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Study Of Risk Factors And Outcome In External Ventricular Drain Infections

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ABSTRACT
Introduction: *External Ventricular drains are used for monitoring the intracranial pressure as well as therapeutically for diverting the cerebrospinal fluid from obstructed ventricular system. However, it is associated with many complications and the most common complication is EVD infection.*
Aims and Objective*:To analyse the risk factors and the outcome in patients with external ventricular drain related infections.*
Materials and Methods: *In our study, 66 patients admitted to the Neurosurgery department of Dayanand Medical College and Hospital for EVD placement from August 2021 to October 2022 and following the inclusion criteria of the study were included in the study.The data collected was compiled and analysed to study the incidence, risk factors and the outcome of the external ventricular drain infections.*
Results*: Out of 66 patients who were enrolled for the study, 5 patients developed EVD infections giving an incidence of 7.6% . Prolonged duration of EVD drainage, frequency of CSF sampling and systemic coinfection were the risk factors found to be significantly associated with EVD infections. Patients with EVD infections were having longer hospital stay however it doesnot significantly affect the Glassgow outcome scale at the time of discharge.*
Conclusion: *Our study demonstrated prolonged duration of EVD infections, frequency of CSF sampling and systemic coinfection as significant risk factors of EVD infections so widespread attention should be given to these factors to reduce the incidence of EVD infections.*
Keywords*: External Ventricular Drain, Infection, Risk factors, Outcome*

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I. Introduction

External Ventricular drains are used for monitoring the intracranial pressure as well as therapeutically for diverting the cerebrospinal fluid from obstructed ventricular system.1

However, they are associated with many complications which includes intracranial hemorrhage or tract hemorrhage, vascular injury, accidental pull, blockage, excessive drainage, obstruction by choroid plexus, infection, CSF leak and pneumocephalus. Infection is the most common complication of EVD .2 The average rate of EVD related infections is 10%.3 Different conditions which include depressed skull fracture, subarachnoid hemorrhage or intraventricular hemorrhage, CSF leak, frequent CSF sampling, catheter irrigation, frequent changing of catheter, prolonged duration of catheter insertion, systemic coinfections have been found to increase the risk of infection in EVD patients.4-8

EVD infections extend the patient's hospital stay and increases the economic burden on the patient.9 Early diagnosis and management can help in improving the outcome in these patients. Thus, this study was conducted to identify various risk factors of external ventricular drain infections and their outcomes so that preventive measures can be taken to fend off the complications.

II. Material and Methods

The study was conducted on patients who underwent external ventricular drain placement in Department of Neurosurgery in Dayanand Medical College and Hospital, Ludhiana from August 2021 to October 2022. The study was approved by thesis and ethical committee of the institution.All the patients above the age of 18 years who underwent EVD placement were included in the study.Patients presenting with open skull fracture, cerebrospinal fluid leakage,with previous history of central nervous system infections were excluded from the study.

Diagnostic criteria for EVD related infection

The criteria used for diagnosing infection: (1) positive CSF culture results plus clinical symptoms or CNS pleocytosis/cell count increase; or (2) in the case of negative CSF culture, clinical symptoms and increased pleocytosis of the central nervous system (CNS), increased serial measurement/cell count, hypoglycemia (less than50% of simultaneous blood sugar), and increased lactate (more than 2 mmol/dL or 36 mg/lit) or gram-positive smear.10

III. OPERATIVE PROCEDURE

The SURGIWEAR external ventricular drain was used in the study and it was inserted under sterile conditions in the operation theatre. The patient's scalp was shaved and prepared with standard sterile technique. The skin incision was given at kocher's point and catheter was inserted in to the frontal horn of the ventricle for about 5 cm until cerebrospinal fluid was obtained. The catheter was then tunneled under scalp laterally for about 5cm and was connected using 3 way stopcocks to external cerebrospinal drainage system. The catheter was securely fixed with suture and sterile dressing was applied. The catheters were not impregnated with antibiotics. Prophylactics antibiotics were administered before catheter insertion and during the period of drain in place.

All the patients were monitored and dressing was done daily. The elevation of catheter was forbidden to prevent back flow of cerebrospinal fluid. If a patient required external drain insertion for extended duration then a new external drain was inserted at another site at 10th day.

