

Predictors of Ventriculo-Peritoneal Shunt Infection

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BACKGROUND: Hydrocephalus is a very common childhood condition usually requiring placement of cerebrospinal fluid (CSF) shunt. Infection is considered one of the most significant complications that leads to prolonged hospital stay and more cost.

OBJECTIVE: The aim of the work was to correlate ventriculo-peritoneal (VP) shunt infection in relation to preoperative, operative and postoperative predictors and also to identify measures to decrease shunt infection.

PATIENTS AND METHODS: We performed a prospective study of fifty children below two years of age evaluated in a single neurosurgery department from 2017 to 2019. All included children underwent CSF shunt insertion. A shunt infection was defined by growth of bacteria in the CSF of a child who underwent shunt removal within 7 days of presentation. All cases of shunt infection were correlated to preoperative predictors such as age, operative predictors including operative time and postoperative predictors such as fever and CSF leak.

RESULTS: In our study, 4 cases presented with shunt infection in the follow up period representing 8% of all cases. Shunt infection occurred mainly in the first six month of age. Fever was the leading sign in case of shunt infection and it occurred in 75% of cases of shunt infection.

CONCLUSION: The lower the age of the child, the more the incidence of shunt infection. Fever, irritability and clinical signs such as CSF leak, erythema and fluid tracking over the shunt were strong predictors for shunt infection.

KEYWORDS: Cerebrospinal fluid, Infection, Pediatric, Predictors, Ventriculo-peritoneal shunt.

INTRODUCTION

Ventriculoperitoneal shunt is considered the most common surgery in the field of pediatric neurosurgery. Incidence of complications is still high, approximately 11–25% during the first year after initial shunt operation.¹ These complications are either shunt obstruction or infection and are more common in children than adults. Many studies have been designed to identify predictors of shunt infection which help in reducing prolonged hospital stay and billions in medical costs every year.² In these children, infection of ventricular hardware may lead to ventriculitis, meningitis, and encephalitis, which are often associated with high morbidity and mortality. Early identification of children at high risk of shunt infection may help guide early antimicrobial therapy and operative intervention.³

The aim of this study was to assess the predictors of shunt infection in fifty children below two years of age.

PATIENTS AND METHODS

Study Design

Our study was a case series, carried on prospectively in

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the Neurosurgery Department, Mansoura University, by operating on 50 children below than two years. The study started in 2017, and the operated cases were followed up to 2019.

The study was approved by the institutional review board of our faculty.

Inclusion criteria

Cases of active hydrocephalus in first two years of life whatever the cause either congenital or acquired.

Exclusion criteria

Previous cases of shunt infection.

Preoperative evaluation and preparation:

Patients included in the study, underwent complete preoperative evaluation including history taking, neurological examination, and radiographic studies.

A. History taking:

Included factors predominated to cause of hydrocephalus, detailed history of chronic fits, incubator admission, prematurity and interventions prior to surgery.

B. Neurological examination:

Mainly assessment of the anterior fontanelle

and presence of congenital anomalies such as myelomeningocele (MMC) or encephalocele.

C. Radiographic studies:

Computerized tomography (CT) was done for all cases due to its ease, availability and being fast and reliable. In addition, magnetic resonance imaging (MRI) brain was done in special cases as congenital and secondary hydrocephalus to brain tumors.

D. Laboratory investigations:

Routine full investigations and CSF analysis and culture and sensitivity was performed mainly in case of post meningitic hydrocephalus and MMC.

E. Patient preparation:

Third generation cephalosporins (30 mg per kg) or Vancomycin (10 mg per kg) were administered intravenously one hour prior to the surgery. We encouraged body wash and shampoo the night prior to the surgery using soap and water or betadine solution. Razor blades was avoided in some cases and we used a trimmer to shave the least required area for the incision. The number of all personnel was limited to the minimum required in the operating room (OR) to decrease OR traffic.

F. Operative technique, main points for decreasing shunt infection:

Meticulous care during skin handling was ensured in order not to touch the skin edges. In addition, the edges of the skin were hidden from exposure with a sterile towel soaked with amikacin or gentamicin and held in place under the teeth of the self retaining retractors.

The shunt components were handled with only forceps, also gloves were changed before the handling of the shunt. The instruments handling the shunt were placed on a separate sterile table away from the instruments used for the dissection of the skin and soft tissue.

