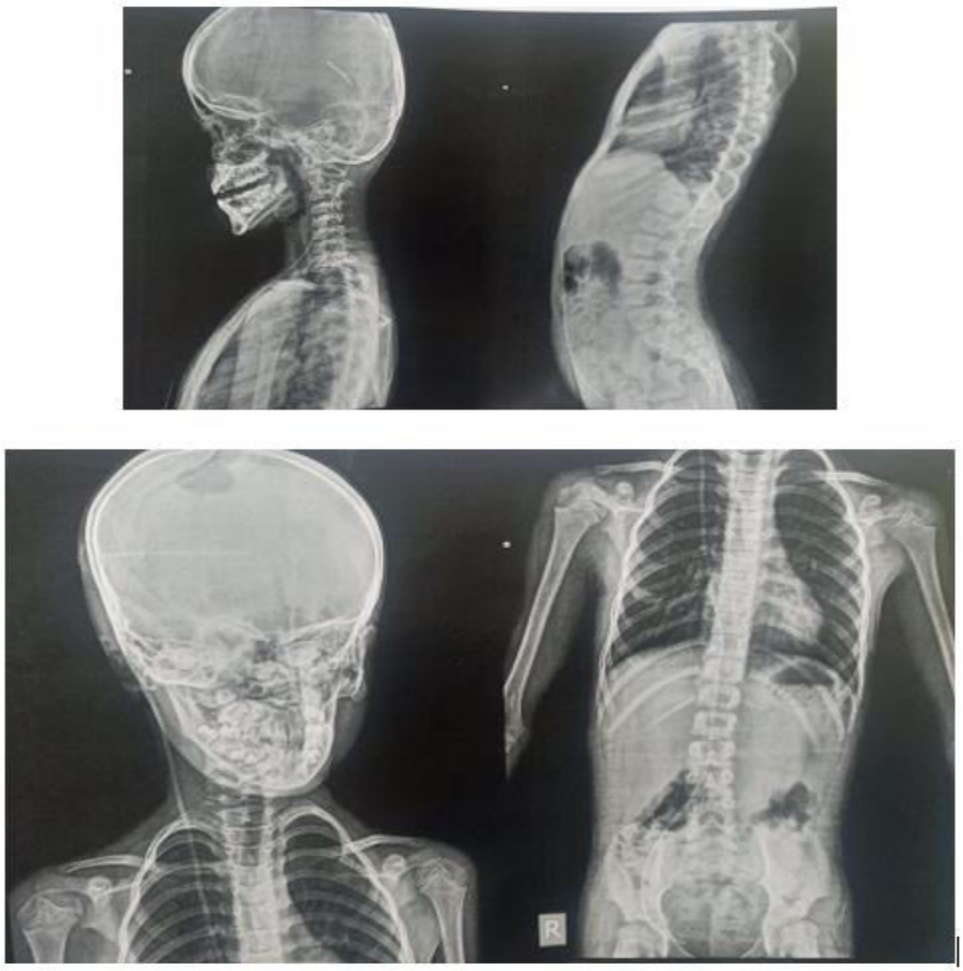

Fig.13. Anteroposterior and lateral X-ray showing a slipped from flasher and downward migrated.