The sample of cerebrospinal fluid was taken at the time of external ventricular drain insertion and on 4th day,7th day, 10th day or when patient developed signs of sepsis. The cerebrospinal fluid sample was sent for cytology, biochemistry study, gram staining, KOH stain, ZN staining and culture. The blood sample was also taken at the time of cerebrospinal fluid sampling for monitoring blood glucose levels.If a patient was found to have external ventricular drain related infection, then more detailed findings were taken with regard to the possible factor leading to infection, antimicrobial susceptibility, treatment provided and the outcome of the patient.

Outcome

The duration of hospital stay and morbidity of the patients was assessed and the patients were grouped as good recovery, moderate disability,severe disability and vegetative state, death on the basis of criteria laid down by Glasgow Outcome Scale.

Statistical Analysis

Data on demographic information(age and sex), diagnosis, number of EVD placements, length of ICU stay and hospital stay , laboratory tests i:e serum and CSF analysis were recorded. Data were described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data were normally distributed, a Kolmogorov-Smirnov test was used. Comparison of quantitative variables between the study groups was done using MannWhitney *U* test for non-parametric data. For comparing categorical data, Chi square ($\chi 2$) test was performed and fisher exact test was used when the expected frequency is less than 5 with relative risk. A probability value (*p* value)less than 0.05 was considered statistically significant.All statistical calculations were done using (Statistical Package for the Social Science)SPSS 21version (SPSS Inc., Chicago, IL, USA)statistical program for Microsoft Windows.The data collected was compiled and analysed to study the incidence, risk factors and the outcome of the external ventricular drain infections.

IV. Results

In our prospective study, 66 patients admitted to the Neurosurgery department of Dayanand Medical College and Hospital for EVD placement and following the inclusion criteria of the study were included. 5 patients got external ventricular drain infections giving an incidence of 7.6%. The mean age of patients with EVD infection was 59.60(+-12.26) years and in patients with no EVD infection was 53.72(+-14.84) years. Among 5 patients with EVD infections,3 patients were female and 2 were male. 4 patients in infectious group received EVD insertion due to SAH or ICH while 1 patient received EVD placement due to space occupying lesion. However, among patients with no EVD infections, 48 patients were male and 13 were female. 49(74.24%) patients received EVD insertion due to SAH or ICH, 7(10.60%) due to hydrocephalus secondary to brain infarct, 4(6.06%) due to traumatic hydrocephalus and 1(1.51%) due to space occupying lesion. No significant statistical association was seen in patients with EVD infection and with no infection in terms of age , gender and indication for inserting an EVD.

The mean duration of EVD drainage in infectious group was 24.0+-7.52 days while in non infectious group was 14.77+-6.24 days and was found to be significantly more in patients with EVD infections (p=0.003). The mean frequency of CSF sampling was 10.60+-4.70 times in EVD infection patients compared to 5.51+-2.15

times in patients with no EVD infection. Thus, increased frequency of CSF sampling was significantly found to be more in patients with EVD infections (p=0.00). Systemic coinfection was present in all the 5(100%) infected patients while it was present in only 19 (31.1%)patients with no EVD infection. Thus, systemic coinfection was found to be significantly more in patients with EVD infection.(p=0.002) Use of prophylactic intravenous antibiotics (p=0.773)) were not found to have significant role in preventing EVD infections in our study. No significant rate of EVD infection was found in patients undergoing other neurosurgical procedure (p=0.064).

Among patients with EVD infections,2 patients were diagnosed on positive cerebrospinal fluid culture. One patient had positive culture for E.coli on 4th day of third EVD while the other patient had positive cerebrospinal fluid culture for pseudomonas putida on 10th day of first EVD. Both of these patients also showed decreased glucose levels in cerebrospinal fluid.The other 3 patients were having negative cerebrospinal fluid culture and they were diagnosed on biochemistry tests. These patients were having decreased glucose levels in CSF (less than 50% of blood glucose).

Outcome

The mean duration of hospital stay was found to be longer in patients with EVD infections i:e 27.40+-5.94 days compared to 22.31+-5.09 days in patients with no EVD infections and the difference was statistically significant. However, no significant difference was seen in two groups in terms of Glasgow Outcome scale at the time of discharge. Out of 5 patients with EVD infections, one patient was in vegetative state and

4 patients were having severe diasability according to the Glassgow coma outcome scale at the time of discharge. In patients with no EVD infections, 12 patients were in vegetative state,26 patients were having severe disability, 13 patients were having moderate disability and 9 patients were having low disability at the time of discharge.

