SAS Journal of Surgery
Abbreviated Key Title: SAS J Surg
ISSN 2454-5104
Journal homepage: https://www.saspublishers.com

OPEN ACCESS

Neurosurgery

Clinical Significance of Modified Greab Score in Patients of Intra Ventricular Hemorrhage when Treating with External Ventricular Drainage

Dr. Md. Mahfuzur Rahman[1*], Dr. Md. Shamiul Alam Siddique[2], Dr. Md. Shafiqul Islam[3], Prof. Asit Chandra Sarker[4], Dr. Sukriti Das[5], Dr. Fazle Elahy Milad[6], Dr. Md. Sumon Rana[7]

[1]Assistant Professor, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh
[2]Assistant Professor, Department of Neurology, Mymensingh Medical College & Hospital, Mymensingh, Bangladesh
[3]Associate Professor, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh
[4]Professor & Head, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh
[5]Associate Professor, Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh
[6]Professor, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh
[7]Assistant Professor, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh

DOI: 10.36347/sasjs.2022.v08i04.001 | **Received:** 25.02.2022 | **Accepted:** 28.03.2022 | **Published:** 11.04.2022

***Corresponding author:** Dr. Md. Mahfuzur Rahman **E-Mail ID:** *mahfuz945@gmail.com*
Assistant Professor, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh

Abstract **Original Research Article**

Background: There is no consensus in the literature on the effects of the development of hydrocephalus on survival and disability after intracerebral hemorrhage (ICH) and the benefits of external ventricular drainage (EVD). Some studies showed good outcomes whereas some showed poor outcomes after insertion of EVD in patients with spontaneous intraventricular hemorrhage with hydrocephalus. ***Objective*****:** This study is planned to describe the role of external ventricular drainage in treating patients with spontaneous, either primary or secondary, intraventricular hemorrhage with hydrocephalus. ***Method*****:** A hospital-based prospective interventional study was conducted in the Department of Neurosurgery of Dhaka Medical College Hospital, which is a tertiary level hospital, from April 2016 to September 2017. A total of 42 patients of spontaneous intraventricular hemorrhage, either primary or secondary, with hydrocephalus were selected for this study. Glasgow Coma Scale score for level of consciousness and Modified GRAEB score for severity of ventricular hemorrhage were recorded preoperatively. All the collected data were entered into IBM SPSS software, Version 22.0. Correlations were determined by linear regression analysis. ***Results*****:** Among 42 patients, the age range was 26-75 years with a mean age of 65.2±10.87 years. Male were 26(61.9%) and females were 16(38.1%). The male-Female ratio was 1.625:1. A total of 9(21.42%) patients had a primary intraventricular hemorrhage and the rest of 33(78.58%) had an intraventricular hemorrhage. Preoperative GCS ranged from 4 to13 with a mean value of 7.14 ± SD 1.995. Modified GRA Escoresre was ranged from 5 to 19 with the mean 8.85± SD 0.7693. The difference in GCS at 24 hours was ranged from a minimum of 3 to a maximum of +10 with an increase of +1.67± SD 2.09. Collected CSF volumes at 24 hours were ranged from a minimum of 50 to a maximum of 480 ml with a mean of 338 of 0.33 ml ±SD 113.329. Total 5 patients died within 30 days. Mortality was 11.9%. 17 patients recovered well with mild or no disability. ***Conclusion:*** The results of the present study showed that external ventricular drainage has a good role in the treatment of patients with spontaneous intraventricular hemorrhage with hydrocephalus when other bad prognostic factors such as large intracerebral hemorrhage or initial poor GCS are absent or Modified GRAEB score is low. The volume of collected CSF and initial improvement in GCS at 24 hours are good indicators of functional outcomes. The outcome of primary intraventricular Cross-sections was found better than the secondary intraventricular hemorrhage.

Keywords: Intracerebral hemorrhage (ICH), External ventricular drainage (EVD), Hydrocephalus, Glasgow Coma Scale score.

