An analysis of outcome of paediatric hydrocephalus: A 10 year study from Central India

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Abstract

Introduction*:* Ventriculo-peritoneal (VP) shunt is an easy and inexpensive procedure done for the management of hydrocephalus all over the world. However, it is associated with several complications and morbidity.

Objectives: To assess the outcome of children having hydrocephalus who underwent a VP shunt.

Method*:* In this retrospective study, records of 196 children who were operated on by the first author for hydrocephalus were analysed and the spectrum of complications noted. This ten year study was conducted from May 2010 to April 2020 and the patients were operated in various hospitals and tertiary care centres in Bhopal city, Madhya Pradesh, India.

Results*:* Out of the 196 patients, 120 were boys and 76 were girls. In this series 130 (66.3%) patients were less than 1 year of age. Median age was 20.7 months (range 1.4 months to 9.5 years). Aqueductal stenosis (35.7%) was the commonest congenital cause and tubercular meningitis (16.3%) the commonest acquired cause of hydrocephalus. Vomiting (18.4%) was the commonest symptom and enlargement of head (40.8%) the commonest sign. Common indications for shunt revision were shunt obstruction (10.2%) and shunt infection (6.6%). Mortality in this series was 12.8%.

Conclusions*:* Of the 196 children who underwent VP shunt for hydrocephalus over a period of 10 years, 12.8% died, 10.2% had shunt obstruction and 6.6% had shunt infection.

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Introduction

With present day high standards of care, most patients operated for paediatric hydrocephalus survive but morbidity and mortality from hydrocephalus still exist[1]. Ventriculo-peritoneal (VP) shunt is the commonest surgery done for paediatric hydrocephalus[2]. Despite technical advances, shunt infection is yet a serious complication[3,4]. Besides VP shunt, other shunting techniques for hydrocephalus are endoscopic third ventriculostomy, ventriculo-atrial shunts and lumbar-peritoneal shunts[5].

Objectives

To assess the outcome of children having hydrocephalus who underwent a VP shunt.

Method

In this retrospective study, records of 196 children who were operated on by the first author for hydrocephalus in the paediatric age group were studied and the spectrum of complications noted. This ten year study was conducted from May 2010 to April 2020 and the patients were operated in various hospitals and tertiary care centres in Bhopal city, Madhya Pradesh, India.

Inclusion criteria: Patients 12 years of age and below, with a diagnosis of hydrocephalus were included.

Exclusion criteria: Patients over the age of 12 years, patients with intracranial space occupying lesions and those not giving consent for surgery were excluded.

On admission, demographic profile like age, sex, weight, head circumference, duration of symptoms and signs, were noted. Thorough clinical examination was done. General condition of patient was assessed and necessary radiological and laboratory investigations were done. Trans-fontanelle ultrasonography (USG), computed tomography (CT) and magnetic resonance imaging (MRI) were done to assess ventricular dilatation and parenchymal thickness.

After investigation, patients were subjected to VP shunt insertion under general anaesthesia. Third-generation cephalosporins were given at the time of induction in all cases. After incision over sc alp, a

small burr hole was made and the dura was incised with cautery and the fenestrated ventricular end was placed, in the lateral ventricle. A tunnel was made in the subcutaneous plane for shunt tube placement and distal end was placed in the supra-hepatic space through a small transverse right upper quadrant incision. Upper end of the shunt tube was fixed to scalp layers with absorbable suture. Postoperatively, all patients were monitored in the paediatric intensive care unit (PICU) or neonatal intensive care unit (NICU). They were given intravenous (IV) fluids, antibiotics, and analgesics. The patients were discharged in five days if there were no complications.

The patients were followed up in the outpatient department (OPD) at various intervals up to one year after surgery. Milestones of development, convulsions, acceptance of feed, fever, signs of increased intracranial pressure were noted clinically on follow up. Function of VP shunt was checked by compressing and rapid refilling of the shunt chamber. Three months after surgery a follow up CT scan was done. Data were collected, analysed and compared with other available literature.

Ethical issues: As this was a retrospective observational study of records of operated patients available with the first author from various centres where he worked, no ethical clearance was obtained and informed consent was not a possibility. Confidentiality is ensured.

Results

In the ten year period, out of the 196 children operated, 120 were boys and 76 were girls, 130 (66.3%) were less than 1 year of age and the median age was 20.7 months (range 1.4 months to 9.5 years).