V. Discussion

A total of 66 patients were included in our study. No significant statistical association was seen in patients with EVD infection and in patients with no EVD infection in terms of age , gender and primary reason of EVD insertion. Similar results were seen in a study by Shang et al,11 however age was identified as a risk factor of EVD infections in study by Flibotte et al. and Wright et al.12,13

5 EVD infections among 66 enrolled patients were reported giving an incidence of 7.6 % which falls within the range of EVD infections in literature.

In a study conducted by Hagel et al, 18 patients out of 218 patients developed EVD infections giving a cumulative incidence of 8.3%(95% CI, 5.3–12.7).14 In another prospective multicentre cohort study conducted on 452 patients over 6 months in UK and ireland,46 EVD related infections were seen giving an infection risk of 9.3%. 15

One of the key finding of our study was the relation of duration of EVD with risk of infection. The mean duration of EVD drainage in infectious group was found to be significantly more i:e 24.0+-7.52 days compared to 14.77+-6.24 days in patients with no EVD infection. (p=0.003). Thus, increased risk of EVD infection was seen with longer duration of EVD. Similar results were seen in a study by Hoefnagel et al, (>11 days: OR 4.1; 95% CI 1.8–9.2, p = 0.001).16 by Shang et al,11 where duration of EVD drainage appeared to be a risk factor for infection. The study by Shang et al concluded that increased duration of catheter in place could significantly increase the risk of infection and catheter duration of >11 days (Wals=4.8, RR=17.3, 95% CI: 1.4-218.3, P=0.028), considerably enhances the risk of infection.11

In our study, frequency of CSF sampling was found to be significantly more in patients with EVD infections i:e 10.60+-4.70 times compared to 5.51+-2.15 times in patients with no EVD infections.(p=0.00). Increased frequency of CSF sampling [OR & 95%CI: 4.12, (1.84–9.22); *P*-value, 0.001] was identified a risk factor to EVD infection in a study by Hoefnagel et al.. 16

Systemic coinfection was found to be significantly more in patients with EVD infection(100% versus 31.1%)(p=0.002). Studies by Bota et al. [OR & 95%CI: 3.92, (0.66–7.84); *P*-value, 0.02], Holloway et al. [*P*-value, 0.001], Kirmani et al. [*P*-value, 0.002], and Mounier et al. [OR & 95%CI: 11.8, (2.5–56.8); *P*-value, 0.002] had also reported that systemic coinfection was found to be significantly associated with ventricular catheter infection. 17-20

Use of prophylactic intravenous antibiotics(p=0.773)were not found to have significant role in preventing EVD infections in our study.This finding is consistent with other study in which discontinuation of continuous antibiotic prophylaxis did not lead to an increase in infection rate (1.1% vs 0.4%, p = 0.22).21 However, few studies had reported significantly reduced infection rates by continuation of antibiotic prophylaxis as long as the EVD was in place.22

No significant rate of EVD infection was found in patients undergoing other neurosurgical procedure (p=0.064)in study.However, in literature, many studies had found other neurosurgical operation as a risk factor of EVD infections.17,18,23,24

Our study had reported significantly longer duration of hospital stay in patients with EVD infections i:e 27.40+-5.94 days compared to 22.31+-5.09 days in patients with no EVD infections. However, longer hospital stay in patients with EVD patients did not lead to worse glassgow coma outcome scale at the time of discharge. Several studies in literature had also shown similar results . Longer hospital stay was seen in study by Hagel et al and Walek et al 14,25 while Bari et al. found no association between EVD infections and length of hospital stay (P value: >0.05). 26

Ina study by Hagel et al,patients with an EVD-related infection had a significantly longer ICU (11 versus 21 days, $P < 0.01$) and hospital stay (20 versus 28.5 days, $P < 0.01$) but it was not associated with increase in hospital mortality (17% versus 18%; $P = 1.0$).14

Thus, our study reported prolonged duration of EVD infections, frequency of CSF sampling and systemic coinfection as significant risk factors of EVD infections so widespread attention should be given to these factors to reduce the incidence of EVD infections.

VI. Conclusion

Diagnosing EVD infection at an early stage is very difficult. Preventive measures can help in reducing the incidence of EVD infections. Hence, external ventricular drains should be removed as early as possible and lower frequency of cerebrospinal fluid sampling should be adopted to decrease the risk of infection.

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