MANAGEMENT OF UNUSUAL VENTRICULOPERITONEAL SHUNT COMPLICATIONS

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ABSTRACT

Objectives: Ventriculoperitoneal shunt surgery is the most widely used procedure in the treatment of hydrocephalus. However, this procedure has been associated with several delayed unusual complications. This paper will discuss these cases, their management and suggest ways on how to avoid these complications.

Methods: This prospective study was conducted in the neurosurgery unit at King Hussein Medical Centre, and included the patients between January 1996 - July 2007. The patients' images and management were reviewed.

Results: Sixteen patients were included in the study (10 males and 6 females). Their age was between three months and 40 years. One case had rectal perforation by ventriculoperitoneal shunt, seven cases had intraventricular migration of ventriculoperitoneal shunt, one case had umbilical perforation, one case had chest wall perforation by ventriculoperitoneal shunt, one case had liver perforation, four cases had overdrainage with subdural hematoma, one case had bladder perforation and one case had colon perforation by a ventriculoperitoneal shunt resulting in pneumocephalus. The management of ventriculoperitoneal shunt complications is discussed in details in this study.

Conclusions: The information provided within this study provides an analysis of our cases and the literature as it relates to the unusual complication of ventriculoperitoneal shunt through symptomatic presentation, diagnosis and management of these cases.

Key words: Hydrocephalus, Unusual complications, Ventriculoperitoneal shunts

JRMS December 2009; 16(3): 55-60

Introduction

The cerebrospinal fluid (CSF) shunt devices are associated with a number of complications, which has tempered the initial enthusiasm and, subsequently, the hope arisen by the introduction of any newly designed CSF shunt apparatus. Actually, the overall analysis of the results after treatment clearly indicates that the impact of CSF shunt device improvements on the failure rates seems to be very limited. Prevention, early identification and management of CSF shunt failures remain the main tools for assuring the quality of patient's long term outcome.

Methods

A prospective study of patients who developed unusual complications following ventriculoperitoneal (VP) shunt for hydrocephalus between January 1996 and July 2007 at the neurosurgery unit at King Hussein Medical Centre was carried out. There were 16 patients in this study, ten were males and six were females. Their age ranged between three months and 40 years.

Our patients presented with unusual ventriculoperitoneal (VP) shunt complications. It was easy to diagnose them on the bases of clinical presentation especially when the VP shunt tip protruded out of the anus or the penis. These

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Manuscript received November 15, 2007. Accepted May 22, 2008

Table I. Management of CSF shunt infections

1. Prevention	▪ Short operative time ▪ Presence of only required staff in the operating room ▪ Plastic isolators (sterile-drapes) ▪ Small surgical wounds ▪ Shunt components away from the incision line ▪ Avoid direct manipulation of the shunt (use sterile gauzes and forceps) ▪ Perioperative antibiotics
2. Treatment	▪ Remove the infected shunt and position an external ventricular catheter through the existing burr hole. ▪ Intrathecal antibiotics based on CSF cultures for 10-12 days ▪ Combine IV antibiotics only in case of systemic manifestations ▪ Three CSF negative cultures after discontinuing the antibiotic treatment followed by new shunt placement ▪ Consider systemic antibiotics and immediate shunt replacement only in children with compromised general conditions (e.g. reduced immune defenses during chemotherapy)

Table II. Management of post-shunting collections

1. Epidural hematoma	▪ Craniotomy ▪ Raise the valve pressure (mild symptoms) ▪ No treatment (asymptomatic cases with thin collections: close neuroradiological screening)
2. Acute subdural hematoma	▪ Craniotomy ▪ Temporary external subdural devices (mild symptoms; sub-acute collections) ▪ Raise the valve pressure (thin collections; asymptomatic patients)
3. Chronic subdural hematoma	▪ Surgical treatment also in asymptomatic children (high rate of hematoma calcification in the pediatric age group) ▪ Burr holes and temporary external drainage and/or ▪ Valve pressure raising ▪ Craniotomy (fibrous membranes) ▪ Subduro-peritoneal shunts (highly fluid collections)
4. Chronic subdural hygroma	▪ Transient external subdural or subduro-peritoneal shunts (unilateral also for bilateral collections) and/or ▪ Raise the valve pressure ▪ Implant a programmable valve

