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Intraventricularhemorrhage: Role of External Ventricular Drainage in the Management

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Abstract: ***External ventricular drain (EVD) usage in patients with intraventricularhemorrhage (IVH) is variable in current practice and in clinical trials, and itsimpact on outcome remains controversial. The increased intracranial pressure andacute hydrocephalus caused by IVH is managed by placement of anexternal ventricular drain (EVD).Intervention to reduce intracranial pressure using ExternalVentricular Drain (EVD) is a common life saving measure in a neurosurgery intensivecare unit (ICU).During the period of 2 years, between January 2017 and January 2019, 62 patients were subjected to external drainage procedure and were prospectively enrolled in this study. The study done in the neurosurgery teaching hospital/Baghdad/Iraq. Information was collected on each patient regarding age, sex, diagnosis, underlying illness, secondary complications, other coexisting infections, antibiotic treatment.***

Keywords: IVH, external ventricular drain, EVD catheter, outcome

1. Introduction

The external ventricular drain (EVD), also called as ventriculostomy or external ventricular drain, is often used as an emergency procedure in neurosurgery to manage hydrocephalus and reduce raised intracranial pressure (ICP) when there is acute obstruction to the normal flow of cerebrospinal fluid (CSF). Insertion of an EVD help in reduction of ICP by draining CSF/intraventricular blood, permits introduction of various medications and allow intracranial pressure monitoring.Well-trained nursing staff are required for managing these cases to ensure appropriate zeroing, maximum sterility, and flawless integrity of the EVD collecting system. ICP waveform analysis and close monitoring of CSF drainage are extremely important and can affect clinical outcomes. External ventricular drainage (EVD) has its own drawbacks; mechanical complications such as dislodgement and blockade are common occurrences. However, it is the infective complications resulting in ventriculitis and meningitis that incur the maximum morbidity and are responsible for most adverse sequelae. Not only do they result in a protracted hospital course and escalate costs, but are also difficult to treat.Despite the availability of high-potency antibiotics and closed drainage systems, the infection rate of ventricular catheters remains high; infection rates of 0–40% have been reported. The optimum duration of ventricular catheters need for replacing them periodically, and the use of intraventricular antibiotics are all controversial issues with no consensus yet. Yet, several reports suggest that infection is independent of catheter duration, hence recommending that a functioning ventricular catheter should be allowed to remain such until gets infected or blocked or is no longer required. Concurrently, other reports have documented an increase in infection rates with increasing duration of ventricular catheters (1, 2, 3, and 4).

2. Materials and Methods

The present retrospective observational study was carried out at Neurosurgery teaching hospital/Baghdad/Iraq. The data of the patients who underwent placement of external ventricular drainage for intraventricular hemorrhage (IVH) from January 2017 to January 2019 was retrieved from the hospital case records and analyzed. The demographic, clinical, radiological, management and outcome details of the patients were recorded.

During this period of 2 years, 62 patients weresubjected to external drainage procedure.External ventricular catheter placement was performed in the operation theatre and a standard approach was followed to perform the procedure i.e. Kocher's point to insert the ventricular catheter, tunneling of the catheter to reduce infection, fixation of the catheter to the scalp, secure attachment for CSF collection and keeping the CSF collection bag at appropriate height. The side of the insertion was decided based on the ventricular enlargement and amount of the blood in the lateral ventricles. EVD catheter was subcutaneously tunneled for an approximate distance of 5 cm from the ventriculostomy site incision and externalized. All the patients received prophylactic pre-operative antibiotics. After EVD insertion, patients were managed in intensive care unit and CSF output was closely monitored. CSF was regularly monitored for any evidence of infection (cell count, gram staining and culture). Once the CSF became clear andventricles were cleared reasonably of blood (particularly disappearance of the blood from the fourth ventricle), the EVD catheter was removed. Before removing

the EVD, the drain was raised approximately 20 cm above the external auditory meatus to make sure that the patient is not drain dependent. Systemic antibiotics were given in all cases after theinsertion of an EVD prophylactically. The treatment of postoperative ventriculitis would be removal and/or change of catheter, systemic and intraventricular antibiotic therapy. Information was collected on each patient regarding age, sex, diagnosis,underlying illness, secondary complications, other coexisting infections, and antibiotic treatment. The presence of intraventricular hemorrhage (IVH) was noted radiologically, as well as clinically bedside by the appearance of blood in the external tubing.Computed tomography scan was done, both preoperatively, as well aspostoperatively, for detection of any intraprocedural hemorrhagic complications and comparison of the size of ventricles, after drainage. Inclusion criteria were patients ≥ 18 years old with IVH after ICH, trauma, tumor, or vascular pathologies. The main target for treatment was symptomatic hydrocephalus requiring EVD, including patients who were offered EVD but did not have the intervention due to conservative goals of care. Symptomatic hydrocephalus was defined as radiologically proven hydrocephalus causing more than drowsiness (i.e., patients would not open eyes to voice and/or follow commands). In patients who were comatose with IVH but without radiographic hydrocephalus, EVD was placed if successive CT scans showed ventricular enlargement.

