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Multi Loculated Hydrocephalus and Simple Hydrocephalus: Comparison of Outcomes in a Paediatric Population

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Abstract

Background: Management for simple hydrocephalus in low/middle income countries include insertion of a ventriculoperitoneal shunt (VPS) or performance of an endoscopic third ventriculostomy (ETV). **Objective:** This present study was carried out to compare presenting features, surgical management and outcomes for patients with simple and loculated hydrocephalus. **Methodology:** This case-control study was performed in the Department of Paediatric Neurosurgery at National Institute of Neurosciences and Hospital, Dhaka, Bangladesh from July 2017 to June 2019. The patients with loculated hydrocephalus were included in the analysis and comparison made to case matched simple hydrocephalus controls. Presenting features, operative details, and outcomes measured by the Glasgow Outcome Scale- Paediatric (GOS) were recorded over a follow up period of one year. **Results:** A total number of 17 patients with loculated hydrocephalus were recruited for this study. Loculated patients underwent ETV (n=3), VPS (n=7), aqueductoplasty (n=1) and no procedure (n=6). Simple hydrocephalus patients underwent ETV (n=4), VPS (n=7), no procedure (n=2). Patients undergoing intraoperative irrigation had a mean GOS of 3 compared to a GOS of 6 in non-irrigated patients (p=0.0434). Mortality occurred in 9 patients (5 loculated HCP and 4 simple HCP). Mortality was seen to be higher in male patients (p<0.0001) and those with congenital aetiologies (p<0.0001). **Conclusion:** There is no statistically significant difference in mortality or GOS at follow up between the 2 groups. *[Journal of National Institute of Neurosciences Bangladesh, July 2022;8(2):112-120]*

Keywords: Hydrocephalus; loculated hydrocephalus; simple hydrocephalus; endoscopic third ventriculostomy; ventriculoperiotneal shunt

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Introduction

Hydrocephalus (HCP) is the most common neurosurgical condition in children worldwide[1]. Low and middle income countries (LMIC) are seen to face a heavy burden of hydrocephalus due to higher birth rates, greater prevalence of neonatal infections, nutritional deficiency and delayed antenatal diagnosis[2]. Hydrocephalus results from change in the dynamics of cerebrospinal fluid (CSF) flow with an underlying pathology[3]. Treatment options for hydrocephalus include ventriculoperitoneal shunt (VPS), endoscopic third ventriculostomy (ETV) with or without choroid plexus cauterization (CPC), ventriculosubgaleal shunt (VSG), external ventricular drainage (EVD) and ventricular tapping (VT)[4].

Causes of hydrocephalus include: congenital causes secondary to neural tube defects (NTD), intra-uterine infections, post myelomeningocele repairs and post infectious[5]. Studies in Uganda conducted by Warf et al. reported 60.0% of cases occurring secondary to central nervous system (CNS) infection with 76.0% occurring in the first month of life[6]. Other studies have reported similar numbers, for example, with 58.0% secondary to post infectious causes, non-infectious 28.0%, myelomeningocele in 13.0% and post haemorrhagic in 1.0% cases[7]. Studies in Bangladesh by Mukherjee et al[8] Reported ToRCH is a significant cause in Hydrocephalus in intrauterine infection, where commonest age group was 31 to 90 days (45.0%). Mozambique have an incidence of congenital hydrocephalus equivalent to or greater than developed countries and that post-infectious acquired hydrocephalus occurs at even higher rates[9]. Studies conducted in Uganda had demonstrated infection accounting for 60.0% of hydrocephalus cases. Post-infectious aetiology is also more common in neighbouring India[10].

Loculated hydrocephalus usually arises from interventricular septations and can be described as uni/ multiloculated[11]. These include multiple intraventricular septations, resulting from the presence of membranes or septa that encroach the ventricular system, an isolated lateral ventricle and unilateral hydrocephalus, secondary to obstruction of one Monro foramen in the former, obstruction occurs after treatment of previously symmetrical hydrocephalus, and in the latter, it occurs as the primary form, leading to accumulation of fluid in only one lateral ventricle, while the remaining ventricular system is of normal size, entrapped temporal horn, resulting from adhesions in the region of the trigone, leading to isolation of the temporal or temporooccipital horn containing choroid plexus and isolated fourth ventricle, caused by obstructions of the aqueduct and of the foramina of Luschka and Magendie[11]. The multiloculated form is defined as multiple separated cystic cavities or spaces located in or in relation to the ventricular system and filled with fresh or altered CSF[12].

