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A Study of Complications of Ventriculo-Peritoneal Shunt

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Abstract: Hydrocephalus is one of the most commonly encountered in pediatric neurosurgical diseases. The total 487 patients of hydrocephalous operated in neurosurgery department of tertiary care hospital were included in the study. The out of total 487 cases of 134 cases were with complications and 353 cases were without complications. Ventriculo-peritoneal shunt was indicated in total 487 cases and complication were reported in 134 cases, out of 134 cases pediatric and adult were 58.18% and 41.18% respectively. Male preponderance is noted in both surgery and also in complications. Clinical presentation includes commonly headache, vomiting, fever convulsion and altered consciousness. Clinical signs include increase head circumference pappiloedema, cranial nerve deficit and wound gapping. Primary disease in ventriculo-peritoneal shunt surgery patients were congenital malformation, tuberculous meningitis and pyogenic meningitis and its percentage were 44.88%, 25.86% and 29.94% respectively. Total 169 patients develop complication post operatively and common complications were infection (13.6%), blockage of shunt (62.72%), exposure of shunt (11.24%) and wound discharge (5.91%). Total 169 patients require revision surgery due to complication. Emergency surgeries were done in 79.2% cases more common than elective surgery in 20.76% cases. After surgery improvement, worsening and death were noted in 90.29%, 1.49% and 8.2% respectively. The timely diagnosis of shunt complication and proper treatment can bring out good outcome in majority of patients.
Keywords: Hydrocephalous, Etiology, Ventriculo-peritoneal shunt, Complications, Revisions.

INTRODUCTION

Hydrocephalus is one of the most commonly encountered pediatric neurosurgical diseases. The first implantable shunt was placed in 1952[1],and since then shunt placement has remained the most common treatment of hydrocephalus. The word *shunt* is derived from the Middle English word *shun*, which indicates being pushed away or "to the side" and suggests diversion The peritoneum is the most common location for placement of the distal catheter; however, the distal end can also be placed in the right atrium, pleural cavity, or gallbladder. Since the 1960s, the use of modern shunt has become common practice in neurosurgery. As a mechanical device, a shunt can be expected to fail at a rate of approximately 10% a year[2]Shunt malfunction is a life-threatening condition, and any neurosurgical center serving a large population performs a significant number of ventriculo-peritoneal shunt revisions, the procedure most frequently performed in children by neurosurgeon[3]. The malfunction of the shunt impacts significantly on the quality of life of patient [4]. This clinical summary concentrates on the nature of shunt malfunction, its diagnosis and management.

MATERIALS AND METHODS

The total 487 patients of hydrocephalous operated in neurosurgery department of tertiary care hospital in Ahmedabad were included in the study. The out of total 487 cases of 134 cases were with complications and 353 cases were without complications. All patients with ventriculo-peritoneal shunts presented to neurosurgery department were included except normal pressure hydrocephalous and patients who had lost follow up were excluded from the study. All patients were assessed clinically for the signs of raised intracranial pressure, head circumference and anterior fontanels in children, fundus examination for pappiloedema, CT scan brain plain. Preoperatively in all cases x-ray skull (AP) and (Lateral), X-ray chest (PA) view, X-ray abdomen (AP) and CT scan brain plain and if necessary with contrast or MRI brain plain if necessary with contrast were done. The indicated surgical procedures were carried out on emergency basis or elective surgery planned as indicated. During

immediate and up to 2 years postoperative outcome and complications were assessed. All patients were reassessed in postoperative period in follow up examination and were followed up for various period of time from 3 months to 2 years in outpatient department.

RESULTS

The study of ventriculo-peritoneal shunt reveals following reports.

Table-1: Shows distribution of age incidences in ventriculo-peritoneal shunts patients with and without complications

Age in years	No of cases (%)	No of cases with complications (Percentage)
Less than 1 year	95(19.5%)	30(22.38%)
1-18 years	172(35.31%)	48(35.82%)
More than 18 years	210(43.12%)	56(26.66%)
Total	487(100%)	134(100%)

Table1 shows that maximum number of patients were pediatrics age up to 18 years 267(54.8%), followed by adults group 220(43.2%). Complications were more common in pediatric age group (58.18%) than in adults group (41.82%).