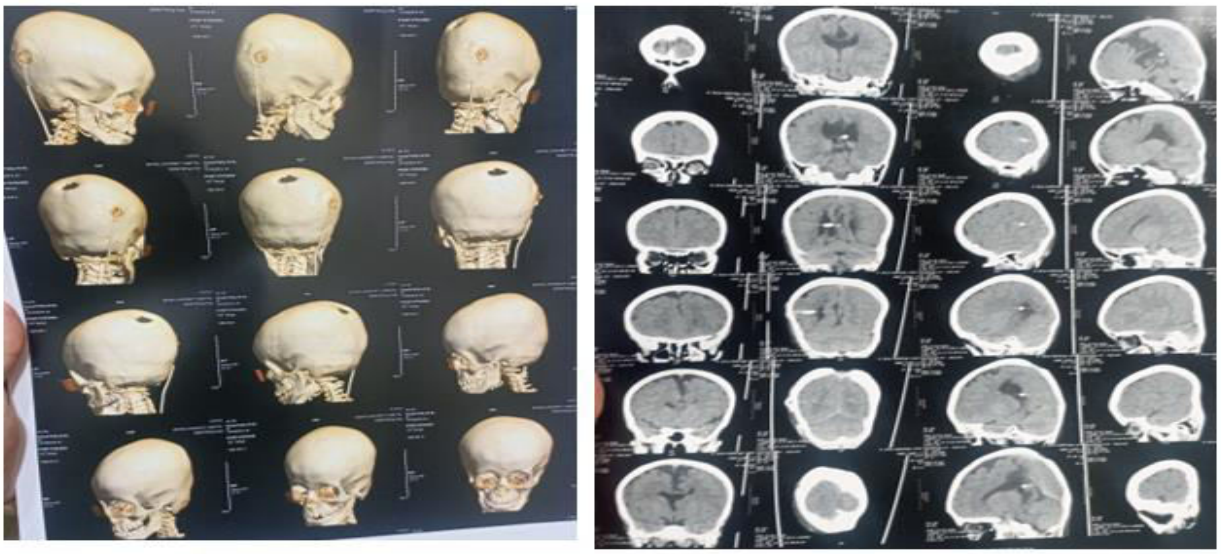

Fig.14.CT showing a slipped from flasher and downward migrated.

Statistical analysis

Data was tabulated and analyzed using Microsoft Excel (© Microsoft Office 365, version 2024) and SPSS software (IBM-SPSS, version 25; August 2017). Qualitative data were expressed as numbers and percentages, while quantitative data were expressed as median, minimum, maximum and interquartile range (IQR).

Results

Twelve patients (9 males, 3 females) with male to female ratio 3:1. Age ranging from 4 months to 20 years, pediatric to adult ratio 5:1. Fever was the most dominant complain for all our patients with 6 patients showed early meningeal irritation signs in the form of neck rigidity. Reinsertion of new distal tube of ventriculoperitoneal shunt in 10 cases and the remaining 2 cases only revision of the present distal shunt tube. During our period of follow up 6months-2 years) all cases showed good manual functioning VP shunt postoperative with no record for postoperative infection, CSF leak from the wound, or shunt obstruction. (**Table. 2**) showed these data.

Table 2. Analysis of the clinical data of the included cases.

Variables		Value
Age (in months)	Median	12.5
	Range	(4-240)
	IQR	(6.75-69)
Age group	Adults	2(16.7%)
	Children	10(83.3%)
Sex	Male	9(75%)
	Female	3(25%)
Shunt insertion time	Median	11
	Range	(3-84)
	IQR	(5.62-50.75)
Cause of hydrocephalus	Congenital	10(83.3%)
	Post-traumatic	1(8.3%)
	Post-meningitis	1(8.3%)
Migration site	Anus	4(33.3%)
	Scrotum	2(16.7%)
	Other sites	6(50%)
Manifestations	Fever	12(100%)
	Meningeal irritation	6(50%)
Management	Revision of the distal tube	2(16.7%)
	Extraction & insertion of a new distal tube	9(75%)
	Insertion of a new distal tube	1(8.3%)
Outcome	Good	12(100%)

Discussion

An established treatment method for hydrocephalus is the VP shunt procedure (**Mutlu et al., 2015**). Relatively unusual complications include the distal end of the VP shunt migrating and perforating in various body parts **(Al Fauzi et al., 2017; Vivek et al., 2015)**. Abdominal wall contractions that force the catheter out into the fibrous tract surrounding it may be the cause of peritoneal catheter migration. This might happen as a result of a calcified point around the tube causing the catheter to migrate towards subcutaneous tissue, or it

can happen as a result of excessive intra-abdominal pressure.