The shunt components once opened, were put in gentamicin or amikacin containing solutions. After tunneling the peritoneal catheter, its distal end was wrapped in a sterile towel soaked with gentamicin or amikacin. After the shunt procedure and prior to closure, 1 ml (10 mg/ml) of vancomycin mixed with 2 ml (2 mg/ml) of gentamicin were injected intraventricularly.

Criteria for diagnosis of Infection:

Fever (temperature more than 37.5), neurological signs and symptoms such as headache, irritability, meningismus, seizures, features of decompensated hydrocephalus, abdominal manifestations such as pain, ileus and may be acute abdomen, signs and symptoms of shunt malfunction and skin changes over the shunt such

as local redness and tenderness and fluid tracking over the shunt.

Each patient with suspected shunt infection did a shunt tap, and CSF was sent to be analyzed and cultured. An elevated protein and white blood cells (WBC) count with a decrease in glucose is considered shunt infection until being confirmed by positive CSF culture.

Predictors correlated to shunt infection:

A. Preoperative predictors: Age, type of hydrocephalus, sex and history of previous operations.

B. Operative predictors: Including operative time, use of neuroendoscopy and number of surgeons.

C. Postoperative predictors:

1. Symptoms such as fever, irritability, lethargy, fits and abdominal symptoms.
2. Signs such as erythema over the shunt, fluid tracking over the shunt and bulging anterior fontanelle.

RESULTS

Demographic criteria:

Age: The age of patients who were included in our study was below 2 years, with mean age 5.533 month and a standard deviation of ± 4.9 month. (**Fig. 1**)

Sex: 40% of patients were females (20 cases) and 60% were males (30 case).

Type of hydrocephalus:

As regard the type of hydrocephalus included in our study, variety of types were included such as post infectious hydrocephalus which represented the most common type in our study and accounted for 20 cases, 3 cases were secondary to brain tumors, 8 cases were congenital hydrocephalus, meningomyelocele with secondary hydrocephalus accounted for 12 cases, and 7 cases were secondary to intraventricular hemorrhage (IVH). (**Fig. 2**)

History of previous operations:

Regarding history of previous operations, 82% of cases had no previous surgeries while 16% underwent MMC repair and endoscopic procedures such as previous endoscopic third ventriculostomy (ETV) and choroid plexus coagulation. Another 2% of cases underwent brain tumor excision prior to the shunt placement.

Operative data:

Neuroendoscopy was used in 8% of cases in our study and as regards operative time, it varied from 30 minutes up to 240 minutes with the mean 51.20 minutes and standard deviation of 40.64 minutes.

Incidence of infection: In our study, 4 cases presented with shunt infection in the follow up period representing

8% of all cases. For each type of hydrocephalus, shunt infection percentage in MMC was 16.7% while for post haemorrhagic hydrocephalus, it was 14.3% followed by post infectious hydrocephalus which was 5%.

During the follow-up period, some symptoms and signs were detected which were the early manifestations of shunt infection such as fever, which was found in 75% of cases with shunt infection, erythema over the shunt (25%), fluid tracking over the shunt (25%) and CSF leak which happened in one case from the four cases diagnosed with shunt infection.

Predictors for shunt infection: In our study, age was significant predictor of infection ($p = 0.03$), while sex

($p = 0.472$), type of hydrocephalus ($p = 0.5$) and history of previous operation ($p = 0.196$) were not significant predictors.

As regard operative data, operative time ($p = 0.010$) and number of surgeons ($p = 0.02$) were good predictors while use of neuroendoscopy was not correlated well to shunt infection ($p = 0.394$).

Fever and irritability represented a very significant predictor for shunt infection ($p = 0.001$). Physical signs such as erythema over the shunt , fluid tracking over the shunt and CSF leak also was considered useful predictors for shunt infection ($p = 0.001$).