3. Results

Sixty-two patients were included in this study. There were 40 male (65%) and 22 female (34%) with a male to female ratio of 1.81: 1.

	Poor outcome (GOS 1-3)	Good outcome (GOS 4,5)
Male	30(75%)	10(25%)
Female	10(45.4%)	12(54.6)

Mean age was 53.7 ±11.6 years andmajority were in the age group of 51-60 yrs.

Age group	Poor outcome (GOS 1-3)	Good outcome (GOS 4,5)
21-30	4(80%)	1(20%)
31-40	2(50%)	2(50%)
41-50	5(83.3%)	1(16.7%)
51-60	15(65.2%)	8(34.8%)
61-70	8(66.6%)	4(32.4%)
71-80	6(60%)	4(30%)
	40(63%)	22(37%)

47 patients (75%) were known hypertensives and 9 patients (15%)were diabetic. Past history of smoking was recorded in 14(23%) patients and alcohol intake in 15 patients (25%). Clinical presentation included altered sensorium in 59 patients (96%), hemiparesis in 55 patients (90%), vomiting in 36patients (58%) and seizures in 8 patients (13%). At the time of admission, 54 patients (87%) had diastolic blood pressure more than 90 mmHg, 56 patients (91%) had systolic blood pressure more than 140 mmHg. Pupillary asymmetry was noted in 5 patients. Pupillary light reaction was absent in 3 patients. GCS at the time of admission was 3-8 (low) in 35 patients (57%), 9-12 in 21 patients (33%) and 13-15 in 6 patients (10%). Mean GCS at admission was 8 ±3.

GCS	Poor outcome (GOS 1-3)	Good outcome (GOS 4,5)
3-8	29(82.8%)	6(7.2%)
9-12	8 (38%)	13(62%)
13-15	3(50%)	3(50%)

Major site of hemorrhage was basal ganglia in 21 (35%), thalamus in 12 (19%), cerebellum in 5 (7%), brain stem in 3, frontal/temporal in 2 patients. SAH with IVH was noted in 10 patients (16%) and only IVH was noted in 9 patients (14%).

Location of bleed	Poor outcome (GOS 1-3)	Good outcome (GOS 4,5)
Basal ganglia	16(76%.1)	5(33.9%)
thalamus	7(58.3%)	5(41.7%)
cerebellum	2(40%)	3(60%)
SAH with IVH	5(50%)	5(50%)
IVH only	6(66.6%)	3(33.4)
Frontal/temporal	1(50%)	1(50%)
brainstem	3(100%)	0

Patients with deep and infratentorial hemorrhages had higher rate of poor outcome 28/40(70%). IVH location site were recorded

IVH location	No.
RLV or LLV only	8(12.9%)
RLV &/or LLV+3rdV	16(25.8%)
RLV&/or LLV+4thV	14(22.6%)
3rd+4th only	3(4.8%)
4th only	3(4.8%)
RLV or LLV+3rd+4th	10(16.2%)
paraventricular	8(12.9%)

Most patients of poor outcome group lie in the three ventricles hemorrhage extension.

Mean duration of external ventricular drainage was 4.6+1.7 days (Range 1-9 days).EVD was kept in place, until the time draining CSF was clear and the neurological condition would improve. Prolonged use is associated with the risk of rebleeding, infection, increased morbidity and mortality. Evaluation of the use of EVD was done by comparing preoperative and postoperative grading scores. Morbidity of the patients was assessed, they were grouped as moderate disability, severe disability, and vegetative state on the criteria laid down by Glasgow Outcome Scale. Mean hospital stay was 11.3±7.5 days and mean ICU stay was 8+5.38 days. Thirteen patients died during hospital stay. At the time of discharge, poor outcome (Glasgowoutcome score 1-Dead, 2- Persistent vegetative state, 3- Severe disability) wasnoted in 40 patients (63%) and good outcome (Glasgowoutcome score 4-Moderatedisability, independent and 5- Good Recovery, Normal life despite minor deficits) was noted in 22 patients (37%).A total of 9 patients had ventriculostomy infection, implying an overall infection rate of 15%. Among the infected 9 patients, cultures were positive in 7 patients (80.5%). The infections were polymicrobial in (49.9%), and 3 were (30.5%) unimicrobial. The causative bacteria were predominantly Gram-negative bacilli. The overall picture was as Staphylococcus spp. (4),

Pseudomonas spp. (01), Klebsiella spp. (01), and Enterobacter (01). Coexistent sepsis was present in 4 (45%) patients at the time of ventriculostomy insertion and 2 (17%) of these had a potential "open" source of infection in the form of a tracheostomy, pressure sore, or wound infection Mean GCS at the time of admission in patients with poor outcome was 7.4+3 as compared to 9.7+1.8 in patients with good outcome. Statistically significant poor outcome was also noted in patients with past history of smoking and alcohol intake. Poor outcome was noted in 94% (13/14) of patients with past history of alcohol intake as compared to 56% (27/48) in patients without history of alcohol intake. Poor outcome was also noted in all the patients (15/15) with past history of smoking as compared to 68% (31/47) in patients without history of smoking. None of the other factors like age, gender, site of bleed, pupillary asymmetry/ reaction to light at the time of admission, systolic blood pressure/diastolic blood pressure at the time of admission, past history of hypertension / diabetes mellitus was found to correlate with poor outcome.