Uniloculated hydrocephalus usually arises from neuroepithelial cysts either arachnoid or ependymal, whilst multiloculated occur after an episode of neonatal meningitis or germinal matrix haemorrhage[13-15]. These locations can complicate the management of hydrocephalus and often require multiple revision surgeries. Predisposing factors to the development of loculated hydrocephalus include low birth weight, prematurity, congenital malformations and perinatal complications[1,16]. Management usually involves the insertion of cystoperitoneal shunts, stereotactic aspiration, shunt placement, craniotomy or lysis of interventricular septation[16-17].

The ideal treatment for multiloculated hydrocephalus usually involves direct visualization of the compartments and microsurgical fenestration of fluid compartments[16]. Moreover, endoscopy for fenestration has been associated with significant reductions in shunt revision and complication rates. Akbari et al[18] compared open craniotomy vs endoscopic treatment in 25 patients, with endoscopic treatment associated with reduced blood loss or shorter hospital stays, shunt revision rates did not reach significance. Schulz et al[19] demonstrated that 56.3% cases of children that had undergone endoscopic treatment for multiloculated hydrocephalus did not require further surgical input and 13.8% suffered from shunt infections. Spennato et al[11] had evaluated effectiveness of neuroendoscopic treatment in multiloculated hydrocephalus and found a reduction in shunt revision rates with resolution of clinical symptoms. Outcomes and efficacy of treatment is readily available for the management of simple hydrocephalus in LMIC. However, data is not readily available with regards to management and prognostic factors for loculated hydrocephalus in LMIC. There are currently no case series that have investigated the management of loculated hydrocephalus in Bangladesh.

The purpose of this present study was to evaluate the outcomes following surgical treatment of loculated hydrocephalus in Bangladesh. It also aims to investigate associations between treatment and outcomes with comparisons being made to simple hydrocephalus controls.

Methodology

Study Population and Settings: Parental consent was taken on behalf of patients. Recruitment of all new presentations of loculated hydrocephalus cases admitted to the National Institute of Neurosciences and Hospital, Dhaka, Bangladesh over a 2 year period from January 2017 to December 2019. Diagnosis was confirmed by computerized tomography (CT-scan) imaging of the head. The patients with loculated hydrocephalus were enrolled in the study. Patient controls were matched simple hydrocephalus cases managed with standard treatment like the first eligible simple, age-matched hydrocephalus case presenting after a septate hydrocephalus case was recruited. Inclusion criteria were first presentation of septate hydrocephalus (case) or first presentation of simple hydrocephalus (control), consent obtained from patient or family member and age of patient less than 18 years at entry to study. Exclusion criteria were previously operated septate hydrocephalus cases.

Study Procedure: Participants underwent either VPS, ETV, aqueductoplasty or had no neurosurgical intervention. Intraoperative irrigation was performed in any patient who fulfilled the criteria of preoperative hyperdensity demonstrated on imaging, preoperative lumbar puncture demonstrating turbid/blood/mixed sample or intraoperative exudate/turbid sample. Irrigation was performed under direct vision by a flexible endoscope, and immediately following endoscope insertion 5ml of cerebrospinal fluid (CSF) was aspirated for study at a proximal location. 500ml of ringers lactate solution mixed with 5ml of sodium bicarbonate was used for irrigation distally performed using a 10ml syringe. If the septum pellucidum was seen to be intact and the contralateral ventricle required irrigation a septostomy of the interventricular septum was performed. A feature of the surgery was fenestration of the pathological septum which was performed by flexible endoscope and monopolar cautery (monopolar coagulating ball electrode Bugbee-storz) wire. Performing a CSF diversion procedure was guided by the CSF colour, third ventricular (TV) floor access and prepontine cisternal scarring. If the CSF appeared clear and TV floor was accessible an ETV was performed. If however, the CSF appeared turbid an EVD was inserted or VSG was done. Where the CSF was clear but the TV floor was not accessible a VPS was performed. In those with scarring of the prepontine cistern we hypothesised ETV may not be successful. Hence, patients with scarring of the cistern needed closer monitoring following ETV. If evidence of ETV failure in cisternal scarred patients was found a VPS was performed rather than a redo ETV. In the event of iatrogenic bleeding irrigation was performed slowly, ensuring positive pressures within the ventricles. Antibiotics or fibrinolytics were not used in cases of bleeding or turbid CSF sampling.