Table 2 shows the male preponderance 60.78% in the study and the complications were slightly more in male 29.72% as compared to females 24.08%.

Table-2: Observed sex distribution of patients of ventriculo-peritoneal shunt with and without complication.

Sex	No of cases (%)	No of cases with complications (%)	Total percentage
Male	296(60.78%)	88(65.67%)	29.72
Female	191(39.22%)	46(34.32%)	24.08
Total	487	134	27.51

Table-3: Observed clinical features of ventriculo-peritoneal shunt patients

Symptoms	Cases (Percentage)	Symptoms	Cases (Percentage)	Symptoms	Cases (Percentage)
Headache	56(33.13%)	Increase in size of head	19(11.3%)	Excessive crying	8(4.7%)
Vomiting	57(33.72%)	Visual symptoms	8(4.7%)	Discharge from wound	16(9.4%)
Convulsion	32(18.93%	Decreased appetite	4(2.3%)	Altered Sensorium	49(28.99%)
Fever	22(13.01%)	Inability to walk	9(5.3%)	Abdominal Distention	10(5.9%)
Exposure	17(10.05%)	Giddiness	6(3.5%)	Swelling and redness	13(7.6%)

Table 3 shows that the most common presenting symptoms include headache (33%), vomiting (33%), altered sensorium (28.99%) and convulsion (18.95%).

Table 4 shows that common clinical signs of VP shunt with complication include increase head circumference (11.24%), wound gapping (9.46%) and cranial nerve deficit (8.28%).

Table-4: Observed clinical signs of ventriculo-peritoneal shunt patients

Signs	No of patient with complications cases (Percentage)	Percentage
Higher motor function	9 (5.3%)	5.3
Cranial nerve deficit	14(8.28%)	8.28
Motor and sensory	4(2.36%)	2.36
Head circumference	19 (11.24%)	11.24
Perinaud syndrome	5 (2.95%)	2.95
Fundus	11 (6.5%)	6.50
Pupils	5 (2.95%)	2.95
Vision	3 (1.77%)	1.77
Speech	6 (3.55%)	3.55
Gait	9 (5.32%)	5.32
Wound gapping	16 (9.46%)	9.46

Table-5: Noted etiology of hydrocephalous, shunt surgery and with complications

Primary diagnosis	Patients undergone shunt surgery (n=487)	Patients with complications(n=134) (percentage)
Congenital malformations-communicating	96(19.17%)	25(26.06%)
Congenital malformations- aqueductal stenosis	85(17.45%)	16(18.82%)
Tumor	82(17%)	19(23.17%)
Tubercular meningitis-	145(29.77%)	52(35.86%)
Pyogenic meningitis	34(6.98%)	10(29.41%)
Spontaneous subarachnoid hemorrhage	15(3.08%)	2(13.41%)
Traumatic Subarachnoid hemorrhage-	30(6.16%)	10(33.33%)

Table 5 shows that congenital hydrocephalous is the most common indication for shunt surgery (36%) in the study followed by tuberculous meningitis (29.77%) and tumors (17%) complications were commons in congenital hydrocephalous (44%) followed by tuberculous meningitis (35.86%).

Table-6: Observed type of complications in ventriculo-peritoneal shunt

Types of complications	No of procedures(Percentage)
Infection	23(13.6%)
Blockage	106(62.72%)
Exposure of shunt	19(11.24%)
Pseudocyst	9(5.32%)
Slit ventricle	1(0.59%)
Trapped 4th ventricle	1(0.59%
Migration	4(2.36%)
Fracture	3(1.77%)
Wound discharge	10(5.91%)
Hemorrhage	3(1.77%)
Over drainage	3(1.77%)
Death	11(6.5%)
Total	169(100%)

Table 6 shows that the commonest complication was blockage (62.72%) followed by infection (13.6%) and exposure of shunt (11.24%) 6.5% of patients expired due to complication itself or more common due to primary diagnosis.