4. Discussion

Numerous forms of acute brain injury benefit from continuous ICP monitoring and cerebrospinal fluid (CSF) diversion provided by an EVD. After insertion, EVD monitoring and maintenance essentially become responsibility of nursing staff and well-trained nursing staff are required to prevent EVD associated meningitis and for early detection of complications like blockage of EVD. [5-13] it has been reported that the occurrence of intraventricular hemorrhage (IVH) ranges from 30% to 50% in cases of spontaneous intracerebral hemorrhage and it frequently results in acute obstructive hydrocephalus. External ventricular drainage is a lifesaving procedure in these patients.EVD does help to drain CSF, remove ventricular and subarachnoid blood and blood products. EVD not only reduce intracranial pressure but also potentially reduce the inflammatory response from blood products which might help in reducing chances of persistent hydrocephalus following IVH. [14] It is difficult to specify the timeline when to remove the EVD as it may vary from cases to case. Once the purpose of EVD is served (either discontinuations of the ICP monitoring or resolution of the clot and hydrocephalus) a decision to remove EVD can be made. EVD placement can be associated with many complications like infection (e.g. ventriculitis and meningitis), hemorrhage, disconnection, misplacement, dislodgement or blockage of the catheter. [15-18] Reported incidence of EVD associated meningitis/ ventriculitis is 0-22%. [2, 20] This risk can be reduced by judicious use of prophylactic antibiotics while taking precautions to avoid the risk of the development of resistant organisms [6, 19]. We followed the standard strategies to reduce the infection rate i.e. proper tunneling of the EVD catheter, careful monitoring of the EVD dressing site, any evidence of CSF leak, keeping the CSF collection system in an upright position, less frequent change in the drain tubing and minimizing the duration of the EVD. [6, 19, 20] EVD related infections could be prevented by careful surgical technique, tunneling of the ventricular catheter 22 and early removal of the EVD (preferably within 5 days). [21, 22] In patients with intracranial hematomas, presence of IVH and associated hydrocephalus are associated with poor outcome and mortality independently. [13, 23, 24] Hypertension, diabetes mellitus, smoking and alcohol intake are reported to be high risk factors for intracranial hematomas. [25, 26].EVD is the procedure of choice for the treatment of acute hydrocephalus andincreased ICP in patients of intraventricularhemorrhage. Despite the risk of infection and the otherknown complications associated with the procedure, the benefits foroutweigh the risks involved. Applying EVD has positive results and influencethe prognosis, and early and late complications of intraventricularhemorrhage. Young ET al. [27] studied the prognostic significance of IVH in supratentorial hemorrhage using volumetric analysis of CT scans in 47 patients. They found that hydrocephalus, the number of ventricles containing blood, the volume of blood in the ventricles, and blood in the fourth ventricle were associated with worse outcome. There was no direct analysis of the relationship between ventricular blood and symptomatic hydrocephalus, but patients with higher IVH volumes had higher mean hydrocephalus and ventricular involvement scores, leading to the remark that "there was a high correlation between ventricular blood volume, the number of ventricles involved, 4th ventricular involvement, and extent of hydrocephalus.

It has been often stated that with a ventricular drain in situ, CSF pleocytosis may be a manifestation of "foreign bodyreaction."[28, 29] Clearly, a sufficiently sensitive definition of ventriculitis has to include CSF pleocytosisas criteria despite the criticism ofthe foreign body reaction as has also been felt by other authors. [18,30]Although Mayhall et al. [29] have chosen to define EVD associated ventriculitisin terms of culture positively, they have also commented on the high correlation between CSF pleocytosis and ventriculitis. The high rate of infection is also attributed to the higher percentage of ourpatients who required a ventricular catheter for a longer duration comparedto other studies. [31, 32] The average duration of EVD prior to infection was 7.5days. A few studies have reported the flushing of ventricular catheters (withantibiotic solutions) to be a risk factor for ventriculitis, [33,34] asagainst the reported safety by another study.[35] The explanation may lie in the inadvertent inoculation of organism into the lumen. Administering intraventricular antibiotics routinely as a prophylaxis has no role inpreventing ventriculitis; however, it may still have an important role in thetreatment of ventriculitis once it has developed. [36, 37].

5. Conclusion

1) Ventriculostomy (external ventricular drainage [EVD]) is the definitive treatment of hydrocephalus associated with IVH.
2) The decision to treat hydrocephalus after IVH is obvious when there is clearly symptomatic hydrocephalus, Symptomatic hydrocephalus was defined as radiologically proven hydrocephalus causing more than drowsiness (i.e., patients would not open eyes to voice and/or follow commands).
3) poor neurological condition at the time of admission, past history of smoking and alcohol intake were associated with poor outcome.
4) The use of EVD should be undertaken only in situation where it is absolutely necessary and ventriculostomy

should be kept only for the duration required, and this should be monitored on a daily basis, given the exponential increase in infection after 5 days

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