In our study, we presented several cases of VP shunt migration including to the urinary bladder. Most of the previous case reports were presented by bladder migration and perforation (**Guimarães et al., 2022; Chen et al., 2011; Eichel et al., 2002; Kataria et al., 2013; Mihajlović et al., 2012; De Aguiar et al., 2011).** However, our case was presented with signs of obstruction of the distal tube by gravels. According to certain earlier discussions and reports (**De Aguiar et al., 2011; Mevorach et al., 1992)**, the size of the bladder may have an impact on the likelihood of a VP shunt perforation. The urinary bladder in our case was of normal size. Authors documented that, there was a time span of two weeks to four years between the last surgery for VP shunt insertion or reapproach and the onset of the aforementioned problem.

We here also presented a child with migrating and coiled VP shunt around the flasher. **Shahsavaran *et al., 2012*** also reported two infants who had a ventriculoperitoneal shunt; the infants later developed shunt coiling and migration. Three months after the shunt insertion, the first case was admitted due to swelling around the proximal incision. At that time, the peritoneal catheter had migrated and coiled beneath the scalp. One month following shunting, the second patient was referred with stiff bulging fontanel and vomiting. The entire peritoneal catheter migrated to be coiled around the flusher with preservation of the ventricular catheter inside lateral ventricles and this was confirmed by brain CT imaging. This might happen as a result of a calcified point around the tube causing the catheter to migrate towards subcutaneous tissue, or it can happen as a result of excessive intra-abdominal pressure. Rotation or flexion-extension of the head and neck vigorously can also help the peritoneal catheter migrate upward **Mwachaka et al., 2010; Martínez-Lage et al., 1993)**. Another theory for coiling is retained memory of the shunt system since the coiled form of the catheter is similar to the shunt packed in the box **(Shafiee et al., 2011; Dominguez et al., 2000)**

In 1966, **Wilson and Bertrand** reported the first instance of the distal end of the VP shunt being extruded anally. We here also presented a trans-anal migration of VP shunt without signs of local infection in four cases. Prior to a clinical diagnosis of peritonitis or anal extrusion, the majority of these cases are asymptomatic. The precise cause of the several hypothesized mechanisms—which include pressure necrosis, silicone tubing-induced foreign body reaction, and maybe weak intestinal wall musculature is unknown. The continues water hammer effect of CSF pulsation can result in bowel perforation, while local inflammatory processes cause fibrosis with shunt tubing adhering to the intestinal wall (**Bansal et al., 2015)**. In addition, a patient's weakened state, inadequate nourishment, weakened host immunity, and surgical methods can all contribute to several risk factors for intestinal perforation (**Yılmaz et al., 2004)**.

We also presented two cases in which the peritoneal catheter migrated into the right side of the scrotum. **Júnior *et al., 2020*** reported that the right side of migration was the most frequent, occurring in 23 individuals (70%). During the embryonic stage, the peritoneum evaginated through the inguinal canal, forming the procesus vaginalisis, which was then followed by the testis' descent. About 80% of full-term children between the ages of 2 years and 16 years , 15 to 30% of adults have it. The anatomical predisposing condition for the development of hydrocele, inguinal hernias, and shunt catheter

migration into the scrotum is the patency of this structure. Increased intra-abdominal pressure is linked to VP shunt. This could put off the vaginal process's natural closure, which is linked to a higher risk of inguinal hernias and hydrocele, and it could also make the distal catheter more likely to migrate **(Ward et al., 2001; Grosfeld and Cooney., 1974).**

This study also presented two rare cases of migration and extrusion through the chest wall, an exploratory wound, and a myelomeningocele wound, we did not find similar literature to compare and interpret.

Early identification, quick shunt removal with the administration of wide-spectrum antibiotics, and additional shunt replacement on the opposite side, if necessary, following two consecutive sterile CSF cultures are the management strategies for these cases **(Sathyanarayana et al., 2000)** Laparotomies are quite seldom necessary for treating peritonitis in patients. After the VP shunt is removed, the majority of perforations heal on their own.

Study limitation: Retrospective in nature with short to medium time follow up, which is not enough to detect the accurate pathogenesis for the abnormal shunt migration. Thus, further studies should be done with long time follow up starting from the initial surgery of shunt insertion.

