Section: Neurosurgery

Original Research Article

A PROSPECTIVE STUDY OF VENTRICULOPERITONEAL SHUNT COMPLICATIONS AND IDENTIFICATION OF RISK FACTORS

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Abstract

Background: Hydrocephalus is a commonly encountered problem in neurosurgery practice. It is often treated with ventriculoperitoneal shunt, which in itself has its attendant complications. It can have complications of shunt failure, requires revisions and long term observation. The aim of the study is to study the incidence, predisposing factors and causes of complications in ventriculoperitoneal shunts. **Materials and Methods:** This was a prospective observational study done in the Department of Neurosurgery, Osmania General Hospital, Hyderabad, over a period of two years four months. The study population comprised of patients diagnosed with hydrocephalus. Ventriculoperitoneal shunts were placed in 300 cases, of which 96 patients had complications. These 96 patients were studied in detail for demographics, clinical features, predisposing factors and mortality. **Result:** Of the 300 patients, complications were seen in 96 patients, wherein, 36 patients were managed conservatively and in 60 patients, shunt revision was done. The patient age ranged from birth to 60 years. The male to female ratio was 1.7:1 Common complications were infection seen in 45 (15%) cases, mechanical malfunction in 30 (10%) cases, shunt migration in 15 (5%) cases, abdominal complications in 6 (2%) cases and shunt extrusion in 3 (1%) cases. Predisposing factors for complications were preterm births, congenital hydrocephalus and multiple revisions. **Conclusion:** Hydrocephalus can occur over a wide age range and the most common causes are congenital hydrocephalus, intracranial tumors and post meningitic. Complications can occur in nearly a third of patients who undergo ventriculoperitoneal shunt placement. Most common complications of VP shunts are infection and mechanical malfunction. Some of the common risk factors for malfunction of VP shunt are age <6 months, premature birth, congenital hydrocephalus, improper placement of shunt in the ventricle, previous shunt infection and multiple revisions.

INTRODUCTION

The term hydrocephalus is derived from the Greek: hydro meaning water and kefale meaning skull. Hydrocephalus is defined as the state of excessive intracranial accumulation of CSF that results from excessive production, circulation, or absorption of CSF. It is often characterized by ventriculomegaly and is broadly classified as communicating and non-communicating/ obstructive type.[1]

Hydrocephalus is a commonly encountered disorder that occurs either as a primary condition or as a sequela to an intracranial hemorrhage, a space occupying lesion or meningitis. Hydrocephalus is more commonly reported in children than in adults. It could be either obstructive type which is more common or the communicating type. Shunting of the cerebrospinal fluid (CSF) from the ventricular system to the peritoneum remains the primary treatment option for patients with hydrocephalus and is also recommended for those who do not improve after endoscopic third ventriculostomy. Hydrocephalus is often treated with diversion of CSF through shunting but it entails many complications and sometimes shunt failures. It often requires revisions and long term follow up and is associated with significant morbidity.

Among various risk factors possibly related to shunt failure, patient demographics such as age, etiology of hydrocephalus, type of hydrocephalus, and other perioperative variables have received considerable attention, although conclusions have been drawn

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regarding their significance in the genesis of shunt failure.[2]

Although this condition is highly prevalent in our hospital referral areas, very few studies from our institute have emanated. Hence, we have attempted to evaluate prospectively the various causes, clinical presentations, investigations and functional outcome of patients operated on various types of hydrocephalus. The data so collected and analyzed would enable us to successfully frame guidelines for future understanding and effective treatment.

Aim of the study

To study the incidence, predisposing factors and causes of complications in ventriculoperitoneal shunts

MATERIALS AND METHODS

This was a prospective observational study done in the Department of Neurosurgery, Osmania General Hospital, Hyderabad, over a period of two years four months from November 2014 to February 2017. The study population comprised of patients diagnosed with hydrocephalus.

Inclusion Criteria

All patients with hydrocephalus irrespective of cause were included.

Patients with obstructive and communicating hydrocephalus, both were included.

Postoperative cases of hydrocephalus were also included.

In all patients post operative CT scan was taken.

