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Original Research Article

A study of VP shunt in management of hydrocephalus

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ABSTRACT

Background: Hydrocephalus a neurological disorder common in both children and adults. VP shunt placement is considered the mainstay of management. The aim was to study complications of VP Shunt and factors influencing shunt malfunction and prognosis.
Methods: This study was conducted in the Department of Surgery, Gandhi Medical College Bhopal, Madhya Pradesh, India between January 2013 to August 2016 and included all patients of hydrocephalus who underwent VP shunt surgery. We performed a retrospective and prospective data review which was subjected to statistical analysis, frequency determination, determination of mean and standard deviation, Pearson's Chi-square test for studying associations between variables.
Results: A total of 198 patients were studied. The predominant etiologies being congenital hydrocephalus, aqueduct stenosis, spina bifida/MMC, intracranial space occupying lesions and tuberculous meningitis. The incidence of overall shunt complications was 28.8%, incidence of shunt revision was 21.2%, shunt blockade 7.6%), shunt migration 5.05%, shunt infection 4.5%, and shunt malfunction due to other causes 8.6%. The mortality rate was 20.2%. Factors associated with increased shunt complications included infective etiology of the hydrocephalus and CSF culture positivity in preoperative period.
Conclusions: Infective and traumatic causes of hydrocephalus are more likely to be associated with complications like infection and obstruction. Shunt migration is seen in paediatric patients.

Keywords: Hydrocephalus, Shunt complications, VP shunt

INTRODUCTION

Hydrocephalus is a neurological condition which arises from any disorder in normal hydrodynamics of cerebrospinal fluid.[1] This may result from any disorder in process of cerebrospinal fluid (CSF) formation, disorder of CSF flow between the ventricular systems, or disorder in CSF absorption, all of which lead to accumulation of excessive amount of CSF in brain. This increased CSF volume causes dilation of ventricles of brain and may cause increase in intracranial pressure. Communicating hydrocephalus is defined as the condition in which there is full communication between all the ventricles of the brain and subarachnoid space. Noncommunicating hydrocephalus is defined as the condition in which there is obstruction in the flow of CSF.[1] Normal pressure hydrocephalus (NPH) is described as a neurological condition which is usually seen in elderly patients, mostly in those with age more than 60 years.[2-4] The literature reports a classic triad of symptoms for NPH known as the Hakim triad.[6] It is triad of gait apraxia, dementia and incontinence. Headache is not seen commonly in NPH patients. The most common cause of congenital hydrocephalus is congenital obstruction of cerebral aqueduct of Sylvius. Other common causes include

congenital malformations like, Arnold-Chiari malformation or Dandy-Walker malformation and neural tube defects like meningomyelocele or spina bifida.

VP shunts are used to alleviate or prevent these complications in hydrocephalus patients. It works on the principle to drain excess accumulated cerebrospinal fluid (CSF) into the peritoneal cavity thus relieving the CSF pressure in brain.[7] Various types of shunts are available with regular up-gradations and modifications being made for better outcomes in different types of cases. The main differences between shunts are usually in the materials used to construct them, the types of valve used, and programmability. Success of VP shunt surgery is influenced by many factors which can be studied and modified accordingly to ensure better outcomes. The aim of this study was to assess effectiveness of procedure against proven standards of care, to study complications of VP shunt and to study factors influencing shunt malfunction.