Table III. Management of visceral perforation, shunt disconnection and migration

Management of Visceral perforation	▪ Remove the shunt and exclude (CSF samples) shunt infection. If no shunt infection is detected ▪ New site peritoneal catheter insertion or ▪ Ventriculo-atrial shunt
Management of Disconnection and/or migration	▪ Open viscus repair in selected cases (e.g. active enteritis; infected pseudocysts) ▪ One step repositioning of the shunt if no external communication is detected (in alternative treat the shunt as an infected one) ▪ Remove the migrated shunt only in case of recurrent CSF infections

patients presented to us with headache, fever, vomiting and signs of meningeal irritation. Chest wall erythema and cerebrospinal fluid leak through the abdominal wall is another presentation. Computed tomography was helpful in the diagnoses of over drainage with subdural hematoma and pneumocephalus.

Results

There are several precautions which should be taken during the ventriculoperitoneal shunt procedure which minimize the risk of shunt infection. When infection occurred the mode of treatment followed is summarized Table I. In cases of post-shunt collection the management of different types of hematomas is discussed in Table II. The perforation of the bowel was a very rare complication. In cases with this complication the shunt was removed without complication and the patients remained asymptomatic (Table III).

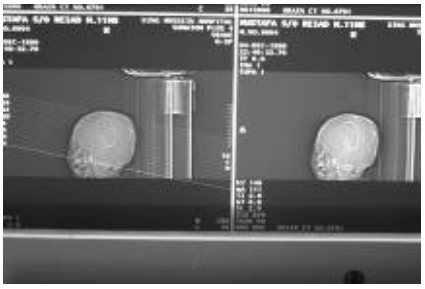

Fig. 1. CT scan showing disconnected VP shunt

Fig. 2. Axial CT scan showing over drainage with chronic subdural hematoma.

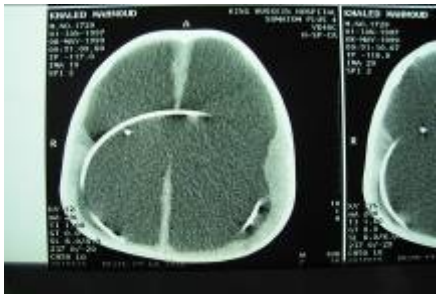

Fig. 3. Axial CT scan showing discrepancy between cranial and brain volumes

Fig. 4. VP shunt protruding through the liver

Discussion

Infection is the foremost type of CSF shunt complication after mechanical malfunctions. Even though the incidence of this complication may vary in the literature, most authors report infection rates between 5% and 18%.[1]

The use of one-piece shunts has decreased the incidence of disconnection complication. Disconnection is mainly seen as a consequence of excessive strain on the pumping device. Stretching at this level causes valve damage and with time may cause the system to fracture. Multipiece shunts can disconnect at any attachment site (Fig 1); because of the continuous traction forces junctions at the neck or the abdomen should always be avoided. The weakest points are the interface between silicone and metallic components and the ligatures, which favor the tearing of the plastic material.[1,2]

In cases with cerebrospinal fluid over drainage, the amount of drained CSF from the cerebral ventricular system is not directly related to the opening pressure of the inserted valve, but to the pressure gradient existing between the ventricles and the body cavities to where the CSF is diverted.[3] Over drainage complications may be divided into acute and chronic. Epidural hematomas (Fig. 2) are an unusual complication of ventriculoperitoneal shunt placement and are much less common than post-shunting subdural collections.[4] Young age and evidence of chronic hydrocephalus are factors recognized to favor this condition; a discrepancy between cranial and brain volumes may further contribute to this condition (Fig. 3). The rapid reduction in intracranial pressure following CSF drainage, results in separation of the dura mater from the skull and tearing of small dural vessels. It is known that the dura mater in children and young adults is less adherent to the skull than in older patients, which explains why most cases of postventriculostomy epidural hematomas occur in children and young adults. Prophylactic measures include the careful evacuation/refilling of the ventricles during surgery and the use of high-pressure opening valve systems in selected cases with severe or long-standing hydrocephalus. Anti-siphon devices and programmable valves have also been reported to reduce the incidence of subdural collections.