All the complications following surgical procedures for the management of hydrocephalus were noted.

Exclusion Criteria

Patients operated for hydrocephalus in the past (recurrent cases) and presenting again with hydrocephalus were excluded.

A complete detailed history was taken in all patients presenting with hydrocephalus. All the patients were clinically examined and CT scan brain plain was taken preoperatively. Investigations done in all cases were CBP, ESR, serum electrolytes, Renal function tests, Blood grouping and Rh typing, X ray chest, ECG, USG abdomen, CT Brain Plain and with contrast, 2D ECHO, CSF analysis.

For statistical analysis, the data was entered in excel sheets and presented as frequency and percentages. The t test and chi square test were applied and p values were calculated.

The patients were categorized into various age groups, various presenting complaints, diagnoses and were categorized with different complications and various risk factors were identified. The patients were managed conservatively and surgically. Surgically the patients were managed by ventriculoperitoneal (VP) shunting and by revision of the procedures after shunt removal was done.

Surgical technique of insertion of VP shunt: The ventricular catheter is usually inserted on the non-dominant side, ie, right side. The patient position is supine with head turned to left side. The procedure is done under general anesthesia. The standard method of VP shunt was performed for all patients.[3]

Figure 1: Intraoperative photo of Right MPVP shunt surgery (tapping ventricles)

RESULTS

In the present study a total of 300 patients were studied prospectively. All the patients were diagnosed with hydrocephalus of various causes and underwent VP shunting procedure. Of these 300 patients, we encountered various complications in 96 patients, wherein, 36 patients were managed conservatively and in remaining 60 patients, shunt revision was done. The complications and various risk factors associated were studied in detail in these 96 patients.

Age: In the present study patients of varying age groups from birth to >60 years were present with mean age of 33 years. The incidence of patients in 0 – 6 months of age and 7 – 12 months was more ie. 105 (35%) and 64 (21.3%) respectively.

Table 1: Age wise distribution

Age	Males	Females	Total (%)
0-6 m	65	40	105 (35%)
7 -12 m	42	22	64 (21.3%)
13 m - 2 y	20	14	34 (11.3%)
3y- 10y	9	6	15 (5%)
11- 20 y	11	7	18 (6%)
21 – 30 y	9	5	14 (4.6%)
31 – 40 y	4	1	5 (1.6%)
41 – 50 y	11	4	15 (5%)
51– 60 y	12	8	20 (6.6%)
>60 y	6	4	10 (3.3%)
Total	189	111	300 (100%)

m=months, y=years

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Presentation-wise distribution: All the 300 patients underwent initial VP shunting procedure for hydrocephalus, of which 96 patients presented with various chief complaints like vomiting, headache, seizures, drowsiness, oral and rectal shunt extrusions, skin excoriation, of which the incidence of patients presenting with altered sensorium, vomiting and headache was 31.2% (30), 29.1% (28) and 17.7% (17) respectively.
Gender: In the present study there were 189 (63%) males and 111 (37%) female patients and the male to female ratio was 1.7:1.

Table 2: Presenting complaints of the patients who had complications

Presenting complaint	No. of patients (%)
Vomiting	28 (29.1%)
Headache	17 (17.7%)
Headache with fever	5 (5.2%)
Seizures	6 (6.2%)
Altered sensorium	30 (31.2%)
Shunt extrusion	3 (3.1%)
Skin excoriation	7 (7.2%)

Diagnosis: In the present study of 300 patients of hydrocephalus, 201 (67%) were due to congenital hydrocephalus with 138 males and 63 females, 60 (20%) were due to intracranial tumors with 39 males and 21 females and 39 (13%) were due to post meningitis with 12 males and 27 females. The incidence rate in males was more in congenital hydrocephalus and intracranial tumors.
Age and gender wise distribution of cases with complications: Of the 300 patients, complications were encountered in 96 patients, of which the incidence of congenital hydrocephalus, intracranial tumors and post-meningitis hydrocephalus was 65 (67.6%), 12 (19.7%) and 19 (12.5%) cases respectively.