INTRODUCTION

Intraventricular hemorrhage (IVH) complicates subarachnoid hemorrhage (SAH) and intracerebral hemorrhage (ICH) in 15% and 40% of patients, respectively. Acute obstructive hydrocephalus can occur when IVH is large enough to impede normal cerebrospinal fluid (CSF) circulation. Communicating hydrocephalus may develop if fibrosis of the basal leptomeninges occurs in the subacute and chronic stages of IVH or if reabsorption of CSF becomes impaired from fibrosis of the arachnoid villus [1]. As a primary intracerebral hemorrhage (ICH) or subarachnoid hemorrhage (SAH) with extension into the ventricular system, intraventricular hemorrhages (IVH) are categorized as either primary, involving the ventricular system and adjacent ependymal lining, or secondary. The main etiologies for primary IVH include hypertension, a spontaneous formation, aneurysms, coagulopathies, head trauma, tumors, or manipulation of an intraventricular catheter. Since secondary IVH is a direct result of ICH or SAH extension, it's most common causes are dependent on ICH and SAH etiologies [2]. By the rapid removal of blood and blood products from the ventricular system, the primary goal of intraventricular hemorrhage (IVH) treatment is to limit hemorrhagic mass effect, edema, increased intracranial pressure (ICP), and obstructive hydrocephalus. This inherently increases the risk of edema, if all ventricles are involved, bleeding if, infection in an already precarious clinical situation. ICH which in turn relates to the type of neurological deficits and disabilities can occur in various cerebral locations, but no clear relationship exists between hemispheric ICH location and mortality. Mortality is associated with ICH volume. For ICH volumes of 30 mL, there exists an incremental, direct relationship to mortality. Currently, all available data support the concept that the IVH extension of an even relatively small ICH (30 mL) increases mortality to 50 to 75%, largely due to the IVH. That IVH is a significant and independent contributor to morbidity and mortality in both ICH and aneurysmal SAH, most recent research supports are viewed. Four prognostics a strong independent effect of IVH on mortality was demonstrated by four prognostic studies. Patients demonstrated a direct, continuous, dose-effect relationship between the initial volume of IVH and mortality. This effect was independent of concurrent ICH size. Mortality estimates for this condition range from 50 to 75% [2]. Hydrocephalus resulting from ICH is generally treated with external ventricular drainage (EVD). However, although appropriate treatment is offered, mortality rates are higher in this group. On the other hand, the clinical response to EVD and its effects on hydrocephalus is not known in detail. The efficacy of ventricular drainage can be evaluated by knowing the patients who will benefit from the treatment by clinical improvement and reversal of the hydrocephalus [3]. The aim of this study was to investigate the efficacy and the results of EVD in hydrocephalus developing after ICH or primary intraventricular hemorrhage.

OBJECTIVE

General objective

To see post-operative neurological improvement after external ventricular drain in spontaneous intraventricular hemorrhage.

Specific objective

- To assess the neurological improvement of the patient after external ventricular drainage by assessing the Glasgow Coma Scale score pre and postoperatively.
- To determine the post-operative short-term outcome of external ventricular drainage by Glasgow Outcome Scale at 30 days and to see the correlation of Modified GRAEB score with the outcome.

MATERIALS AND METHODS

It was a prospective interventional study conducted in the Department of Neurosurgery, Dhaka Medical College Hospital, Dhaka in the period from April 2016 to September 2017. Patients with spontaneous intraventricular hemorrhage, either primary or secondary, were admitted to the Department of Neurosurgery, Dhaka Medical College Hospital. For patients attending the above-mentioned hospital and after fulfilling the inclusion and exclusion criteria, a purposive convenient sampling technique was applied for selecting the sample patients. Patients with spontaneous intraventricular hemorrhage, either primary or secondary to ICH or subarachnoid hemorrhage and the presence of hydrocephalus were included in the study. On the other hand, patients with traumatic intraventricular hemorrhage, intraventricular hemorrhage with large ICH (>30 ml), or gross midline shifting requires surgical evacuation, patients with GCS with non-reacting pupil, and finally, patients with GCS 15 were excluded from the present study. A total of 42 patients with intraventricular hemorrhage, either primary or secondary, with hydrocephalus were selected for this study after fulfilling the inclusion and exclusion criteria. Each patient was evaluated with a detailed case history and physical examination including a neurological examination. The diagnosis was done on the basis of a non-contrast CT scan of the head. A modified GRAEB score was calculated from the CT scan. Preoperative GCS was recorded. All patients were treated with external ventricular drainage only after proper counseling and taking informed written consent. The study subjects were selected on the basis of selection criteria. The demographic information, relevant history, examination findings, investigation report, preoperative and postoperative data of all the study subjects were recorded in the performed data collection sheet. All data were analyzed with the help of the Windows-based Microsoft program IBM SPSS version 22.0. Quantitative data are expressed as

mean± standard deviation. A comparison was done by Paired "t" test. Correlations were seen by linear regression analysis. The confidence level was 95% and a probability value or "P" value of less than 0.05 was considered to indicate statistical significance. The study population was selected on the basis of selection criteria. The demographic information, relevant history, examination findings, investigation report, preoperative and postoperative data of all the study subjects were recorded in the performed data collection sheet. The comparison was done by Paired "t" test. Correlations were seen by linear regression analysis. The confidence level was 95% and a probability value or "P" value of less than 0.05 was considered to indicate statistical significance.

RESULTS

Among 42 patients with intraventricular hemorrhage included in this study, 9(21.4%) patients had primary intraventricular hemorrhage (IVH) and 33(78.6%) patients had intraventricular hemorrhage to subarachnoid hemorrhage (SAH) or intracerebral hemorrhage (ICH). Again 26 patients had ICH either at the thalamic region of basal ganglia region or both and the rest of the 7 patients had intraventricular hemorrhage with SAH. Total 5 patients died within 30 days of intraventricular hemorrhage despite external ventricular drainage. The mortality rate was 11.9 %. Among these 5 patients, 2 patients had SAH, 1 had primary IVH, and the rest 2 had ICH along with IVH. Mortality in the SAH with IVH patients was found at 28.5at 7% and 7.69% in cases of ICH with the IVH group and 11.11% in primary IVH patients. A total of 37(88.1%) patients survived at 30 days postoperatively. Among them 8 patients had a severe disability, 12 patients had a moderate disability and 17 patients had mild or no disability with Glasgow outcome scale scores of 3,4, and 5 respectively. GOS so scores and 5 were considered a favorable outcome and 1 to 3 were considered poor outcomes. Here 29 patients (69.04%) had a favorable outcome and 13(30.96 %) patients had a poor outcome at 30 days.