METHODS

Hydrocephalus is a neurological condition which arises from any disorder in normal hydrodynamics of cerebrospinal fluid1. This may result from any disorder in process of cerebrospinal fluid (CSF) formation, disorder of CSF flow between the ventricular systems, or disorder in CSF absorption, all of which lead to accumulation of excessive amount of CSF in brain. This increased CSF volume causes dilation of ventricles of brain and may cause increase in intracranial pressure. Communicating hydrocephalus is defined as the condition in which there is full communication between all the ventricles of the brain and subarachnoid space. Noncommunicating hydrocephalus is defined as the condition in which there is obstruction in the flow of CSF.[1] Normal pressure hydrocephalus (NPH) is described as a neurological condition which is usually seen in elderly patients, mostly in those with age more than 60 years.[2-4] The literature reports a classic triad of symptoms for NPH known as the Hakim triad.[6] It is triad of gait apraxia, dementia and incontinence. Headache is not seen commonly in NPH patients. The most common cause of congenital hydrocephalus is congenital obstruction of cerebral aqueduct of Sylvius. Other common causes include congenital malformations like, Arnold-Chiari malformation or Dandy-Walker malformation and neural tube defects like meningomyelocele or spina bifida.

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RESULTS

A total of 198 patients were studied. The mean age of patients included in our study was found to be 166 months (13-14 years), ranging from a minimum of half month to a maximum of 72 years (864 months). Maximum number of patients were infants (n=107, 54%) included cases of congenital malformations associated with hydrocephalus. Other pediatric cases were incorporated in 2 age categories (n=31, 15.6%) and included late presenting cases with congenital disease or those with acquired causes like meningitis, tubercular meningitis etc. (Figure 1).

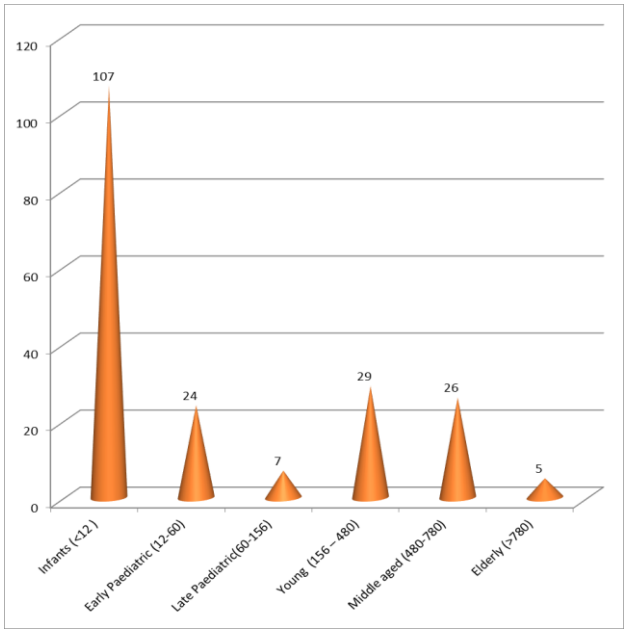

Figure 1: Age wise distribution of patients.

The etiologies of hydrocephalus were varied with the predominant being congenital hydrocephalus (not classified otherwise) noted in (n=38, 19.2%) and aqueduct stenosis (n=34, 17.2%) and spina bifida/MMC (n=24, 12.1%) in pediatric patients.

Intracranial space occupying lesions like tumor or cyst (n=17, 8.6%)and tuberculous meningitis (n=27, 13.6%) were also commonly noted both in adults and children. The etiologies of hydrocephalus in our patients also included NPH (n=5, 2.5%), post hemorrhage (n=9, 4.5%), post-cranial surgery (n=4, 2%), bacterial meningitis or brain abscess (n=9, 4.5%), and idiopathic (n=7, 3.5%). Other etiologies included post-meningitis sequel (n=9, 4.5%), post traumatic (n=9, 4.5%) Dandy-

Walker malformation (n=3, 1.5%), and CVA sequel (n=7, 3.5%).

The Table 1 shows relation between etiology of hydrocephalus and shunt complications.

Table 1: Association between etiology of hydrocephalus and shunt complications.