Table 3: Age and gender wise distribution of cases with complications

	Age	Males (n=59)	Females (n=37)	Total (%) n=96
Congenital hydrocephalus (n=65)	0 – 6 m	23	11	34 (52.3%)
	7 – 12 m	13	7	20 (30.7%)
	13 m – 2 y	7	4	11 (16.9%)
Total		43	22	65 (67.6%)
Post meningitis hydrocephalus (n=12)	2 – 10 y	1	2	3 (25%)
	11 – 20 y	2	3	5 (41.6%)
	21 – 30 y	1	3	4 (33.3%)
Total		4	8	12 (12.5%)
Intracranial tumors (n=19)	1 -2 y	1	1	2
	3 – 10 y	1	0	1 (5.2%)
	11 – 20 y	1	0	1 (5.2%)
	30 – 40 y	1	1	2 (10.5%)
	40 – 50 y	3	2	5 (26.3%)
	51 – 60 y	3	2	5 (26.3%)
	>60 y	2	1	3 (15.7%)
Total		12	7	19 (19.7%)

Complications: In the present study of 300 patients, 96 patients encountered various complications like infection was seen in 45 (15%) cases, mechanical malfunction was seen in 30 (10%) cases, shunt migration in 15 (5%) cases, abdominal complications in 6 (2%) cases and shunt extrusion in 3 (1%) cases. The commonest complication encountered was infection. In patients diagnosed with shunt infection, the CSF culture and sensitivity was positive in 10 cases and the most common organism isolated was Staphylococcus epidermidis followed by Staphylococcus aureus.
Age wise incidence of infection: The infection rate was common in the age group of 0-6 months with the incidence rate of 20 (44.4%), in the age group of 7 months to 2 year it was 10 (22.2%), 3 to 5 year age group it was 7 (15.5%) cases, in the 6 to 10 year group it was 4 (8.8%), in the 11 to 30 year group it was 3 (6.6%) and above 30 year it was 1 (2.2%) case.
Diagnosis: Infection was seen in 45 cases, of which 36 cases were of congenital hydrocephalus, 15 cases were of post meningitis hydrocephalus and 1 cases was of intracranial tumor.
Malfunction: The commonest type of malfunction was due to proximal blockage of the shunt seen in 18 (72%) patients, distal blockage was seen in 7 (28%) cases and both blockages were seen in 5 (20%) cases.
Migration: Shunt migration was seen in 15 patients of which proximal migration was in 5 (33.3%) cases and distal migration was seen in 10 (66.7%) cases.
Abdominal complications: In the present study abdominal complications were encountered in 6 (2%) cases. Of these 6 patients, 2 patients were diagnosed with pseudocyst, 3 patients developed abdominal distension and 1 patient developed acute pain abdomen.
Shunt extrusion: In the present study shunt extrusion is seen in 3 patients with the incidence rate of 1% of which 2 patients had rectal extrusion and 1 patient presented with oral extrusion of shunt.
Shunt revision: Of the 96 patients who encountered complications, 36 patients were managed

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conservatively and 60 patients underwent shunt revision, Shunt revision was done twice in eleven patients and thrice in five patients. The reasons for the shunt revision were the various complications such as malfunction in 17 (17.7%) cases, infection in 25 (26%) cases, migration in 15 (15.6%) cases, pseudocyst in 1 (1.045) cases and rectal shunt extrusion in 2 (2.08%) cases. The incidence of shunt revision was more common in cases with infection and malfunction.

Mortality rate: Mortality was seen in 2% cases, ie. six patients, of which four patients had intracranial tumors, and one patient each had post meningitis hydrocephalus; and congenital hydrocephalus.

DISCUSSION

Hydrocephalus has been described in medical writings since the time of Hippocrates but its treatment has remained a major neurosurgical enigma. Hydrocephalus is a commonly encountered disorder that occurs either as a primary condition or as the sequalae to an intracranial hemorrhage, a space-occupying lesion, or meningitis.

More recently the ventriculoperitoneal shunt procedure has become a popular operation to achieve CSF diversion especially after peritoneal tubings were made of silasti which were found to stay open longer. However, like any other shunt system, VP shunt is associated with potential complications.