Table 1 shows the causative factors for hydrocephalus. Aqueductal stenosis was the commonest congenital cause and tubercular meningitis the commonest acquired cause of hydrocephalus.

Table 1: ***Causative factors for hydrocephalus***

Causative factor	Number (%)
Congenital	
Aqueductal stenosis	70 (35.7)
Dandy Walker syndrome	12 (06.1)
Arnold Chiari malformation	12 (06.1)
Lumbosacral meningomyelocoele	30 (15.3)
Occipital encephalocoele	06 (03.1)
Acquired	
Tubercular	32 (16.3)
Pyogenic	26 (13.3)
Post traumatic	04 (02.1)
Ventricular haemorrhage	04 (02.1)
Total	196 (100.0)

The symptoms of hydrocephalus are shown in Table 2. Vomiting and headache were the most common symptoms.

Table 2: ***Symptoms of hydrocephalus***

Symptom	Number (%)
Asymptomatic	66 (33.7)
Vomiting	36 (18.4)
Headache	34 (17.3)
Fever	22 (11.2)
Convulsions	14 (07.1)
Dull and Drowsy	12 (06.1)
Irritability	12 (06.1)
Total	196 (100.0)

The signs of hydrocephalus are shown in Table 3. Enlargement of head was the most common sign.

Table 3: ***Signs of hydrocephalus***

Signs	Number (%)
Raised head circumference	80 (40.8)
Wide and deformed cranial sutures	40 (20.4)
Papilloedema	30 (15.3)
Bulging anterior fontanelle	28 (14.3)
Deranged higher mental functions	18 (09.2)
Total	196 (100.0)

Complications of VP shunts requiring revision are shown in Table 4.

Table 4: ***Complications of ventriculo-peritoneal shunts requiring revision (n=196)***

Causes	n (%)
Peritoneal end block/ malfunction	17 (08.7)
Shunt tract infection	13 (06.6)
Ventricular end block/ malfunction	03 (01.5)
CSF leak from wound	02 (01.0)
Anal protrusion of shunt	02 (01.0)
CSF pseudocyst	02 (01.0)
Displaced ventricular end	01 (0.5)
Extrusion from neck	01 (0.5)
Extrusion from abdominal incision	01 (0.5)
Total	42 (21.4)

CSF: Cerebrospinal fluid

The most common indications of shunt revision were shunt obstruction comprising 20 (10.2%) cases and shunt infection comprising 13 (6.6%) cases. There were 2 cases of cerebrospinal fluid (CSF) leak from abdominal wound following VP shunting and both were managed successfully by revision of the peritoneal part of shunt. Two cases presented as extrusion of peritoneal part of VP shunt catheter through the anus without features of peritonitis or meningitis (Figure 1). This was managed by a mini laparotomy with revision of the peritoneal part of shunt alone.

Figure 1: ***Extrusion of shunt through anus***

We observed two cases of CSF pseudocysts in the peritoneal cavity following VP shunt operations (Figure 2), both presenting with progressive abdominal distention and malfunction of the peritoneal part of the shunt.. Both were managed by formal exploratory laparotomy, excision of the cysts and relocation of the peritoneal catheter.

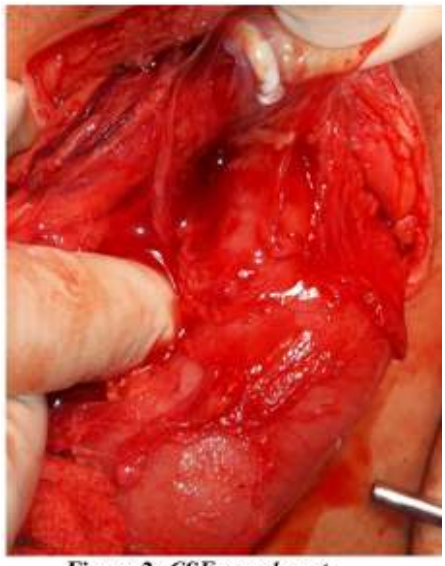

Figure 2: ***CSF pseudocyst***

Complications of VP shunts which did not require revision are shown in Table 5.