Table-1: Age distribution of the study population (N=42)

Age in year	n	(%)
21-30 yrs.	1	2.4
31-40 yrs.	0	0.0
41-50 yrs.	5	11.9
51-60 yrs.	14	33.3
61-70 yrs.	14	33.3
71-80 yrs.	8	19.1
Age Mean ± SD	65.2±10.87	
Minimum age	26	
Maximum age	80	

The table shows the age distribution of 42 patients with the spontaneous intraventricular hemorrhage who were selected for this study. Only one patient (2.4%) was within 21-30 years, 11.9 % were within 41-50 years, 33.3% were within 51-60 years, 33.3% were within 61-70 years and 19% were within 71-80 years. The minimum age was 26 and the maximum age was 80 years. Mean age was 65.2±10.87 years.

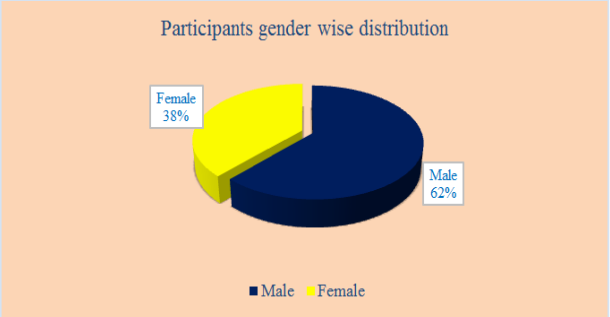

Fig-I: Participants Gender wise Distribution

Figure I showed the gender distribution of the present study. Male were 26 (61.9 %) and female were 16(38.1%) in number. Male: Female was 1.625:1.

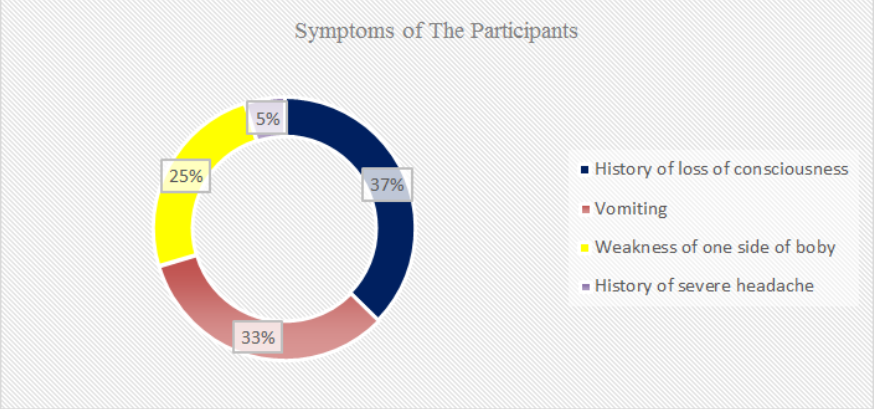

Fig-II: Participants Presenting Symptoms (N=42)

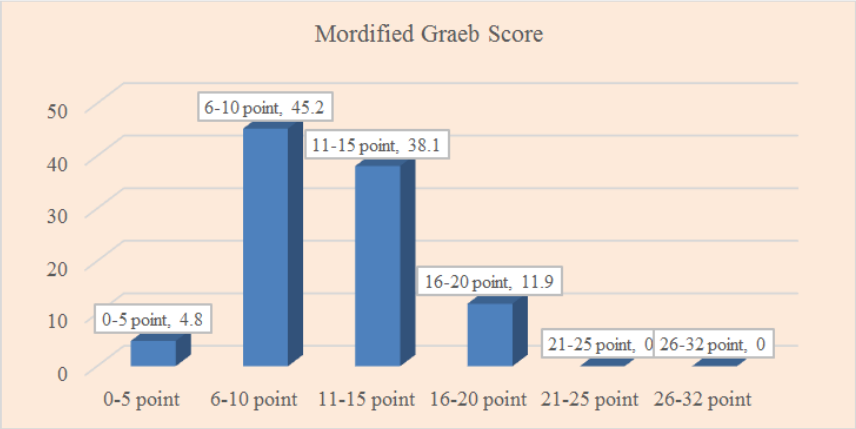

Fig-III: Frequencies of Graeb score (N=42)

Figure III showed the Modified Graeb score of the patients. The minimum score was found for 4 who had 4th ventricular hemorrhage only. Maximum was found at 19. The mean score was 8.86±SD 3.8. Total 19(45.2%) patients had modified Graeb score 6-10, 16(38.1%) patients had 11-15, 5(11.9%) patients had 16-20 and 2 (4.8%) patients had the score 0-5.

Table-2: Preoperative GCS of the patients (N=42)

Preoperative GCS	n	(%)
4	1	2.4
5	8	19.0
6	4	9.5
7	16	38.1
8	6	14.3
9	3	7.1
10	1	2.4
11	1	2.4
12	0	0.0
13	2	4.8
Total	42	100
GCS Mean ± SD	7.19±1.96	

Table 2 showed the frequency of preoperative GCS in the patients in this study. The minimum GCS was 4 and the maximum was 13. Total 16(38.1%) patients had GCS 7; 8(19%) patients had GCS 5. 6(14.3%) patients had GCS 8. 4(9.5%) patients had GCS 6. GCS 4, GCS 10, and GCS 11 were found in one patient respectively. Mean GCS was 7.19 ± SD 1.96.