Follow Up and Outcome Measures: Data was collected via a handwritten form that was completed by medical staff at the patient's initial visit to hospital and one year and stored in a study file. Follow up was conducted over a period of one year. Follow up included assessing for postoperative deficits, Glasgow Outcome

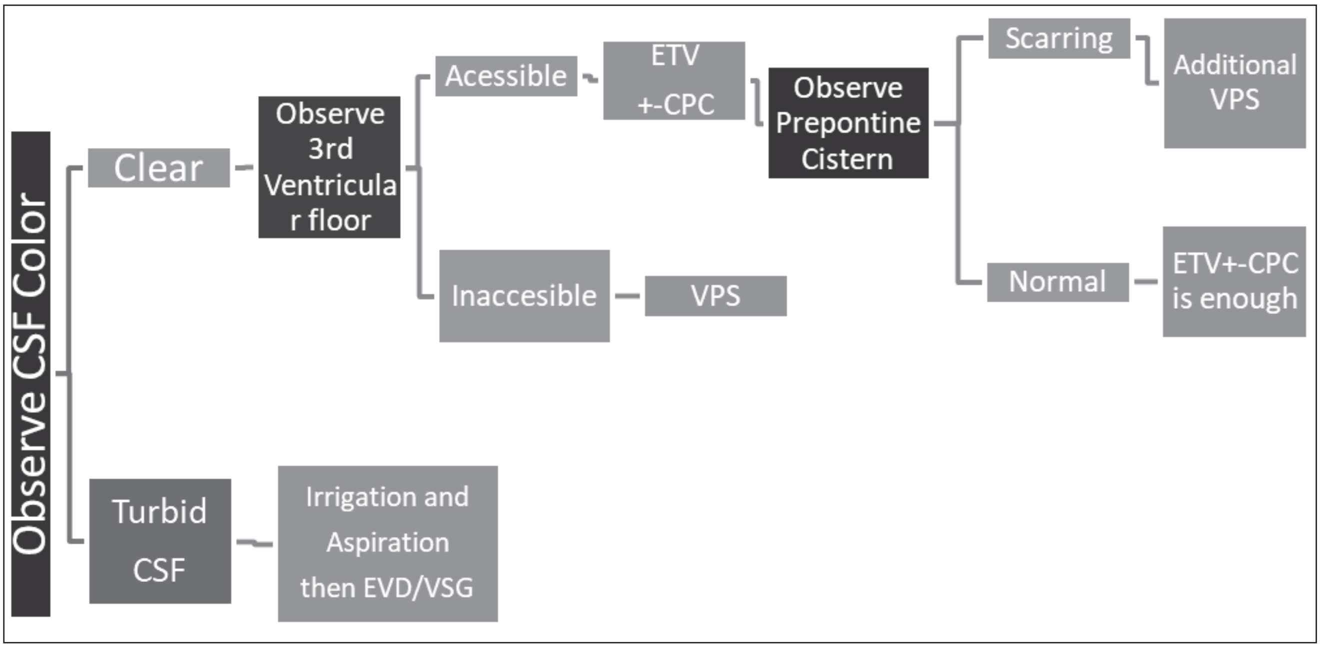

Figure I: CSF Diversion during in intra-ventricular endoscopy

Score–paediatric (GOS) and reoperations/readmissions. Success of surgery was defined as patients having a GOS less than 4 at the last available follow up or patients requiring no further surgery. GOS score was followed up according to Beers et al. Glasgow outcome scale extended paediatric version (GOS-E peds)20..