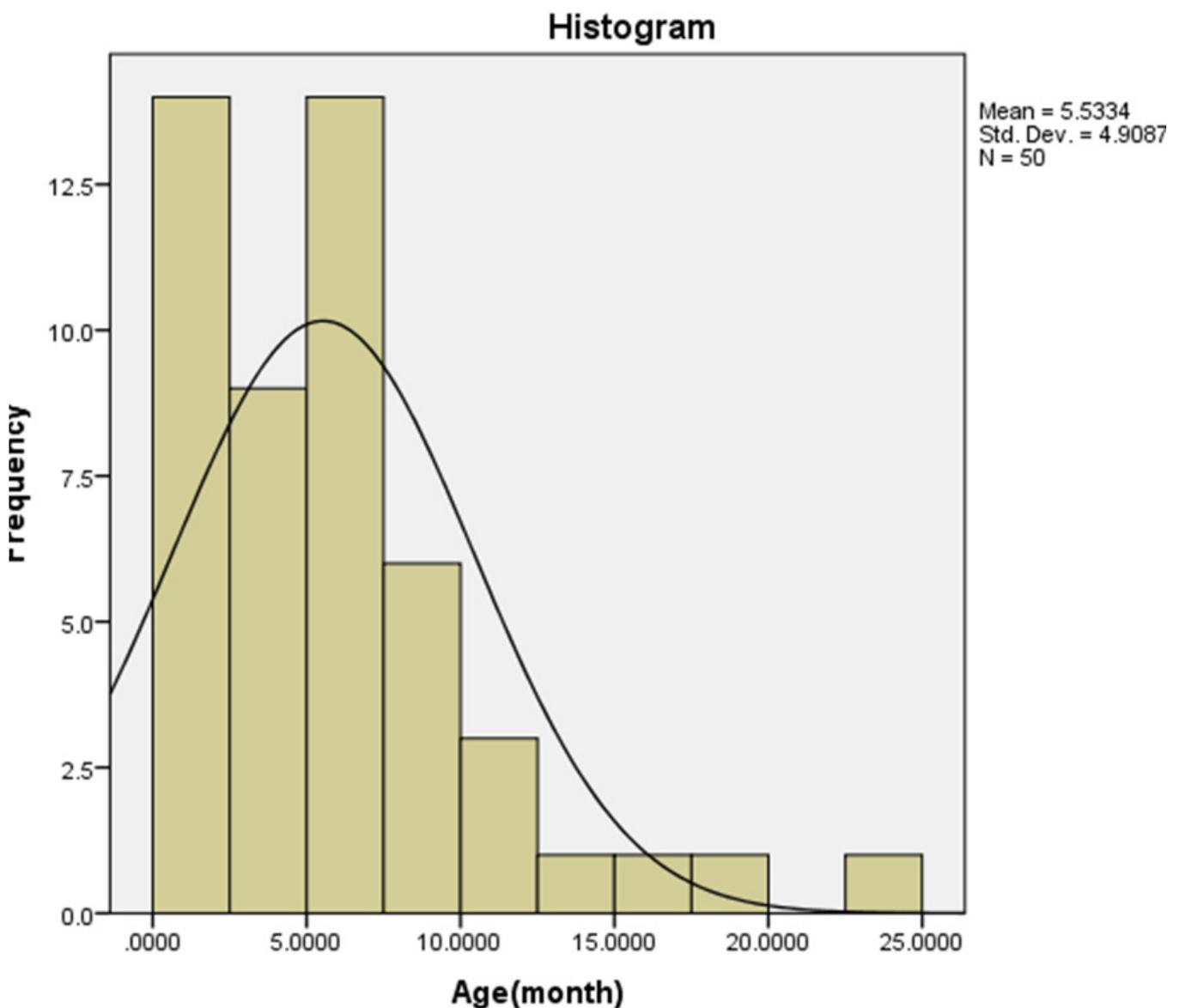


Fig 1: Distribution of the patients in the study group according to age.