Table-3: Postoperative GCS at 24 hours of the patients (N=42)

Postoperative GCS	n	(%)
3	2	4.8
4	1	2.4
5	3	7.1
6	1	2.4
7	3	7.1
8	8	19.0
9	8	19.0
10	7	16.8
11	2	4.8
12	3	7.1
13	3	7.1
14	1	2.4
Postoperative GCS Mean ± SD	8.79 ± 2.64	

Table 3 showed the frequency of postoperative GCS at 24 hours in the patients of this study. Minimum GCS was 3 and maximum was 14. 8 (19%) patients had GCS 8 and GCS 9 respectively. 7(16.7%) patients had GCS 10. 3(7.1%) patients had GCS 5, GCS 7, GCS 12 and GCS 13 respectively. 2(4.8%) patients had GCS 3 and GCS 11 respectively. 1(2.4%) patient had GCS 4, GCS 6 and GCS 14 respectively. Mean postoperative GCS was 8.79 ± SD 2.64.

Table-4: Difference of GCS (Δ GCS) at 24 hours postoperatively (N=42)

Δ GCS at 24 hours postoperatively	n	(%)
-3	1	2.4
-2	2	4.8
0	9	21.4
1	6	14.3
2	11	26.2
3	9	21.4
4	3	7.1
10	1	2.4
Difference of GCS Mean ± SD	1.67 ± 2.09	

Table 4 showed the frequency of difference of GCS of the patients at 24 hours postoperatively. GCS decreased by 3 points in one (2.4%) patient and 2 in 2(4.8%) patients. GCS was unchanged in 9(21.4%) patients. GCS improved by 1 point in 6(14.3%) patients, 2 in 11(26.2%) patients, 3 in 9(21.4%) patients, 4 in 3(7.1%) patients. One patient had an improvement of 10 points and was operated on immediately after the deterioration of consciousness. The mean difference of GCS was +1.67 ± SD 2.09.

Table-5: Collected CSF volume at 24 hours postoperatively (N=42)

Collected CSF Volume at 24 hours	n	(%)
150	3	7.1
200	3	7.1
250	3	7.1
300	4	9.5
350	8	19.0
370	2	4.8
380	2	4.8
400	6	14.3
420	1	2.4
430	4	9.5
450	6	14.3
Collected CSF volume at 24 hours Mean ± SD	346.19 ml ± SD 90.39 ml	

Table 5 showed the volume of collected CSF at 24 hours postoperatively. The minimum volume was 150 ml and the maximum was 450 ml. Collected CSF volumes were 150 ml, 200 ml, and 250 ml for each of 3(7.1%) patients respectively. 4(9.5%) had 300 ml and 430 ml respectively, 8 (19%) had 350 ml, 2(4.8%) had 370 ml and 380 ml respectively,6(14.3%) had 400 ml and 450 ml respectively. 1(2.4%) patient had 420 ml. The mean collected CSF volume at 24 hours was 346.19 ml ± SD 90.39 ml.

Table-6: Glasgow Outcome Scale (GOS) score at 30 days of the patients (N=42)

Glasgow Outcome Scale (GOS) score at 30 days	Interpretation	n	(%)
1	Death	5	11.9
2	Persistent vegetative state	0	0.0
3	Severe disability	8	19.0
4	Moderate disability	12	28.6
5	Mild or no disability	17	40.5
GOS score Mean ± SD		3.87 ± 1.29	

Table 6 showed the Glasgow Outcome Scale at 30 days of the patients. The minimum GOS score was 1 (death) and the maximum was 5. A total of 5 (11.9%) patients died within 30 days and had a GOS score 1. 17 (40.5%) patients had mild or no disability and had GOS 5. 12(28.6%) patients had a moderate disability and GOS score 4. 8 (19%) patients had a severe disability and GOS score 3. No patient was found in a persistent vegetative state. The mean GOS score was 3.87±SD 1.29.

Table-7: Comparison of preoperative and postoperative GCS at 24 hours (N=42)

Preoperative GCS	Frequency (n)	Postoperative GCS at 24 hours	Frequency (n)	P-value
4	1	3	2	<0.001
5	8	4	1	
6	4	5	3	
7	16	6	1	
8	6	7	3	
9	3	8	8	
10	1	9	8	
11	1	10	7	
12	0	11	2	
13	2	12	3	
		13	3	
		14	1	

Table 7 showed the mean of preoperative GCS was 7.19 ± SD 1.96 and postoperative GCS at 24 hours was 8.79 ± SD 2.64. P-value was found < 0.001 which was statistically significant. That means there was a significant improvement in GCS after 24 hours of external ventricular drainage.

Table-8: Correlation in-between collected CSF volume at 24 hours and Glasgow outcome scale at 30 days. (N=42)

Collected CSF volume at 24 hours	Frequency (n)	GOS score at 30 days	Frequency (n)	P-value
150	3	1	5	0.014
200	3	2	0	
250	3	3	8	
300	4	4	12	
350	8	5	17	
370	2			
380	2			
400	6			
420	1			
430	4			
450	6			

Table 8 showed the correlation was seen by "Linear regression analysis". P-value was found 0.014 which is <0.05 and statistically significant. That means an increased volume of collected CSF was associated with an increased Glasgow Outcome Scale score or a better outcome. Collected CSF volume was an indirect indicator of reduction of ventricular size.