Statistical Analysis: The statistical analysis in this study was conducted using GraphPad Prism 7 (GraphPad Software, San Diego, USA). The data was expressed as mean values, with standard error of the mean (SEM) being used. Assessment for normal distribution of the data was conducted using a Shapiro-Wilks test. Data was not seen to follow a normal distribution and so Mann-Whitney U test was used to allow for comparisons. Statistical significance was considered to be p value less than 0.05.

Results

In total 13 patients with simple hydrocephalus were enrolled in the study and among these 12 males and 1 female were enrolled, and the average age of simple hydrocephalus patients was 9 months. 10 males and 7 females were included and the average age of loculated hydrocephalus patients was 17 months. 6 patients resided within Dhaka (3 patients from each group).

Aetiology: Of the total study population, 66.7% of cases were due to congenital causes, 20.0% cases due to post infectious causes, 3.3% cases due to spina-bifida and 10.0% of cases did not have a documented cause. No statistically significant differences in aetiology were seen between the simple and loculated groups. About 82.3% (n=14) of patients with loculated hydrocephalus had uniloculated HCP and 17.6% (n=3) of patients had multiloculated HCP (Table 1).

Procedures Performed by Hydrocephalus Type: Overall, 23.3% patients with HCP underwent an ETV, 46.7% cases underwent VPS insertion and 26.7% cases had no operation performed. There was no significant difference in procedure type between the simple and loculated groups. However, a larger proportion of the loculated HCP group had no operation performed, but this effect was not statistically significant (Table 2).

Table 1: Aetiology of Hydrocephalus in Study Population

Aetiology	Loculated HCP	Simple HCP
Post infectious	2	4
Congenital	12	8
Spina bifida	1	0
Not documented	2	1
Total	**17**	**13**

Table 2: Procedures Performed on Patients by Hydrocephalus Type

Procedures	Loculated
ETV	23.3%
VPS	46.7%
Aqueductoplasty	5.88%
No operation	35.28%

Presenting Features in Study Population: Fever (56.6%), abnormal fontanelle (50.0%) and downgaze palsy (46.6%) were the most common presenting features of hydrocephalus within our cohort. These three symptoms were most common amongst both simple and loculated subgroups. Signs of raised intracranial pressure such as vomiting were seen in 43.3% of patients on admission, focal neurological deficit including limb weakness, cranial nerve deficit and visual changes were seen in 6.7% cases, 0.0% cases and 23.3% cases of patients respectively on admission. Seizures were seen on admission in 7.7% cases of simple HCP patients versus 17.6% cases of loculated HCP patients, this did not achieve statistical significance. On comparison of the other presenting features no statistically significant differences were seen in the presenting features between loculated and simple HCP patients. 13.3% cases (n=2) of patients with documented CSF cultures were found to have positive cultures, streptococcus (loculated HCP, n=1) and methicillin-resistant staphylococcus aureus (MRSA) (simple HCP, n =1). The remaining 13 patients whom had CSF cultured demonstrated no growth. CSF culture was not documented in 50.0% (n=15) of patients (Table 3).

Intraoperative and Immediate Postoperative Complications: Intraoperative haemorrhage was seen to occur in 9.1% (n=2; 1 loculated, 1 simple) of

Table 3: Comparison between Presenting Features in Patients with Loculated and Simple Hydrocephalus

Presenting Features	Loculated HCP (n=17)	Simple HCP (n=13)
Fever	46.6%	61.5%
Abnormal Fontanelle	50.0%	84.6%
Downgaze Palsy	23.5%	53.8%
Limb Weakness	6.7%	7.7%
Cranial Nerve Deficits	0.0%	0.0%
Seizures	17.6%	7.7%
Vomiting	43.3%	38.5%
Reduced Consciousness	11.8%	0.0%
Visual Changes	23.3%	23.1%

operated patients. There were 0 patients with intraoperative hypotension, hypertension, bradycardia or tachycardia. Post-operatively, 22.7% (n= 5) of patients suffered from CSF leak, with higher rates being seen in simple HCP patients (p=0.0351). About 4.5% (n=1) patients were seen to have a post-operative hyponatraemia post-VPS insertion. About 4.5% (n=1) patients were seen to have post-operative skin necrosis with exposure of the cranial end of the VPS, 4.5% (n=1) of patients were suspected to have shunt-related nephritis and 13.6% (n=3) of patients developed post-operative infections. The complications listed above were not seen to correlate to mortality. Complication rates did not differ significantly based on the procedure conducted.