Table 5: ***Complications of ventriculo-peritoneal shunts not requiring revision of shunt (n=196)***

Causes	**Number (%)**
Seizure	14 (07.1)
Superficial wound infection	04 (02.0)
Ascites	04 (02.0)
Craniosynostosis	02 (01.0)
Subgaleal collection	02 (01.0)
Inguinal hernia	02 (01.0)
Hydrocoele	02 (01.0)
Total	30 (15.3)

There were 2 cases of inguinal hernia after VP shunts related to an accumulation of CSF in excess of the peritoneal absorption rate. Two cases of subgaleal fluid accumulation after shunt surgery were seen in this study (Figure 3).

Figure 3: ***Subgaleal CSF collection***

We also encountered extrusion of the peritoneal part of the VP shunt catheter, one each from neck wound (Figure 4) and from the abdominal wound (Figure5). In both cases disconnection of tube was done from shunt chamber under local anaesthesia and distal tubing was pulled out. Re-shunting on opposite side was done later.

Figure 4: ***Extrusion of shunt through neck wound***

Figure 5: ***Extrusion of shunt through abdominal wound***

In this study two cases of craniosynostosis were seen (Figure 6).

Figure 6: ***Craniosynostosis***
Permission given by parents to publish photograph

Mortality in this study was 12.8% (25 out of 196).

Discussion

Hydrocephalus is the pathological accumulation of intracranial CSF due to overproduction or decreased circulation to other brain compartments leading to swelling of the ventricular system and ultimately to brain damage[6,7]. The commonest causes of shunt failure in children are obstruction and infection[8]. In this study, overall complications of VP shunt in congenital hydrocephalus was 72 (36.7%), which is in accordance with global figures of 25–40%[3,9,10]. The incidence of shunt blockage has been reported in the literature to range from 5% to 47%[11,12]. In this series the incidence of shunt blockage was 10.2%.

In this study, infection was the second common complication following shunt surgery with an incidence of 6.6%. In various studies 40% of shunt infections are due to *Staphylococcus epidermidis* and 20% to *Staphylococcus aureus*[13]. Because these organisms form a part of the normal skin flora, endogenous spread from patient or staff is the probable route of infection[14]. Shunt infection was treated by intermittent CSF tapping and IV antibiotics based on culture and sensitivity of CSF and exteriorization of the shunt. Revision of shunt was done only when CSF samples confirmed absence of infection. Choux M, *et al*[15] showed that better selection of indications, adequate skin preparation with disinfecting baths and a standardized surgical technique greatly reduced the infection level. Premature neonates are at the greatest risk for shunt infection as their immune system is not fully developed[16]. Rotim K, *et al*[17] adopting a strict protocol for shunt placement, including adequate skin preparation, perioperative antibiotics, and short operating time, reduced their rate of shunt infection from 17.9% to 8%.

In our study two cases presented as extrusion of the peritoneal part of VP shunt catheter through the anus without features of peritonitis or meningitis. Perforation of bowel by catheter tubing is a rare complication of VP shunt placement carrying the risk of ascending infection to the brain in the form of meningitis, encephalitis, or brain abscess[18]. We observed two cases of CSF pseudocysts in peritoneal cavity following VP shunt operations, both presenting with progressive abdominal distention and malfunction of the peritoneal part of the shunt. CSF pseudocysts in the peritoneal cavity is a known complication of VP shunt malfunction with an incidence of <1% to 4.5%[19,20]. USG and CT scan of abdomen and pelvis are excellent imaging modalities for diagnosis of CSF pseudocysts. The treatment options for CSF pseudocysts in the peritoneal cavity are excision of the cysts and relocation of the shunt that can be done either through formal laparotomy or laparoscopically[21,22]. Two cases of subgaleal fluid accumulation after shunt surgery were seen in this study. Various studies have described this complication mostly with malfunctioning shunt in the early post-operative period[23,24]. We also encountered extrusion of the peritoneal part of the VP shunt catheter, one each from the neck wound and the abdominal wound. In this study two cases of craniosynostosis were seen. Hydrocephalus is found in 4-10% of cases of craniosynostosis[25].

Although the risk in performing shunt operation is low, the complications related to shunts are many and in this study 20 (47.6%) of the failures were seen within three months of surgery. Several reports have mentioned that 40-60% of shunt infections manifest within three months after shunt insertion[26]. In this study there were 25 (12.8%) deaths and the mortality reported in various studies was around 13.7%[27]. Endoscopic third ventriculostomy obviates the need for a ventricular shunt, thus avoiding shunt-related complications[28]. CSF shunting has a propensity for mechanical failure and children with VP shunts should be regularly followed-up through transition to adulthood.

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