Table-9: Correlation between Modified GRAEB score and Glasgow Outcome Scale score at 30 days (N=42)

Modified GRAEB score	Frequency (n)	GOS score at 30 days	Frequency (n)	P-value
0-5	2	1	5	0.001
6-10	19	2	0	
11-15	16	3	8	
16-20	5	4	12	
21-25	0	5	17	
26-30	0			

Table 9 showed the correlation between the Modified GRAEB score and Glasgow Outcome Scale score at 30 days. The correlation was seen by linear regression analysis after reversing the chronology of the GRAEB score. "P" value was found < 0.001 which is statistically significant. It indicates that a higher GRAEB score was associated with the poor outcome despite external ventricular drainage.

Table-10: Correlation between the difference of GCS at 24 hours and Glasgow Outcome Scale score at 30 days (N=42)

Δ GCS at 24 hours postoperatively	Frequency (n)	GOS score at 30 days	Frequency (n)	P-value
-3	1	1	5	
-2	2	2	0	
0	9	3	8	
1	6	4	12	
2	11	5	17	0.001
3	9			
4	3			
10	1			

Table 10 shows a correlation between the difference in GCS at 24 hours and the Glasgow Outcome Scale score at 30 days. The correlation was seen by linear regression analysis, the "P" value was found <0.001 which is statistically significant. It indicated that improvement in GCS at 24 hours was associated with a higher Glasgow Outcome Scale score or a better outcome.

Table-11: Correlation in-between collected CSF volume at 24 hours and difference in GCS at 24 hours (N=42)

Collected CSF volume at 24 hours	Frequency (n)	Δ GCS at 24 hours	Frequency (n)	P-value
150	3	-3	1	
200	3	-2	2	
250	3	0	9	
300	4	1	6	
350	8	2	11	0.002
370	2	3	9	
380	2	4	3	
400	6	10	1	
420	1			
430	4			
450	6			

Table 11 shows a correlation between collected CSF volume at 24 hours and the difference in GCS at 24 hours. The correlation was seen by linear regression analysis. "P" value was found 0.002 which is <0.05 and is statistically significant. It indicated increased volume of collected CSF was associated with improvement in GCS at 24 hours.

Table-12: Correlation between preoperative GCS and Glasgow Outcome Scale score at 30 days (N=42)

Preoperative GCS	Frequency (n)	GOS score at 30 days	Frequency (n)	P-value
4	1	1	5	0.007
5	8	2	0	
6	4	3	8	
7	16	4	12	
8	6	5	17	
9	3			
10	1			
11	1			
13	2			

Table 12 shows the correlation between preoperative GCS and Glasgow Outcome Scale at 30 days. The correlation was seen by linear regression analysis. "P" value was found 0.007 which is < 0.05 and statistically significant. It indicates that higher preoperative GCS was associated with a higher Glasgow Outcome Scale score or a better outcome.

DISCUSSION

Intraventricular hemorrhage (IVH) is a significant and independent contributor to mortality and morbidity in both intracerebral hemorrhage (ICH) and aneurysmal subarachnoid hemorrhage (SAH). Four prognostic studies have demonstrated a strong independent effect of IVH on mortality. Most recently, a prospective evaluation of ICH patients demonstrated a