Mortality: During the course of the study the total mortality was 9 (5 patients in the loculated HCP group and 4 in the simple HCP group). 88.8% (n=8) of these patients had hydrocephalus attributed to a congenital aetiology, p<0.0001. About 88.8% (n=8) of the patients who had died were of male gender p<0.0001, it is important to note there were significantly more male than female patients within this cohort (p<0.05). No statistically significant differences in mortality were demonstrated between the loculated and simple HCP groups (Figure II A and IIB).

Postoperative Deficits during Follow Up: On analysis of post-operative deficits in patients undergoing neurosurgical interventions, it appeared all deficits were more common in patients with loculated hydrocephalus including seizures (8.3% of loculated patients vs. 0.0% of simple HCP patients), speech deficits (25.0% of loculated patients vs. 9.1% of patients with simple HCP), cranial nerve deficits (33.3% of loculated patients vs 9.1% of simple HCP patients (this is post-op deficits rather than presenting features which was 0.0%) and limb weakness (41.7% of loculated HCP vs. 18.2% of simple HCP). However these differences were not statistically significant (Table 5).

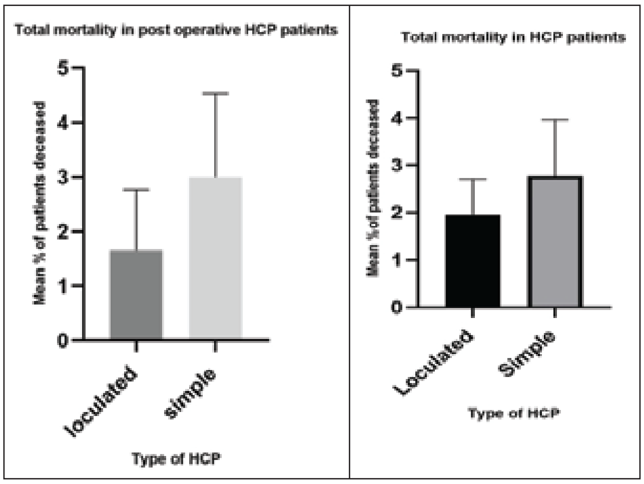

Figure II: Mortality in Hydrocephalus Patients (A) Mortality in all patients admitted with hydrocephalus, including those not operated on. (B) Mortality in patients undergoing neurosurgical intervention. Expressed as mean percentage of patients deceased during follow up and comparison being made between loculated and simple hydrocephalus. Data expressed as Mean +SEM. HCP, hydrocephalus; SEM, standard error of the mean.

Table 5: Comparison of Postoperative Total deficits amongst Loculated and Simple HCP Patients

Post-Operative Deficits	Loculated	Simple	P value
Seizures	1 (8.3%)	0 (0%)	0.999
Visual	3 (25.0%)	1 (9.1%)	0.474
Speech	3 (25.0%)	1 (9.1%)	0.141
Limb weakness	5 (41.7%)	2 (18.2%)	0.155
Cranial nerve	4 (33.3%)	1 (9.1%)	0.307

Comparison of Long-Term Outcomes: Glasgow Outcome Score-Paediatric (GOS) of all patients at the last available follow-up was analyzed (Figure II). The last available follow-up score documented was used for this analysis. A GOS >4 is consistent with severe disability. There was no statistical difference in the average GOS at follow-up between the loculated (mean GOS = 4.55) and the simple (mean GOS = 4.54) groups (Table 6).

Comparison of good and poor outcomes post-ETV in loculated versus simple HCP revealed no statistically significant difference p=0.7429 and p=0.2571 respectively. Comparison of good and poor outcomes post-VPS in loculated versus simple HCP revealed no statistically significant difference p=0.6329 and p= 0.3100 respectively. Follow-up data not available on 1 loculated patient undergoing VPS and so was not included in analysis (Table 6).