Craniotomy and removal of the clot is needed in patients with acute and/or rapid clinical worsening. Short term application of subdural suction devices is an alternative option in mildly symptomatic cases. Other therapeutic options are temporarily closing the drainage and changing the drainage system to one with a higher opening pressure valve.[3]

Visceral perforation

Visceral perforation is an unusual but serious complication of ventriculoperitoneal shunting; the

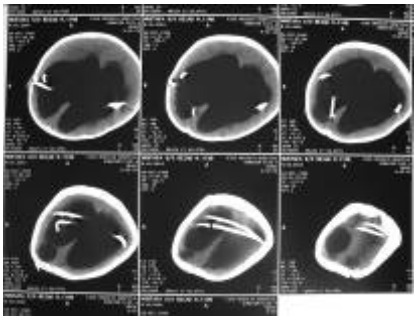

Fig. 5. Axial CT scan showed VP shunt migration into the lateral ventricle

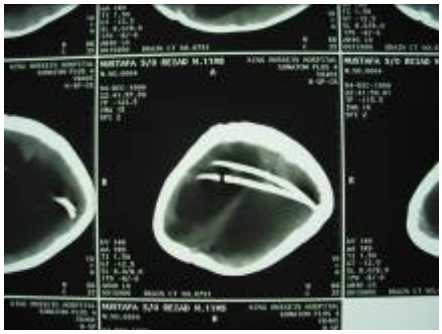

Fig. 6. Axial CT scan showed shunt migration into the lateral ventricle

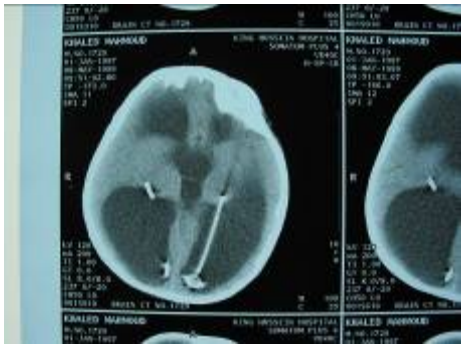

Fig. 7. Axial CT scan showed VP shunt migration into the lateral ventricle

Fig. 8. VP shunt extrusion into the chest

Fig. 9. VP shunt migration into the abdominal wall

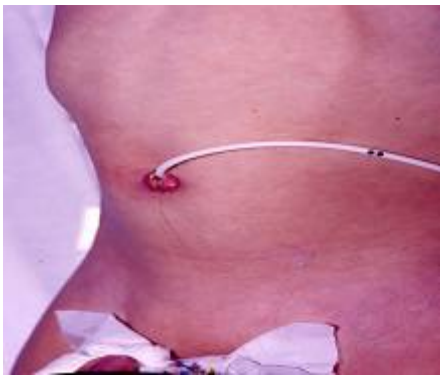

Fig. 10. VP shunt protrusion through the umbilicus

incidence of mortality can be as high as 15%. The bowel is the most involved site (0.1%) with the protrusion of the ventriculoperitoneal shunt through the anus[5] (Fig. 4), the bladder (Fig. 5), the stomach, or the liver (Fig. 6). Early cases occur at the time of insertion because the surgeon mistakes a viscus wall for the peritoneum. Peritoneal adhesions and improper (too high for the liver and gallbladder; low for the bladder and vagina) skin incisions increase the risk. No definite cause has been recognized for later occurrences. It is speculated that local inflammation favors fibrous encasement of the tube; the following chronic friction slowly weakens the viscus wall leading to its breakdown. Complete lack of symptoms is possible and in almost all the cases of colonic perforation[6] signs of peritonitis are lacking On the contrary, abdominal pain and distention, fever and erithema of the abdominal wall may be evident in cases of bladder perforation, corresponding to the immediate occurrence of secondary peritonitis.[7] Leptomeningitis signs may complicate the clinical course and often are the first manifestation when rectal penetration by a disconnected ventriculoperitoneal shunt tube has happened.[8] Gram-negative bacteria are the main pathogenic agents, with E. Coli as the most frequently isolated organism in colonic cases.[9] Pneumocephalus, although rare, has also to be