Conclusion

To sum up, anomalous distal ventriculoperitoneal shunt extrusion is hardly common. We were unable to provide a clear explanation for VP shunt extrusion and their unusually unpredictable behavior, despite a number of hypotheses. Further investigation is required to determine the causative agents of VP shunt extrusion. In the meanwhile, we support lifelong monitoring, the creation of a plan for managing these patients, and education for the patients, their parents, and guardians. In order to improve outcomes and reduce related mortality and morbidity, these problems should be treated as soon as possible.

References

- **Borkar SA, Satyarthee GD, Khan RN, Sharma BS, Mahapatra AK. (2008).** Spontaneous extrusion of migrated ventriculoperitoneal shunt catheter through chest wall: a case report. Turkish neurosurgery, 1;18(1).
- **Broggi M, Zattra CM, Schiariti M (2020).** Diagnosis of ventriculoperitoneal shunt malfunction: A practical algorithm. World Neurosurg, 137:e479–86.
- **Robert H. Bonow and Samuel R. Browd. (2018)** Principles of Neurological Surgery (Fourth Edition).
- **Çelik A, Ergün O, Arda MS, Yurtseven T, Erşahin Y, Balik E.(2005).** The incidence of inguinal complications after ventriculoperitoneal shunt for hydrocephalus. Child's Nervous System, 21:44-7.
- **Frazier JL, Wang PP, Patel SH, Benson JE, Cameron DE, Hoon Jr AH, Avellino AM. (2002).** Unusual migration of the distal catheter of a ventriculoperitoneal shunt into the heart: case report. Neurosurgery, 1;51(3):819-22.
- **DeSousa AL, Worth RM. (1979).** Extrusion of peritoneal catheter through abdominal incision: report of a rare complication of ventriculoperitoneal shunt. Neurosurgery, 1;5(4):504-6.
- **Whittle IR, Johnston IH. (1983).** Extrusion of peritoneal catheter through neck incision: a rare complication of ventriculoperitoneal shunting. Australian and New

Zealand Journal of Surgery, 53(2):177-8.

- **Bryant MS, Bremer AM, Tepas 3rd JJ, Mollitt DL, Nquyen TQ, Talbert JL. (1988).** Abdominal complications of ventriculoperitoneal shunts. Case reports and review of the literature. The American Surgeon, 54(1):50-5.
- **Kast J, Duong D, Nowzari F, Chadduck WM, Schiff SJ. (1994).** Time-related patterns of ventricular shunt failure. Child's Nervous System, 10:524-8.
- **Akcora B, Serarslan Y, Sangun O. (2006).** Bowel perforation and transanal protrusion of a ventriculoperitoneal shunt catheter. Pediatric neurosurgery, 42(2):129-31.
- **Mutlu M, Kader S, Aslan Y, Yazar U, Imamoglu M. (2015).** An acute complication of ventriculoperitoneal shunt with bladder perforation and extrusion through the urethra in a newborn: Case report and review of the literature. Pediatr Neurosurg, 50:264–9.
- **Al Fauzi A, Djatisoesanto W, Wahyuhadi J, Parenrengi MA, Turchan A. (2017).** A rare case of repeated migration and transurethral extrusion of ventriculoperitoneal shunt. J Pediatr Neurosci, 12:96–8.
- **Vivek K, Tarun G, Gaurav J. (2015).** Urinary bladder perforation and per-urethral extrusion of lumbo-peritoneal shunt in a patient: Case report and review literature. J Spine Neurosurg, 4:1–3.
- **Guimarães AS, Júnior MV, Martins SP, Fagundes-Pereyra WJ. (2022).** Rare case of migration and perforation of the urinary bladder by ventriculoperitoneal shunt catheter with intravesical knotted formation: A case report and literature review. Surgical Neurology International, 13.
- **Chen TH, Lin MS, Kung WM, Hung KS, Chiang YH, Chen CH. (2011).** Combined ventriculoperitoneal shunt blockage, viscus perforation with migration into urethra, presenting with repeated UTI. Ann R Coll Surg Engl, 93:151–3.
- **Eichel L, Allende R, Mevorach RA, Hulbert WC, Rabinowitz R. (2002).** Bladder calculus formation and urinary retention secondary to perforation of a normal bladder by a ventriculoperitoneal shunt. Urology, 60:344.
- **Kataria R, Sinha VD, Chopra S, Gupta A, Vyas N. (2013).** Urinary bladder perforation, intra-corporeal knotting, and per-urethral extrusion of ventriculoperitoneal shunt in a single patient: Case report and review of literature. Childs Nerv Sys, 29:693–7.
- **Mihajlović M, Tasić G, Raičević M, Mrdak M, Petrović B, Radlović V. (2012).** Asymptomatic perforation of large bowel and urinary bladder as a complication of ventriculoperitoneal shunt: Report of two cases. Srp Arh Celok Lek, 140:211–5.
- **De Aguiar GB, Mizrahi C, Aquino JH, Tavares CM, Telles C, Nigri F. (2011).** Urethral extrusion of a peritoenal catheter in a patient with neobladder: A rare complication of shunt insertion. Neuropediatrics, 42:124–7.
- **Mevorach RA, Hulbert WC, Merguerian PA, Rabinowitz R. (1992).** Perforation and intravesical erosion of a ventriculoperitoneal shunt in a child with an