Intraoperative irrigation was conducted in 45.5% (n=5) of simple HCP patients at the time of surgery and 11.8% (n=2) of patients with loculated hydrocephalus at the time of surgery. The comparison was made between all patients (loculated + simple) who had undergone intraoperative irrigation versus those that had not undergone intraoperative irrigation. Intraoperative irrigation was associated with a mean GOS of 3.0 whilst patients who had not received irrigation had a mean GOS of 6.0 results highlighted (Figure II) (p=0.0434) (Figure III).

Table 6. Postoperative Outcomes in Simple versus Loculated Hydrocephalus Patients Undergoing ETV or VPS

Outcomes	Loculated ETV	Loculated VPS	P value	Simple ETV	Simple VPS	P value	Total Loculated	Total Simple	Total P value
Good (GOS <3)	1 (33.3%)	2 (33.3%)	0.6429	3(75%)	2(28.6%)	0.0788	3 (33.3%)	5(45.5%)	>0.9999
Poor (GOS >4)	2 (66.7%)	4 (66.7%)	0.3810	1(25%)	5(71.4%)	0.3939	6 (66.7%)	6(54.5)	0.0613

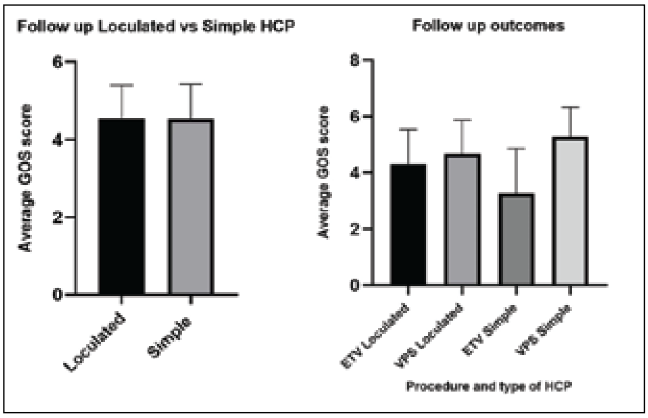

Figure III: GOS Outcomes between Hydrocephalus Groups. (A) Demonstrates the average GOS values between the loculated (n=9) and simple (n=11) HCP groups who had underwent either ETV or VPS, p=0.8251. (B) demonstrates GOS values between the patients undergoing the different surgical procedures, p<0.05 (GOS=Glasgow outcome score;

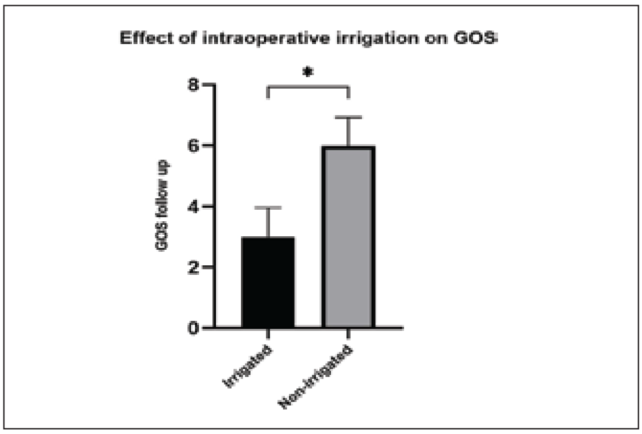

Figure III: Intraoperative Irrigation and Its Impact on Long Term Outcomes; Intraoperative irrigation at the time of surgery was associated with a mean GOS of 3 whilst patients who had not received irrigation had a mean GOS of 6 (p=0.0434)

Fenestration of pathological septum was documented in 3 patients in the loculated HCP group and septostomy was not associated with statistically significant differences in GOS outcomes. No significant differences in re-operation rates were seen on comparison of ETV versus VPS amongst loculated and simple HCP patients.

Discussion

New technologies, including flexible endoscopes for performing endoscopic procedures in the management of hydrocephalus, are enabling non-invasive neurosurgical treatment of simple and complex hydrocephalus[2]. Although the results of endoscopic third ventriculostomy for simple hydrocephalus have been published, there is limited data available for outcomes after complex loculated hydrocephalus[21]. The current study has evaluated the effectiveness of ETV and VPS insertion in both loculated and simple HCP. The study has investigated the effects of treatment on: mortality, GOS scores, readmissions and reoperation rates.