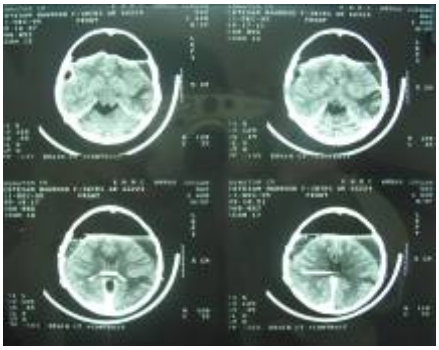

Fig. 11. Axial CT scan showed air penetration into the skull

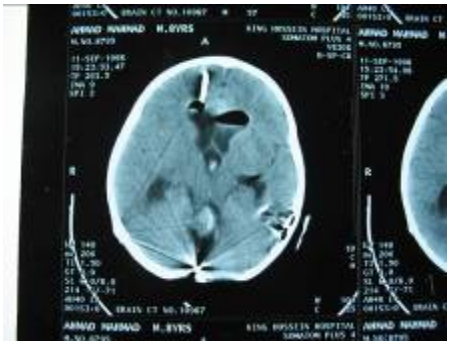

Fig. 12. Axial CT scan showed air inside the lateral ventricle

Fig. 13. Ventriculoperitoneal shunt protruding through the anus

Fig. 14. Ventriculoperitoneal shunt protruding through the urethra

regarded as a typical onset in these patients. In an appropriate clinical setting, it helps to establish the origin of a meningeal infection.[10]

Migration or Extrusion

Migration or extrusion of the CSF implanted device is rare. Incidence is higher for VP shunts, favored by the high mobility of the peritoneal end inside the abdomen as well as by the anatomical characteristics of the abdominal cavity itself.[11]

Various ways of migration have been described such as into the lateral ventricle[12] (Fig. 7 & Fig. 8), mediastinum, chest (Fig. 9), gastrointestinal tract, abdominal wall (Fig. 10 & Fig. 11), bladder, vagina and scrotum. Spontaneous extrusion through the umbilicus (Fig. 12), a very rare occurrence, probably underlies two mechanisms: the patency of the umbilical end of the vitello-intestinal duct and the intrinsic anatomical weakness of the umbilicus region, acting as a centrally situated natural scar.[13] Proximal migration is definitely unusual, but cases have been reported of complete shunt settling into the subgaleal tissue, inside the ventricles, the subarachnoid and subdural space and the brain parenchyma.[14] Various hypotheses have been advanced. Scott *et al.* postulated that flexion-extension movements of the patient's head may act as a windlass, facilitating upward movement of the peritoneal catheter.[15] Other mechanisms suggested by Abou el Nasr are negative suction from intraventricular pressure and positive intra-abdominal pressure.[16]. A role of loose subcutaneous tissue has been suggested. "Memory" of the packaged coiling of the shunt system may further mediate the process.[16]

Pneumocephalus

Even if this complication cannot be regarded as a direct manifestation of CSF over drainage, air penetrating into the skull in hydrocephalic patients (Fig. 13 % Fig. 14) may correspond to the reduction in volume of the brain, due to the siphon effect of the shunt.[3] Discontinuities of the cranial floor are important.[17] Negative pressures are developed in standing positions; CSF is displaced either through the cranial base or through the shunt. The negative pressure and the displaced volume of CSF flow allow the air to fill the vacuum. The air is then

trapped by brain plugs as a result of a ball-valve phenomenon.[17,18] Treatment of patients with thinning of the cranial base would probably benefit from high pressure shunt-valves or antisiphon devices. These might reduce the high negative pressures and increase the margin of safety.[17]

Upon emergency, a burr hole is indicated, to relieve tension air collections.[18] The etiology and site of the skull base connection are crucial to therapy. Treatment of choice is the closure of the fistula, with eventual temporary removal (or conversion to an external drainage) of the CSF shunt. In patients with pneumocephalus due to visceral perforation, the shunt should be removed, the connection closed if necessary and a new shunt placed at a different site after a temporary extraventricular drainage, to exclude CSF infections.[10]

Conclusion

As doctors we should be aware of unusual complications of VP shunts, especially when patients present with acute abdomen with signs of meningeal irritation in which we should keep in our mind bowel or viscus perforation. Long term follow up of patients with VP shunt is important for early detection of rare complication.

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