augmentation cystoplasty. J Urol, 147:433–4.

- **Shahsavaran S, Kermani HR, Keikhosravi E, Nejat F, El Khashab M. (2012).** Ventriculoperitoneal shunt migration and coiling: A report of two cases. Journal of Pediatric Neurosciences, 1;7(2):114-6.
- **Mwachaka PH, Obonyo NG, Mutiso BK, Ranketi S, Mwangombe N. (2010).** Ventriculoperitoneal shunt complications: A three-year retrospective study in a Kenyan national teaching and referral hospital. Pediatr Neurosurg, 46:1–5.
- **Martínez-Lage JF, Poza M, Izura V. (1993).** Retrograde migration of the abdominal catheter as a complication of ventriculoperitoneal shunts: The fishhook sign. Childs Nerv Syst, 9:425–7.
- **Shafiee S, Nejat F, Raouf SM, Mehdizadeh M, El Khashab M. (2011).** Coiling and migration of peritoneal catheter into the breast: A very rare complication of ventriculoperitoneal shunt. Childs Nerv Sys, 27:1499–501.
- **Dominguez CJ, Tiagi A, Hall G, Timothy J, Chumas PD. (2000).** Subgaleal coiling of the proximal and distal components of a ventriculoperitoneal shunt. An unusual complication and proposed mechanism. Childs Nerv Syst, 16:493–5.
- **Wilson CB, Bertan V. (1966).** Perforation of the bowel complicating peritoneal shunt for hydrocephalus. Report of two cases. The American Surgeon, 32(9):601-3.
- **Bansal H, Gupta G, Gupta M, Kaushal R. (2015).** Unusual ventriculoperitoneal (VP) shunt tube extrusion through anus in a child with dandy walker malformation: A rare case report. Journal of clinical and diagnostic research: JCDR, 9(1):PD25.
- **Yılmaz N, Kıymaz N, Yılmaz C, Çaksen H, Yuca SA. (2004).** Anal protrusion of ventriculo-peritoneal shunt catheter: report of two infants. Journal of Pediatric Neurology, 1;2(4):241-4.
- **Júnior AG, Macedo FA, de Oliveira Vasconcelos E, Pinto AL. (2020).** Migration of ventriculoperitoneal shunt catheter into the scrotum: A case report and literature review. Archives of Pediatric Neurosurgery, 18;2:e282020-.
- **Ward JF, Moquin RR, Maurer ST. (2001).** Expanding the differential diagnosis of the acute scrotum: ventriculoperitoneal shunt herniation. Urology, 58(2):281.7.
- **Grosfeld JL, Cooney DR (1974).** Inguinal hernia after ventriculoperitoneal shunt for hydrocephalus. J Pediatr Surg. (9):311–316.
- **Sathyanarayana S, Wylen EL, Baskaya MK, Nanda A. (2000)**.Spontaneous bowel perforation after ventriculoperitoneal shunt surgery: case report and a review of 45 cases. Surgical neurology, 1;54(5):388-96.