Table 7 shows that most of complications occurred between 2 months to 1 year period (39.64%) followed by less than 8 weeks (31.36%).

Table 8 shows that the erosion of clenoidal process was noted in 17.75% of cases. Normal x-ray skull was noted in 65% cases.

Table-7: The Interval between shunt insertion and subsequent revision

Time interval of shunt revision	Procedures(N=169)(percentage)
Less than 8 Weeks	53(31.36%)
8 weeks to 1 year	67(39.64%)
1 Year to 2 years	13(7.69%)
More than2 Years	36(21.30%)

Table-8: Noted report of preoperative X-ray skull

X Ray report	Procedures (N)(percentage)
Normal	110(65.08%)
Erosion of clenoidal process	30(17.75%)
Sutural diastesis	20(11.83%)
Malposition	5(2.95%)
Migration	4(2.36%)
Fracture	3(1.77%)

Table-9: Observe reports of preoperative neuroimagine (CT/MRI brain).

CT/MRI findings	No of procedures(percentage)
Dilated lateral ventricle	143(84.61%)
Dilated third ventricle	141(83.43%)
Dilated fourth ventricle	74(43.78%)
Periventricular seepage	136(80.47%)
Ventriculitis	10(5.91%)
Malposition	5(2.91%)
Pseudocyst	8(4.73%)
Intraventricular hemorrhage	3(1.77%)
Mass lesion	28(16.56%)
Erosion of clenoidal process	30(17.75%)

Table 9 shows that dilated ventricles were noted in 84% of cases and normal size of ventricles were noted due to leak of CSF from the wound. All cases of pseudocyst were confirmed on sonography and CT abdomen. The contrast study was performed in suspected cases of infective etiology and tumors.

Table-10: The number of first procedure and revision

No of procedure and revision	No. of Cases(percentage)	No. of procedures(percentage)
1st procedure	353(72%)	353(55.32%)
One revision	109(22%)	218(34.16%)
Two revision	18(3.6%)	36(5.64%)
Three revision	5(1.02)	20(3.13)
Four or more	2(0.4)	11(1.7%)
Total	487	638

Table 10 shows that in (81.34%) cases only one revision was sufficient. 13.43 % cases required two revisions. One patient had four and another had five revisions.

Table 11 shows that 79.2% of total procedures were performed in emergency.

Table 12 shows that total 487 patients are followed up till the study and patients who lost follow up were excluded from the study.

Table-11: The timing of procedure

Type of procedure	No of procedure (%)
Elective	132(20.76%)
Emergency	506(79.2%)
Total (Includes all revisions)	638(100%)

Table-12: The duration of follow up of patients with ventriculo-peritoneal shunt

Follow up yrs	Patients n=487	Patients with complications n=169	Procedures n=134
3months - 1 yr	47	169	39(29.1%)
1-2 yrs	319	120	45(33.58%)
>2 yrs	118	63	50(37.31%)

Table-13: The types of revision surgery

Type of revision surgery	Patients (N=169)(percentage)
VP Shunt	117(69.23%)
VA Shunt	8(4.73%)
ETV	5(2.95%)
Removal Only	37(21.89%)
Conservative	1(0.59%)
Tumor Excision	1(0.59%)
Total	169(100%)

Table13 shows that 69% of times revision was removal of the complicate and insertion of new shunt on same or opposite side. Only removal was done in 21.89% of times most commonly for pyogenic

meningitis. One patient with infection was treated with antibiotics and conservatively. In one patient excision of colloid cyst was curative for blocked shunt.

Table-14: Clinical status on follow up

Clinical status	Cases (%)
Improved	121(90.29%)
Worsened	2(1.4%)
Death	11(8.2%)
Total	134(100%)

Table 14 shows that 90.29% patients improved after procedures. Only 1.49% patient deteriorated. 8.2% procedures did not benefit and ended in death.