Age and gender: [Table 1 and 3] A total of 300 patients underwent surgery for hydrocephalus during the study period and 96 patients presented with complications, of which 60 patients underwent revision surgery.

Out of 300 patients 189 (63%) were male and 111 (27%) were female and the ratio of male to female was 1.7:1. Khan F et al,[4] study showed male (66.5%) and female (33.5%) out of 227 patients. So, the present study results are also showing almost similar results in view of incidence of hydrocephalus in relation to gender.

Types of presentation: In the present study, 96 patients presented with various complications [Table 2] the most common being altered sensorium followed by vomiting and headache. Our findings are comparable with study by Khan F et al [4] who reported similar incidence rates of 40.1% and 30.4% and 44.5% for altered sensorium, vomiting and headache.

Diagnosis: A total of 300 patients had ventriculoperitoneal shunting over the period under study, the most frequent indication for peritoneal shunting was congenital hydrocephalus comprising of 67%. Agha FP et al,[5] also reported similar observation. Other indications were intracranial tumours 20% and post meningitic hydrocephalus 13%. The diagnosis was made from history, physical examination and ventriculogram where indicated. Patients with congenital hydrocephalus presented mostly before their first birthday, but there was no particular pattern noted for age at presentation for patients with hydrocephalus due to the other lesions mentioned.

Complications: In the present study of 300 patients, 96 patients encountered various complications like infection, mechanical malfunction, shunt migration, abdominal complications like pseudocyst and abdominal distension, shunt extrusion with the incidence rate of 15%, 10%, 5%, 2% and 1% respectively.

In a study by Mwachaka PM et al,[6] the results of complications for ventriculoperitoneal shunting were 19.7% for infection, 21.4% for migration and 53.8% for malfunction and are comparable with the present study.

Infection was the most common complication in the present study. The patients with age group of 0-6 months had an incidence rate for infection of 44.4% for a total of 45 patients with infection. There are different variables proposed to affect shunt infection rates, the most common being patient age, with neonates and very young children having increased risk.[7,8] In one cohort study, children 6 months or younger had a 19% rate of infection, versus 7% among older children; this finding is similar to the reports by other workers.[7] A variety of explanations accounts for the increased shunt infection rate in very young children, including the presence of age-related changes in the density and identity of bacterial populations on the skin of neonates, as well as increased susceptibility to pathogens due to the relative deficiency of the neonatal immune system. Although maternal breast-feeding has been associated with the maintenance of immunoglobulin G levels in neonates, no data exist on the potential role of breast-feeding in reducing the risk of shunt infection.

The patients with congenital hydrocephalus had an incidence rate of infection of 64.4% followed by post meningitis hydrocephalus with an incidence rate of infection of 33.3%. Two studies reported that patients with congenital hydrocephalus had lower rates of infection than did patients with either post infectious hydrocephalus. One study reported that half the children in the post infectious group had at least one episode of shunt infection by the end of 1 year.[9] In our study the patients with diagnosis of congenital hydrocephalus are more in number but with respect to the infection rate seen in a small sample of post meningitis hydrocephalus in our study is comparable with the above studies.

In patients diagnosed with shunt infection, the CSF culture and sensitivity was positive in 10 cases for Staphylococcus epidermidis followed by Staphyloccus aureus. This is comparable with the other studies where the most common organisms found in shunt infections are typical skin flora such as coagulase-negative S. epidermidis,[10] followed by S. aureus in a roughly 2:1 ratio. Interestingly, data suggest that in addition to its easy access by virtue of being a skin contaminant, S. epidermidis secretes a

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mucoid material that enhances its ability to adhere to foreign bodies such as shunt material.[11]

Of the 45 cases with infection, the biochemical analysis and cytology of CSF showed neutrophilic leucocytosis with increased proteins and decreased sugars.