direct, continuous, dose-effect relationship between the initial volume of IVH and mortality. This effect was independent of concurrent ICH size. Mortality estimates for this condition range from 50 to 75% [2]. Intraventricular hemorrhage (IVH) frequently complicates intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) in 40% and 15% of patients respectively [1]. Hydrocephalus resulting from ICH is generally treated with external ventricular drainage (EVD) However, although appropriate treatment is offered, mortality rates are higher in this group. On the other hand, the clinical response to EVD and its effects on hydrocephalus is not known in detail. The efficacy of ventricular drainage can be evaluated by knowing the patients who will benefit from the treatment by clinical improvement and reversal of the hydrocephalus. The result of a prospective study suggested that EVD is a life-saving and effective procedure that should be performed in patients who develop hydrocephalus following spontaneous intracerebral hemorrhage [3]. The present study was designed to find out the role or effectiveness of the commonly used surgical procedure-external ventricular drainage in the treatment of spontaneous intraventricular hemorrhage, either primary or secondary which was carried out in the Department of Neurosurgery, Dhaka Medical College Hospital during the period of April 2016 to September 2017. In the present study mean age± SD was found 65.2±10.87 years. The minimum age was 26 and the maximum age was 80 years. This result correlates with other international studies such as [1, 3, 9] observed a mean age± SD was 62± 15.6 years, 57±13.1 years, and 61.7±10.2 years respectively. Regarding the sex distribution in this study, the male was 61.9% and the female was 38.1%. The male-female ratio was 1.625: 1. This correlates with the study of [1] where the male: female ratio was 1.5:1. In this study, the mean ± SD of the preoperative Glasgow Coma Scale (GCS) score was found as 7.19±SD 1.96. This preoperative GCS is similar to the study [1] where preoperative GCS was observed as 8.7±3.89 in patients with intraventricular hemorrhage. Regarding the modified Graeb score, in this study, the median was found as 9. The main reason behind it may be the difference in inclusion criteria of these two studies. In this study, only patients with intraventricular hemorrhage with hydrocephalus were included which usually require es large volume of intraventricular blood to develop hydrocephalus [1], included all patients with intraventricular hemorrhage irrespective of hydrocephalus where a number of small IVH patients were included. In this study, a total of 5 patients died within 30 days of spontaneous intraventricular hemorrhage despite external ventricular drainage. The overall mortality rate in this study was found 11.9%. Among these 5 patients, 2 patients had SAH, 1 had primary IVH, and the rest 2 had ICH along with IVH. Mortality in the SAH with IVH patients was found at 28.57%, 7.69% in the case of ICH with IVH group, and, 11.11% in primary IVH group patients. A total of 37(88.1%) patients survived at 30 days postoperatively. Among them 8 patients had a severe disability, 12 patients had a moderate disability and 17 patients had mild or no disability with Glasgow outcome scale scores of 3, 4, and 5 respectively. Another study carried out by Dennis J. Nieuwkamp *et al*. [5] on treatment and outcome of severe intraventricular extension in patients with subarachnoid or intracerebral hemorrhage: a systematic review of the literature. In this study, the outcome of intraventricular hemorrhage with subarachnoid hemorrhage or ICH was also found poor but the outcome was found better with external ventricular drainage in comparison with the conservative group. The case fatality rate was 78% and 58% in the conservative group and external ventricular drainage group respectively. In the present study, 9 patients of primary IVH were included among them only one patient died and the rest of the 8 patients survived with a good recovery. The mortality rate was 11.11%. Another study was done by Tuhrim S *et al*. [6] on "Volume of ventricular blood is an important determinant of outcome in supratentorial intracerebral hemorrhage" where all the patients were treated conservatively. In that study, they concluded that the 30-day mortality rate in patients with ICH with IVH was 43%. In comparison to that study, the mortality rate of the current study was lower. Regarding the improvement of GCS at 24 hours, it was found that there was an overall increase in the mean of GCS at 24 hours by +1.67 ± SD 2.09. The preoperative GCS was compared with the post-operative GCS by student paired "t" test which was found statistically significant. ($p<0.001$) This finding is similar to the study carried out by Po-Chou Liliang *et al*. [7] on "Hypertensive Caudate Hemorrhage: Prognostic Predictor, Outcome, and Role of External Ventricular Drainage'' where preoperative GCS score for the surgical patients was 7.162.3 (mean ±SD), whereas postoperative 48-hour GCS score was 9.264.0. The postoperative 48-hour GCS score was better than the preoperative score ($P<0.001$). Again, in the Glasgow Outcome Scale at 30 days, it was found that 17 patients (40.47%) had good recovery with a GOS score of 5 and 12 patients had a moderate disability with a GOS score of 4. Both GOS scores 4 and 5 are considered a good outcome. So, a total of 69.04% of patients had an overall good outcome. No patient was found in a persistent vegetative state. 8 patients (19.04%) were found with severe disability at 30 days with a GOS score of 3. The study done by Kirmani AR *et al*. [4] showed that among the 130 patients, 49 patients survived at 30 days and their scores improved from Grade 3-5 to Grade 2-4. The morbidity of the patients was assessed, and they were grouped as moderate disability, severe disability, and vegetative state on the criteria lay down by Glasgow Outcome Scale. Twenty-nine patients were moderately disabled, 16 patients were severely disabled, and 5 patients were left in a vegetative state. This finding is close to the findings of the outcome found in this study in the case of patients who survived at 30 days except that no

patient went to a vegetative state in the present study. Another observational review study done by Adams Robert E *et al*. [8] Showed that among 22 patients with spontaneous intracerebral hemorrhage with hydrocephalus admitted to ICU and treated with external ventricular drainage, only 3 patients survived at 3 months with good outcomes and 85% of patients died at 3 months. The predicted 30-day mortality rates using models of Tuhrim *et al*. [6] were 51% and 55% in this case but actual mortality was found much higher than this. Again 12 patients in that study had cared withdrawn, based on their prior expressed wishes, in the face of poor unchanged condition. Only 3 patients succumbed to brain death. This result is not inconsistent with the finding of the current study. Because, the three patients who survived with good outcomes found in that study had small ICH volume, stable or improved GCS at admission, and decreased ventricular volume. In this study, patients with intraventricular hemorrhage with small ICH volume only were selected. As we excluded the large ICH patients, the overall mortality was found better than in that study. The correlation between the collected CSF volume at 24 hours and improvement in GCS was analyzed by linear regression analysis and found statistically significant. (p=0.002) It indicates that, if EVD is functioning, the volume of collected CSF increases which decreases the ICP and leads to improvement in GCS in most patients. But in case of massive intraventricular hemorrhage, EVD can be blocked frequently and may become ineffective. On the other hand, in 6 cases, despite having adequate CSF drainages, GCS did not improve or rather decreased. The possible explanation for this can be that the cause of poor consciousness level was not only due to the raised ICP. Rather the toxic effect of blood causes periventricular irritation which leads to a decreased level of consciousness or irreversible damage in the neural tissues that occurred before the time when EVD was given. In the present study, a total of 5 patients developed ventriculitis which was evidenced by fever, decreased level of consciousness and increased polymorph in the CSF, and decreased CSF glucose. 3 patients had positive CSF culture but in the rest of 2 patients, no growth was found in the culture. Out of these 5 patients, 2 patients died and the rest three recovered with an injectable antibiotic. The overall infection rate was 11.9 %. The infection rate in the case of external ventricular drainage varied in different studies. In the study carried out by Kwan-Hon Chan *et al*. [9] on "Prolonged Therapeutic External Ventricular Drainage: A prospective study" where 34 patients underwent therapeutic external ventricular drainage with a valve regulated system for a mean duration of 16 days. No patient developed any ventriculostomy-related infection. But in the study of Kirmani *et al*. [10] 27.6 % of patients developed ventriculostomy-related infections. The increased infection rate was mostly associated with poor GCS found in that study. There are some studies regarding the use of urokinase and rTPA in the treatment of intraventricular hemorrhage. The outcome of the present study was better than this study in comparison to 30 days' mortality or outcome. The strength of the present study is that it is a prospective study. In this study, all the confounding variables were avoided which could give a false interpretation regarding the effectiveness of external ventricular drainage such as the presence of large ICH or patients of GCS 3. Again, patients of good neurological status such as GCS 15 were excluded in this study that is likely to improve without surgery. Therefore, this study shows that external ventricular drainage has a good role in the treatment of intraventricular hemorrhage with hydrocephalus which can improve the outcome of the patients when other bad prognostic factors such as high grade of SAH or high ICH score is not present.