The present study found that abnormal fontanelle, fever and downgaze palsy were the most common presenting features in patients with hydrocephalus, this is similar to what has been reported in earlier studies(4). Congenital causes of HCP accounted for 66.7% of cases and post infectious HCP carried a lesser contribution of 20.0% cases.

Mortality and Long Term Outcomes: With regards to mortality there was no statistically significant difference in mortality rates when comparing loculated and simple HCP, neither was there a significant difference in mortality when comparing ETV with VPS. Lack of difference in procedure related mortality is similar to a recent meta-analysis that demonstrated comparable mortality amongst patients undergoing VPS insertion and those undergoing ETV22. Risk factors for mortality in the present cohort included male gender and congenital aetiology. Patients with loculated and simple HCP undergoing VPS had an average mortality rate of 4.1% which is similar to studies from Malawi, whilst a recent meta-analysis reported higher mortality rates of 8.5% amongst patients undergoing VPS[22]. In keeping with results from Texakalidis et al 2019 our study reported no statistically significant difference in mortality in patients undergoing VPS versus ETV.

Long term outcomes were assessed using the GOS score. In this cohort there was no significant difference in long term outcome between the simple and loculated HCP groups although there was a tendency towards worse outcomes in the loculated group. It has been demonstrated that intraoperative irrigation is associated with better GOS outcomes. Intraoperative irrigation was less common amongst loculated HCP patients which could in part explain the poorer outcomes described in loculated patients undergoing surgery.

Next comparison was made between postoperative deficits following VPS insertion versus ETV. Loculated patients undergoing ETV were significantly more likely to develop limb weakness post-operatively p=0.0083. In addition to this loculated patients undergoing ETV were more likely to develop speech and visual deficits when compared to the VPS groups; this was seen to be approaching significance p=0.0670. The poorer neurological outcomes could be due to intraoperative irrigation being less common amongst loculated patients.

Further Surgery: On comparison of loculated HCP and simple HCP there was no significant difference in reoperation rates, however, CSF leak was much more common in simple hydrocephalus patients. The use of ETV in the management of hydrocephalus aims to reduce the total number of surgeries required in patients. This is especially useful in resource poor areas and LMIC such as Bangladesh where access to neurosurgical centres may be difficult particularly if neurosurgical centres are only found in major cities. Hence, there may be delayed presentations to hospitals in the event of VPS malfunction resulting in poorer outcomes. However, in our cohort the use of ETV was not significantly associated with reducing the number of repeat surgeries when compared to VPS insertion. Texakalidis et al[22] in a current meta-analysis had likewise demonstrated similar re-operation rates between ETV and VPS. Within the loculated patients that had undergone ETV insertion, 33.3% required VPS insertion during the follow up period due to failed ETV. Whilst 25.0% cases of simple HCP patients treated initially with ETV required VPS insertion during follow up due to failed ETV. Those that had failed ETV insertion were found to be younger with a mean age of 3.5 months. This is consistent with Warf et al 2010 where ETV has been associated with higher failure rates in children under the age of 1 years old[23]. Prior to considering patients for ETV insertion it would be advisable to calculate the ETV success score proposed by Warf et al 2010 prior to admission. Moreover, this will allow patients with lower scores to be followed up more vigilantly and parents to be educated on what to look out for and when to seek help. More vigilant follow up is most important in the first 6 months as ETV success at 6 month follow up is associated with a 95.0% cases success rate at 3 years[23].