DISCUSSION

Table 15 shows that in this study, incidence of hydrocephalous in children and adult is 54.8% and 43.2% and incidence of hydrocephalous in Qamile *et al*. study is 33.5% and 66% respectively. High incidence in pediatric age group in this study can be explained by more congenital and post-infectious hydrocephalous in developing country like India as compared to developed country like Germany. The complication rate in pediatric and adult age group is 29% and 26.6% respectively, suggests more complications in pediatric group than adult is probably due to prematurity, low resistance to infection and increase in stature with growth in children than in adult. The data is also comparable with Gathura *et al*. African study with similar circumstances as in India. We did not operate any patients before 1.5 months because of absorptive capacity of peritoneum in such infants.

Table-15: The comparison of age incidence of patients with hydrocephalous

Age (years)	Percentage of total patient(n=487) Present study	Qamile morina study [10] percentage	Patients with complications in present study percentage	Farid khan Pakistan adult [11] Percentage
Infants (Less than1yr)	19.5%	20%	31.57%	-
Children (1-18 years)	35.31%	13.5%	27.9%	-
Adult (more than 18yrs)	43.12%	66.5%	26.66%	15.41
Total	487	196	27.51%	-

Table-16: The comparison of sex incidences in total patients operated for hydrocephalous.

Sex	Total patients in the study (n=487)Percentage	Choksey(UK)[9]	Qamile morina Germeny[10]	Patients with complicationspercentage
Male	60.78%	54%	53%	29.72%
Female	39.22%	46%	47%	24.08%
Total	487	126	154	27.51

Table16 shows that the male sex preponderance is 60.78% in this could be explained by ignorance for treatment in female children in India. The complication ratio in male and female is 29.72% &24.08% respectively suggests nearly equivalence in both sexes. In this randomize study sex ratio sex ratio is comparable with other two studies.

Table 17 shows that headache, vomiting and altered sensorium are noted in nearly more than 1/3rd patients of hydrocephalous suggests symptoms of increased intracranial pressure. These common symptoms are comparable to Faridkhan adult study. Of course inability to walk 39% in Faridkhan study is significant as compared to our study 5.3%, it can be explained by more patients of pediatric age group in this study. CSF discharge from the wound was more common in pediatric age group due to poor wound healing in malnourish and thin skin in children.

Table-17: The comparison of clinical features in patients with hydrocephalous with other studies

Clinical features	The present study percentage	Farid khan adult study119
Headache	33.13%	44.5%
Vomiting	33.72%	30.4%
Altered Sensorium	28.99%	40.1%
Convulsion	18.93%	9.7%
Fever	13.01%	11.1%
Exposure	10.05%	-
Increase in head circumference	11.30%	-
Visual Symptoms	4.7%	11.4%
Decreased Appetite	2.3%	-
Inability To Walk	5.3%	39.3%
Giddiness	3.5%	
Excessive Crying	4.7	-
Discharge from wound	9.4	-
Abdominal Distention	5.9	-
Swelling And Redness	7.6	-

Table-18: The comparison of etiology of hydrocephalous

Primary diagnosis	Patients (n=487) percentage	Chowksey[9] Percentage	Farid khan adult[11]	Farid khan Child[12]	The present study percent age	Faridkhan child Complication[12]
Congenital malformations-communicating	19.17%	27.8%		22%	26.06%	23.1%
Congenital malformations-aqueductal stenosis	17.45%			1.8%	18.82%	15.6%
Tumours	17%	22.2%	13.51%	16%	23.17%	6.25%
Meningities-Tubercular	29.77%	7.9%		8%	35.86%	22.22
Meningities-Pyogenic	6.98%			9.7%	29.41%	45.4%
Subarachnoid haemmorhage-Spontaneous	3.08%	19.8%	2.7%		13.33%	33.3%
Subarachnoid Haemmorhage- traumatic	6.16%			6.5%	33.33%	

Table 18 shows that in developing country like India there is high incidence of infection (meningitis) and congenital hydrocephalous. Because of high proteinous and high cellular content of CSF in meningitis group blockage and over all complications were more common in meningitis group. As we have strategy to do EVD first for hemorrhagic group and then convert it to shunt we found fewer complications for it. Because of thin skin in children exposure was more common and immature immune system in infants complications are more common with congenital hydrocephalous.