Limitation of this study

The sample size is not large enough. There was no control group of conservative patients (This could not be done due to ethical issues as pre-existing knowledge of the effectiveness of EVD in the case of a patient with hydrocephalus due to intraventricular hemorrhage did not allow us to deprive a patient of the benefit from EVD only for study purpose.) A short period of follow-up. Single-center study.

CONCLUSION

The results of the present study showed that EVD has a good role in the treatment of spontaneous IVH with hydrocephalus when ICH volume was low (<30 ml) and the modified Graeb Score was low (≤ 10 found in this study). Preoperative higher GCS or initial improvement in GCS at 24 hours positively correlates with Glasgow Outcome volume is improvement in GCS at 24 hours positively correlates with Glasgow Outcome Scale Score which is an indicator of good functional outcome.

RECOMMENDATIONS

As external ventricular drainage showed good outcomes in the treatment of intraventricular hemorrhage with hydrocephalus, all patients with spontaneous intraventricular hemorrhage with hydrocephalus with altered consciousness levels should be treated with external ventricular drainage. But to avoid ventriculostomy-related infection, strict standard methods of sterility must be followed at every step and EVD should be removed as soon as the ICP decreases to a normal level. The method of long tunneling during the insertion of EVD was found also beneficial to reduce the infection rate. Use of medications for clot lysis may be done in case of massive intraventricular hemorrhage.