Etiology	Total no of patients N%	No of patients with shunt complications N%
Aqueductal stenosis	34 (17.2)	10 (17.5)
Brain abscess B/L frontal lobe with meningitis with hydrocephalus	1 (0.5)	1 (1.8)
Brain abscess with hydrocephalus	3 (1.5)	2 (3.5)
Congenital hydrocephalus	38 (19.2)	10 (17.5)
Congenital hydrocephalus with biliary atresia	1 (0.5)	0
CVA sequelae	7 (3.5)	1 (1.8)
Dandy Walker malformation	3 (1.5)	1 (1.8)
ICSOL astrocytoma	1 (0.5)	1 (1.8)
ICSOL posterior fossa	2 (1)	2 (3.5)
ICSOL suprasellar	1 (0.5)	0
ICSOL with hydrocephalus	10 (5.1)	3 (5.3)
ICSOL/intracranial tumor tuberous sclerosis	1 (0.5)	1 (1.8)
ICSOL/intraventricular tumor tuberous sclerosis	1 (0.5)	1 (1.8)
ICSOL/ventricular cyst with hydrocephalus	1 (0.5)	1 (1.8)
Idiopathic hydrocephalus	7 (3.5)	0
Meningitis with hydrocephalus	4 (2)	1 (1.8)
Meningitis with ventriculitis with hydrocephalus	1 (0.5)	1 (1.8)
MMC ruptured with hydrocephalus	2 (1)	0
MMC with hydrocephalus	18 (9.1)	2 (3.5)
Post craniotomy hydrocephalus	4 (2)	0
Post hemorrhagic hydrocephalus	9 (4.5)	5 (8.8)
Post meningitic sequelae	9 (4.5)	5 (8.8)
Post traumatic hydrocephalus	9 (4.5)	3 (5.3)
Spina bifida with hydrocephalus	4 (2)	1 (1.8)
TBM with hydrocephalus	27 (13.6)	5 (8.8)
Total	198	57

No significant association was found with type of shunt used (MP or LP) (P=0.6, chi square test). No significant association with length of shunt catheter used whether full or reduced length (P=0.29, chi square test (Table 2).

Table 2: Association between shunt factors and shunt complications.

Shunt	Total no of patients (N%)	No of patients with shunt complications (N%)	P-value
Type of shunt used			
LP	43 (21.7)	11 (19.3)	0.6
MP	155 (78.3)	46 (80.7)	
Length of shunt			
Reduced	29 (14.6)	6 (10.5)	0.29
Full	169 (85.4)	51 (89.5)	

A significant association was observed between CSF culture positivity in preoperative period and occurrence of complication. This finding is in accordance with previous studies. Routine intra-operative CSF study for culture sensitivity (P=0.17, chi square test). doing EVD or ventricular tap prior to shunt surgery (P=0.14, chi square test), and setting of surgeries whether done in emergency (P=0.13, chi square test) or as elective procedure (P=0.13, chi square test) were not found to have any significant effect on shunt survival or complication rate (Table 3).

The time from shunt placement to shunt malfunction was recorded ranging from 7 to 1800 days. 23 patients (11.6%) developed shunt complications within first month of shunt insertion. While 45 (27.7%) developed complications over a time of 5 months, which is around 78.94% of the total complications seen.

DISCUSSION

All patients included in this study underwent VP shunt placement at initial presentation. Out of that 156 (78.8%) patients had good shunt survival not requiring any shunt revision or removal, while 42 (21.2%) patients required revision of the shunt due to shunt failure and other complications. Out of these patients, twenty-one (10.6%) underwent primary shunt revision for shunt failure during the same admission, while other twenty-one (10.6%) underwent initial shunt removal surgery and shunt revision later. The incidence of overall shunt complications was found to be 57 (28.8%), while the incidence of shunt revision was 42 (21.2%). Most common were shunt blockade (n=15, 7.6%), shunt migration (n=10, 5.05%), shunt infection (n=9, 4.5%), and shunt malfunction due to other causes (n=17,8.6%). Of the 57 patients who experienced shunt complications, four (2.02%) patients suffered both shunt blockage and shunt infection. The development of shunt complications was found to be significantly associated with the etiology of the hydrocephalus (P=0.02). The mortality rate in present study was 40 (20.2%). This included 24 patients with shunt complications. Out of these 14 deaths were seen among 60 adult cases most of which occurred within first month of surgery.