Table 19 shows that in tubercular meningitis cases commonest reason for revision is blockage of shunt nearly 62.72% cases. 8.2% of patients expired due to complication itself or more commonly from primary disease. Because of poor wound healing and thin stretched skin exposure and wound complications were common among children especially infants. Over all infection rate in the study was comparable to Farid khan study rate of blockage. High rate of infection may be due to more procedures performed in emergancy basis in the present study as compared to Choksey. As newer aseptic precautions developed by Choksey, rate of infection was very low in that study. As we have made a protocol for using different pressure shunt for different etiologies over drainage and under drainage were less common in our study. As fixation of shunt was done meticulously migration and fracture were less common in present study.

Table-19: The comparison of complications of shunt surgery

Complications	% N=169 N is complicated shunts	CHOKSEY[9]	Present study n=487 percentage of total shunts	Farid Khan Pakistan Adult[11]	Farid Khan Pakistan Child[12]
Infection	13.6%	1.1%	3.6%	3.5%	3%
Blockage	62.72%	41.37%	16.79%	11%	11%
Exposure	11.24%		3.01%		
Pseudocyst	5.32%	1.14%	1.4%		
Slit ventrical	0.59%	10.3%	0.1%		
Rapped 4th Ventrical	0.59%		0.%1		
Migration	2.36%	11.49%	0.6%	2.09%	
Fracture	1.77%	8.01%	0.4%		
Wound Discharge	5.91%		1.58%		
Haemmorhage	1.77%	1.14%	0.47%		
Over drainage	1.77%	16.09%	0.47%		
Under drainage	0.59%	9.19%	0.1%		
Death	8.2%		1.7%		
Total			27.51%	15.4%	

Table-20: The comparison of the interval between shunt insertion and revision

Time of revision	Present study percentage	Chowksy study[9]
Less than8 weeks	31.36%	16.09%
8weeks to 1 year	39.64%	20.68%
1 year to 2 years	7.69%	31.03%
>2 years	21.30%	32.18%

Table 20 shows that the most complications occurred between 2 months to 1 year period (39.64%) followed by less than 2 months (31.36%). Because of infection and wound complication are more common in early period we have more revision in early period up to 1 yr. In patient on early anti- tuberculous treatment blockage of shunt was more common, after completion of anti- tuberculous treatment because of improved CSF abnormality complications were less common. Because of calcification and fibrosis due to long standing tuberculosis and retarded growth of children late revision >2 yrs were common as compared to 1-2 yrs.

Table 8 shows that all the patients with suspected complications were subjected to CT scan or MRI with or without contrast. Migration and fracture were diagnosed easily on x-ray but due to low sensitivity of x- ray skull for features of hydrocephalous most of patients had normal x-ray skull so for suspected migration or fracture of shunt x-ray is gold standard but for rest of complication it is very less sensitive. Table 9 shows that the dilated ventricles were found in 84% of cases others due to leak from wound and the rest of patient's ventricles were of normal size. The blockage of shunt presents with dilated ventricles. Treated with removal of complicated shun and revision on opposite or same side. The periventricular seepage is associated with trans ependymal CSF leak and edema in periventricular zone. The ventriculities suggested severe infection with late presentation and repeated procedures. Shunt in such patients was converted to Ommaya or EVD and subjected to antibiotic treatment and external CSF drainage. Once the CSF report was normal Ommay or EVD were converted to VP shunt. Malposition was diagnosed effectively on imaging. Such patients were treated with removal and reinsertion of VP shunt in same sitting. The pseudocyst of abdomen was treated with removal of chamber and abdominal end with drainage of cystic collection with conversion to Ommaya reservoir or EVD. CSF was tapped from the reservoir regularly and when CSF reports were normal, they were converted to VA shunts few days later. Three patients developed IVH and one two developed ICH due to shunt insertion procedure. In all three patients shunt was converted to EVD and after a week of resolution of IVH EVD was converted to VP shunt. Two patients with ICH and mass effect were subjected to craniotomy and evacuation of ICH. One patient among the two improved and another died. Benign and malignant tumors especially epidermoids and posterior fossa tumors were associated with more complications.