In our study proximal shunt blockage was more common with 18 (72%) cases which is comparable with the study by Kai Rui Wan et al.[12]

A shunt blockage from blood cells, tissue or bacteria can occur in any part of the shunt. Both the ventricular catheter, ie, the portion of the tubing placed in the brain and the distal part of the catheter, ie, the tubing that drains fluid to another part of the body can become blocked by tissue from the choroid plexus or ventricles. Increased protein levels in cases of intracranial tumours can result in shunt blockage.

Shunt migration as a complication with distal migration of the shunt was more common in the present study. In some instances, the ventricular end of the catheter prolapsed out of the ventricle and in few cases, the peritoneal end of the catheter migrated out of the peritoneal cavity after 6 months of follow up. The peritoneal catheter had shortened due to axial growth of the patient and did well after lengthening of the catheter, and reinserting it back into the peritoneal cavity. The malpositioning of the tip of the catheter into the ventricle also led to migration.

Abdominal complications were noticed in 2 cases of post meningitis hydrocephalus. On ultrasound scan of the abdomen a pseudocyst was diagnosed. In both cases the shunt was removed and follow-up was done with serial ultrasound scans, of which one patient developed hydrocephalus for which revision of VP shunt was done. Etiology-wise, an inflammatory process is a frequent predisposing factor.[13]

Shunt extrusion was seen in 3 cases. One case had an oral extrusion of the shunt while the other 2 cases had rectal extrusion. Shunt removal was done in all the 3 cases and patients were observed for a week. Then shunt revision was done in both cases of rectal extrusion but the case with oral extrusion was lost to follow up.

Shunt revision: Out of 96 patients who encountered complications 36 patients were conservatively managed and 60 patients underwent revision of shunt. The various reasons for the shunt revisions were malfunction, infection, migration, pseudocyst and rectal shunt extrusion. Shunt infection and malfunction were the commonest causes for revision with the incidence rates of 26% and 17.7%. The shunt revision was done in all cases of shunt migration, 2 cases of rectal extrusion of the shunt and in one case of abdominal pseudocyst.

Shyamal C. Bir et al,[14] Sainte-Rose C et al,[15] and Reddy GK et al,[16] have reported similar results for the shunt revisions. Revision of shunt was done once in 60 cases, twice in 11 cases mostly indicated due to the malfunction. Shunt revision was done thrice in 3 cases of malfunction and 2 cases of infection.

Mortality: In our study of 300 patients the mortality rate was 6 (2%) cases which includes 4 patients of intrcranial tumors, one patient of post meningitis hydrocephalus and 1 patient of congenital hydrocephalus.

The post meningitic hydrocephalic child died on the eleventh day post operatively of bronchopneumonia. Post operative mortality was highest in patients with intracranial tumours comprising 4 cases of all deaths recorded. This high mortality in patients with hydrocephalus due to intracranial tumours undergoing ventriculoperitoneal shunting procedure had also been observed by Robertson et al,[17] who noted that the mortality reflected the nature of the primary lesion.

The congenital hydrocephalus patient died due to low birth weight and inadequately developed immune system.

Present study identified a few risk factors such as: Age <6 months, premature birth and babies with decreased immune status, congenital hydrocephalus followed by post meningitis hydrocephalus, patients presenting with low GCS, improper placement of shunt in the ventricle, previous shunt infection and multiple revisions, infection and shunt malfunction being the independent risk factors.

CONCLUSION

Hydrocephalus can occur over a wide age range and the most common causes are congenital hydrocephalus, intracranial tumors and post meningitic. Complications can occur in nearly a third of patients who undergo ventriculoperitoneal shunt placement. Most common complications of VP shunts are infection, mechanical malfunction, shunt migration, abdominal complications and shunt extrusion. The commonest type of malfunction is due to proximal blockage of the shunt and the commonest type of migration is distal migration. Presence of intracranial tumors confers higher risk of mortality. Some of the common risk factors for malfunction of VP shunt are age <6 months, premature birth, babies with decreased immune status, congenital hydrocephalus, improper placement of shunt in the ventricle, previous shunt infection and multiple revisions. The prophylactic and long-term use of antibacterial agents along with prompt removal of and replacement of the drainage system and early identification of the risk factors and their appropriate treatment and prevention will provide the best results.

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