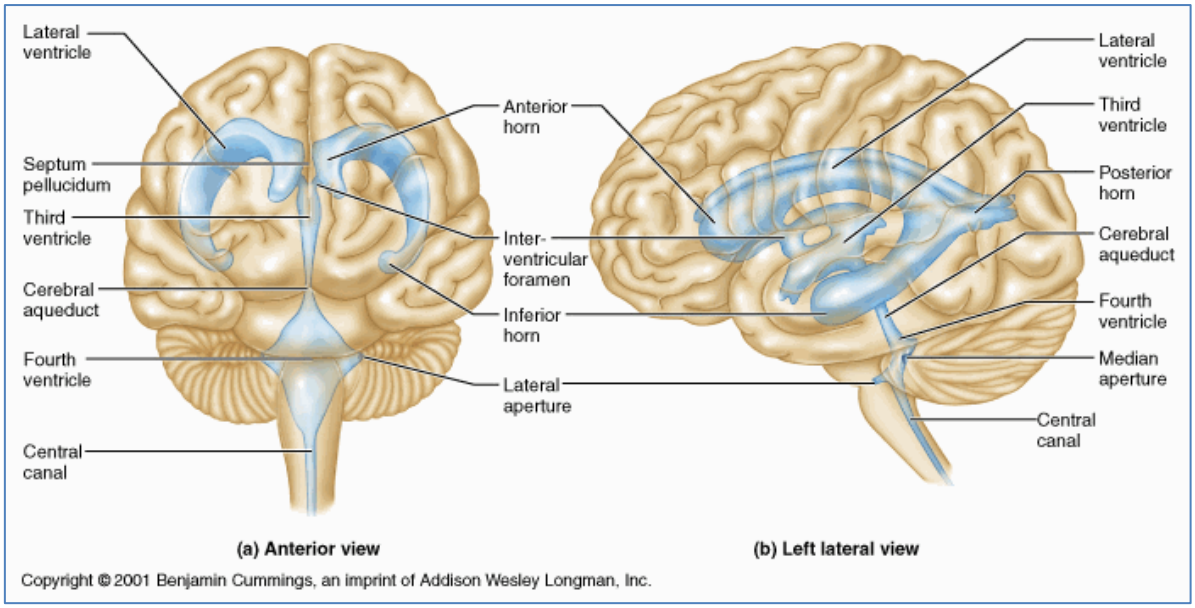

Fig-I: Anterior & Left lateral view of Brain

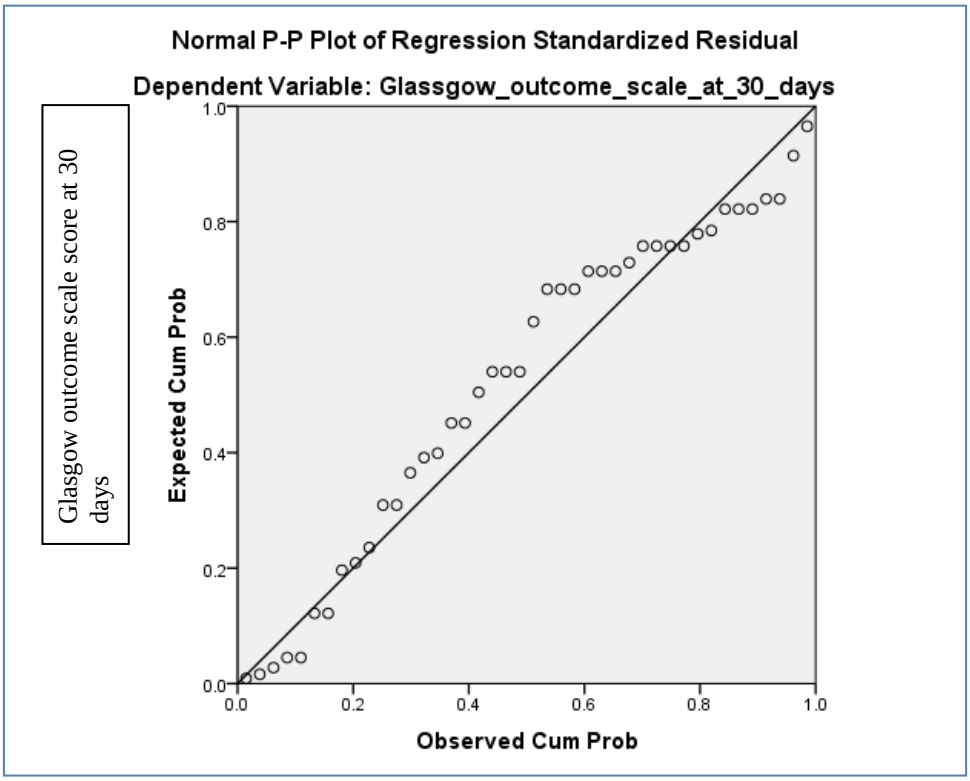

Fig-II: Linear regression analysis between collected CSF volume and Glasgow Outcome Scale score P-P plot shows a positive correlation

REFERENCE

1. Naff, N. J., Carhuapoma, J. R., Williams, M. A., Bhardwaj, A., Ulatowski, J. A., Bederson, J., ... & Hanley, D. F. (2000). Treatment of intraventricular hemorrhage with urokinase: effects on 30-day survival. *Stroke*, *31*(4), 841-847.
2. Hanley, D. F., Naff, N. J., & Harris, D. M. (2005, September). Intraventricular hemorrhage: presentation and management options. In *Seminars in Cerebrovascular Diseases and Stroke* (Vol. 5, No. 3, pp. 209-216). WB Saunders.
3. Sumer, M. M., Açikgöz, B., & Akpinar, G. (2002). External ventricular drainage for acute obstructive hydrocephalus developing following spontaneous intracerebral haemorrhages. *Neurological sciences*, *23*(1), 29-33.
4. Kirmani, A. R., Sarmast, A. H., & Bhat, A. R. (2015). Role of external ventricular drainage in the management of intraventricular hemorrhage; its

complications and management. *Surgical neurology international*, *6*.

5. Nieuwkamp, D. J., de Gans, K., Rinkel, G. J., & Algra, A. (2000). Treatment and outcome of severe intraventricular extension in patients with subarachnoid or intracerebral hemorrhage: a systematic review of the literature. *Journal of neurology*, *247*(2), 117-121.
6. Tuhrim, S., Horowitz, D. R., Sacher, M., & Godbold, J. H. (1999). Volume of ventricular blood is an important determinant of outcome in supratentorial intracerebral hemorrhage. *Critical care medicine*, *27*(3), 617-621.
7. Liliang, P. C., Liang, C. L., Lu, C. H., Chang, H. W., Cheng, C. H., Lee, T. C., & Chen, H. J. (2001). Hypertensive caudate hemorrhage prognostic predictor, outcome, and role of external ventricular drainage. *Stroke*, *32*(5), 1195-1200.
8. Adams, R. E., & Diringer, M. N. (1998). Response to external ventricular drainage in spontaneous intracerebral hemorrhage with hydrocephalus. *Neurology*, *50*(2), 519-523.
9. Chan, K. H., & Mann, K. S. (1988). Prolonged therapeutic external ventricular drainage: a prospective study. *Neurosurgery*, *23*(4), 436-438.
10. Naff, N. J., Carhuapoma, J. R., Williams, M. A., Bhardwaj, A., Ulatowski, J. A., Bederson, J., ... & Hanley, D. F. (2000). Treatment of intraventricular hemorrhage with urokinase: effects on 30-day survival. *Stroke*, *31*(4), 841-847.