Table 21: The 1st procedure and revision one to four or more

Grade	No. Of cases	Chowksy[9]	No. Of procedures	Chowksy[9]
1st procedure	72%	70.63%	55.32%	50.56%
One revision	22%	20.63%	34.16%	29.545
Two revision	3.69%	7.1%	5.64%	15.34%
Three Revision	1.02%	1.5%	3.13%	4.5%
Four or more	0.41%		1.7%	
Total	487	126	638	176

Table 21 shows that in this series mostly one revision was sufficient in (81.34%). 13.43 % cases required two revisions. One patient had four and another had five revisions. Data was comparable with other study.

Table-22: The timing of procedure

Timing	Present study	Chowksy[9]
Elective	20.76%	95.5%
Emergency	79.23%	4.5%
Total	100%	100%

The table 22 shows that when operation was done on the same day of presentation, noted as emergency procedure and while on next day of presentation, noted as elective procedure. Most patients presented to our institute had features of raised intracranial pressure and were in bad neurological condition so they were subjected to emergency operation as per our institutional protocol.

Table 23 shows that all 487 patients are followed up till the study and patients who lost follow up were excluded from the study.

Table-23: The duration of follow up

Follow up in years	No of procedures	Chowksy[116]
3months - 1 year	29.1%	36.87%
1-2 years	33.58%	32.03%
More than 2 years	37.31%	32.08%

Table-24: The advised treatment of complications

Type of revision surgery	Cases (%)
VP shunt	117(69.23%)
VA shunt	8(4.73%)
ETV	5(2.95%)
Removal only	37(21.89%)
Conservative	1(0.59%)
Tumor excision	1(0.59%)
Total	169(100%)

Table 24 shows that procedure of revision includes removal of complicated shunt and insertion of new shunt on same side or on opposite side. which is the commonest (69%) procedure for complicated ventriculo-peritoneal shunt. removal of shunt was procedure of choice in 21.89% cases commonly include pyogenic meningitis and tuberculous meningitis, after removal of complete system patients were treated with antibiotics and followed up with ct scan or MRI after at least 5 days for further management. patients who developed hydrocephalous underwent VP shunt on opposite side. those who did not developed high intracranial pressure were discharged with regular follow up with CT scans. one patient had recovered with antibiotic therapy without surgical intervention. ETV is more successful in adult group than pediatric group. in one patient excision of colloid cyst was curative for blocked shunt Pseudocyst of abdomen were treated with removal of chamber and abdominal end with drainage of cystic collection with conversion to Ommaya reservoir or EVD. CSF was tapped from the reservoir regularly and when CSF reports were normal, as described earlier, they were converted to Ventriculo-atrial shunts few days later. Three patients developed IVH and one two developed ICH due to shunt insertion procedure. In all three patients shunt was converted to EVD and after a week of resolution of IVH EVD was converted to VP shunt, two patients with intracranial hemorrhage and mass effect were subjected to

craniectomy and evacuation of intracranial hemorrhage. One patient among the two improved and another died.

Table-25: The follow up and end result assessment

Clinical status	Percentage	Farid khan adult[11]	Farid khan child[12]
Improved	90.29%	-	-
Worsened	1.49%	-	-
Death	8.20%	5.1%	1.8%

Table 25 shows that 90% patients improved after procedure, only 1, 49%% patient deteriorated and 8.2% procedures ended in death. Death rate was marginally high in present study because of death was primarily related to primary diagnosis most commonly included tumor and tuberculous meningitis.

CONCLUSION

The outcome of recommended treatment for complicated ventriculo-peritoneal shunt depends on following factors: Time of surgery (elective or emergency), the timing of presentation (early or late), and neurological condition on presentation, socio-economical class and nutritional status of patient. Patients who presents earlier, with good neurological outcome, good nutritional status and knowledge of disease & management, have good prognosis and better outcome. Complete asepsis and proper handling of implant can reduce the infection rate and revision rate. Proper treatment of primary pathology (tuberculous meningitis, pyogenic meningitis etc.) can lead to less complication. The timely diagnosis of shunt complication and proper treatment can bring out good outcome in majority of patients.

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