Success of ETV over VPS in hydrocephalus has been reported in middle/high income countries, a randomised control trial conducted by Kamikawa et al[24] in Japan described ETV as having lower reoperation rates, less complications and less infections when compared to VPS. Navaei et al[25] demonstrated no statistical difference in outcomes between patients undergoing ETV vs VPS and so ETV was a possible alternative to VPS in Iran. Contrasting with our study, a case series by Rahman et al[26] from Dhaka had also found better outcomes in patients undergoing ETV but no significant impact on mortality was seen. It is important to note these comparisons were made in simple hydrocephalus patients and so conclusions cannot be extrapolated to the treatment for loculated hydrocephalus. Case series investigating the management of loculated hydrocephalus are scarcer particularly in low/middle income countries. Fritsch et al[27] described a success rate of ETV in loculated hydrocephalus of 50% with minimal morbidity and suggested ETV should be considered prior to shunt placement. However, Spennato et al[11] described ETV being associated with lower success rates in the presence of loculations however, postoperative deficits were not compared. The case controls reported by Spennato et al[11] and Fritsch et al[27] were conducted in high income countries which is likely responsible for the difference in conclusion compared to the present study. Loculated hydrocephalus has been typically associated with shunt placement in post haemorrhagic or post meningitis hydrocephalus but increasingly this variant of hydrocephalus is being seen in children never before treated with shunts. This was the case in the present study, of the patients with multiloculated hydrocephalus 66.7% of them developed this secondary to congenital abnormalities, 100.0% had never had a shunt in situ but 66.7% patients were seen to have pre-existing hydrocephalus prior to their admission. Of the uniloculated cases again, congenital aetiologies accounted for the greatest proportion of causes. With 85.7% of uniloculated cases being due to congenital causes, 43.0% uniloculated cases were pre-existing and 28.6% of patients had a VPS in- situ prior to admission. However, there were no reported shunt infections. This demonstrates that the development of loculations can occur in the absence of VPS systems in-situ and in the absence of proven infective aetiology, although the causative role of undetected infectious agents cannot be excluded. There was no statistical difference in mortality or GOS outcomes in patients with uniloculated versus multiloculated hydrocephalus although small sample sizes were used.

Limitations: The main limitations of this present study include the small total population size, lack of follow up information being available on deceased patients, only a small number of patients undergoing ETV and only a few patients having multiloculated hydrocephalus. This had meant comparisons between uniloculated and multiloculated hydrocephalus was not as representative. In addition to this intraoperative analysis of cisternal scaring and aqueductal patency was not available and so could not be used in assessing success of ETV insertion. The present study included residence of patients however; future studies should incorporate specific distance travelled in order to access neurosurgical care in order to assess its impact on mortality/morbidity. The age of loculated and simple HCP patients was not matched in the present study. A feature of the management of loculated hydrocephalus was endoscopic fenestration however, the nature of the study did not allow us to confidently compare the outcome of fenestration versus non fenestration as the data was not often available and patients were not randomized, this might be a subject for further study.

Conclusion

In the cohort of hydrocephalus patients admitted to the National Institute of Neurosciences and Hospital in Dhaka Bangladesh over a 2 year period; congenital cause of hydrocephalus accounted for the majority of presentations. Downgaze palsy, abnormal fontanelle and fever are found to be the most common presenting features. Patients with loculated hydrocephalus are seen to have poorer outcomes following neurosurgical intervention compared to simple HCP patients. Multiloculated hydrocephalus is not seen to be associated with higher rates of mortality or worse GOS outcomes compared to uniloculated cases. Intraoperative irrigation was associated with better long term outcomes. The main factors influencing mortality in hydrocephalus patients are young age, smaller OFC at presentation and congenital aetiology. The present study does not demonstrate any statistically significant differences with regards to reoperation/readmission rates in patients undergoing ETV versus VPS. The present study has been concluded that VPS in loculated patients is associated with similar long term outcomes as seen in simple HCP and lower rates of postoperative deficits compared to ETV however; further work is needed to determine the safety of ETV use for the management of loculated hydrocephalus.

Abbreviations: GOS-E ped=Glasgow Outcome Scale-Extended-Pediatric; HCP=Hydrocephalus; LMIC=Low and middle income countries; ETV=endoscopic third ventriculostomy; ETV+CPC=Endoscopic third ventriculostomy with choroid plexus cauterization; NTD= Neural tube defects; CT=Computerized tomography; CSF=Cerebrospinal fluid; MRSA=Methicillin-resistant Staphylococcus aureus; TV=Third ventricular; VPS=ventriculoperitoneal shunt

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