Table 3 Association between other factors and shunt complications.

Factors	Total no. of patients (N%)	No. of patients with shunt complications (N%)	p-value
Emergency surgery	21 (10.6)	9 (15.8)	0.13
Elective surgery	177 (89.4)	48 (84.2)	0.13
Prior EVD/ventricular tap	27 (13.6)	11 (19.3)	0.14
Pre operative CSF study	190 (96)	53 (93)	0.17
CSF culture positive	13 (6.6)	9 (15.8)	0.001 (S)

We did not find any significant association of shunt complication rate with type of shunt used (MP or LP) (P=0.6, chi square test) and with length of shunt catheter used whether full or reduced length (P=0.29, chi square test). This observation is consistent with previous studies. There was found to be a significant association between CSF culture positivity in preoperative period and occurrence of complication. (P=0.001 (S**)**, chi square test). This finding is in accordance with previous studies.[8]

It also justifies use of antibiotics and EVD technique in such cases while waiting for infection to resolve, and going for shunt insertion at later stage. We did not find any significant association of shunt complication rate with routine intra-operative CSF study for culture sensitivity (P=0.17, chi square test) or with EVD or ventricular tap prior to shunt surgery (P=0.14, chi square test), and with setting of surgery whether done in emergency (P=0.13, chi square test) or as elective procedure (P=0.13, chi square test). We found that characteristics, such as age, gender, did not affect the shunt function overall. A peculiar observation of present study was a slight predominance of complications in female patients (61.4%) as opposed to male patients (38.6%). This might be a consequence of the random patient selection in study rather than any significant association, as suggested in other similar studies in literature. Maximum no of the shunt complications (n=45, 22.7%) occurred within first 5 months of shunt placement, which is compatible with previous study reports.[9] They included mostly shunt blockage, shunt infection, shunt migration, and shunt malfunction due to other causes like ventricular end displacement/mal-position. The above observation is also in accordance with the previously reported studies about shunt complications.[10] VP shunt failure rate has been reported in studies between 18% to 29%. The overall VP shunt failure rate that we report (n=57, 28.78%) is consistent with the recent literature.

Limitations

This study has certain limitations due to its mixed retrospective and prospective nature. Technical factors like different operating surgeons, preference of surgical techniques can affect present results. Shunt survival data for patients who were excluded due to missing records and non-compliance for follow-up has been excluded from the study. Similarly, shunt survival and complication analysis was performed only for those patients who came for follow-up. This may have skewed the results of our study. In-spite of these limitations, this study is supposed to contribute substantially to the existing scientific pool of knowledge about the topic. More long term prospective studies focusing on periodic evaluation of shunt and functional status may shed more light on the predictors of shunt survival and long-term functional outcome.

CONCLUSION

Hydrocephalus is a neurological disorder common in both children and adults. VP shunt placement has been considered the mainstay of management in both adult as well as pediatric hydrocephalus. The development of shunt surgeries has remarkably changed the neurological

outcome in these patients with better prospects of leading a normal life. VP shunts procedures are still associated with many complications and significant failure rate which can adversely affect the outcome. Infective and traumatic causes of hydrocephalus are also more likely to be associated with complications like infection and obstruction leading to adverse neurological outcome like delayed milestones and mental retardation.[10] This signifies the importance of periodic and regular follow up evaluation of these patients. In most cases, complications develop insidiously over weeks to months. Most of the complications are noticed within first 6 months' period as seen in present study. This warrant regular follow up examinations of patients in early post-operative period so that complications can be identified early and long term neurological outcome can be improved by early and prompt intervention. Knowledge about multiple variable factors found to have association with shunt survival can have a great impact on clinical decision making and improve long term prognosis and surgical outcome.

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