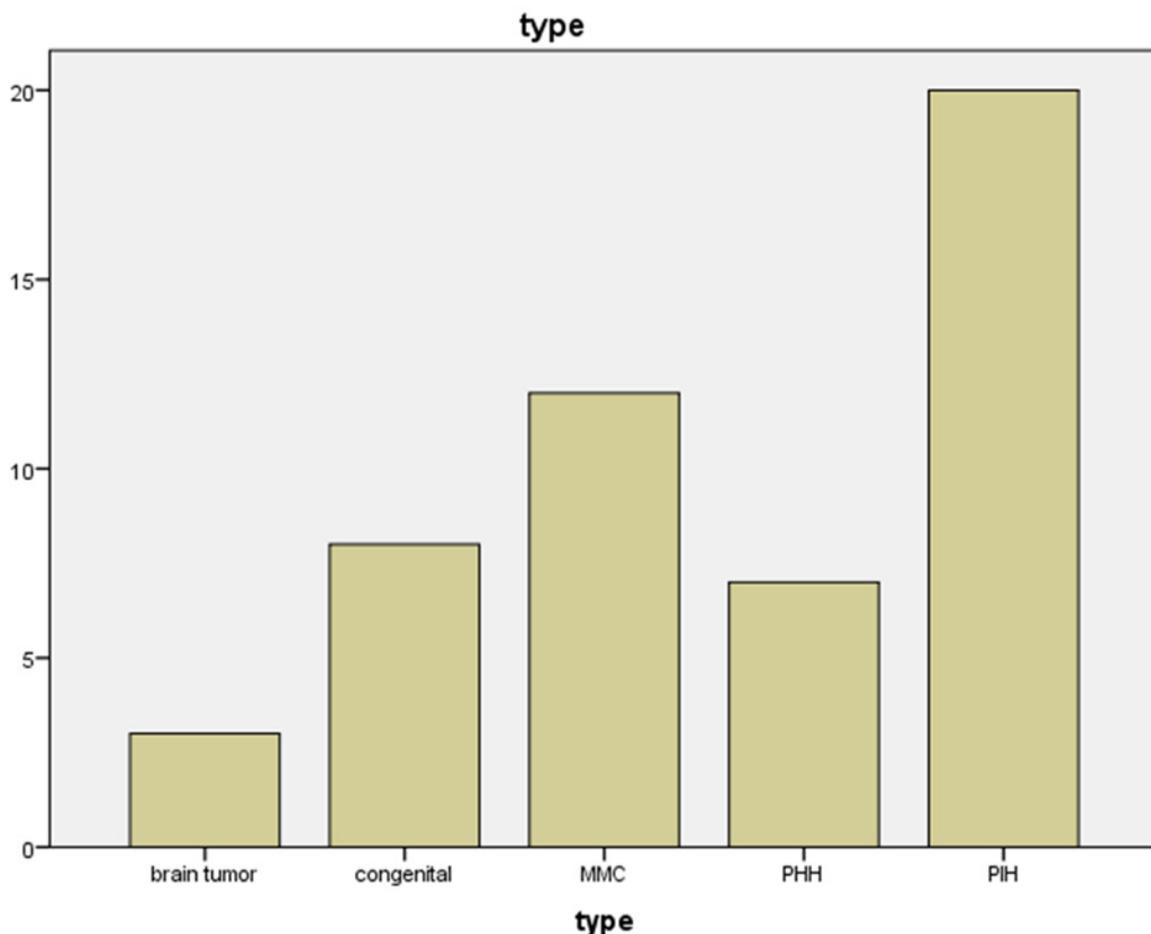


Fig 2: Distribution of patients in the study group according to the type of hydrocephalus.

DISCUSSION

As regards the age, it was found that shunt infection rate is more common in children less than 6 months (three cases in our study aged 3 month, 5 month and one day) compared with older children (one case in our study aged 10 month). Thus, our results were consistent with other studies that showed the increased incidence of shunt infection in children less than 6 month and premature infants.^{4,5} Sex of the patients was not a predictor of shunt infection and this was similar to previous studies but was different from some studies which showed that infection is more common in males³ and others that showed infection is more common in females.⁶

Regarding history of previous surgeries, there was no correlation between it and shunt infection, which is similar to findings discussed before by Simon et al.⁷ who found that prior surgery was protective. Fever happened in 75% of cases having shunt infection in our study and this was similar with previous studies such as Piatt and Garton⁸ who stated that 59% of children with ventricular shunt infection had fever, which is similar to the 58% observed by Kim and colleagues.⁹ It was found that there is no relationship between shunt infection and use of neuroendoscopy, however, in previous studies such

as McGirt et al.,⁵ it has been shown that the use of a neuroendoscope was also associated with an increased risk of shunt infection. It was found that there is correlation between time of the operation and number of surgeons with shunt infection and this coped with the previous studies such as Cochrane and Kestle¹⁰ and Simon et al.⁷

Several predictors noted to be associated with shunt failure in other studies were not statistically significant predictors of failure in our study. Concerning the type of hydrocephalus, our results were coinciding with others who documented that intraventricular hemorrhage was not a predictive factor for shunt failure in their study.¹¹

As regards percentage of infection in cases with myelomeningocele, it was 16.7% which was near to the percentage observed by Dermir et al.,¹² which was 19.8% and in other studies, the rate of VP shunt infection ranges from 15 to 25%.

Shaving the hair with a scalpel did not affect the incidence of shunt infection in our study; however, some studies showed that there is an increase in shunt infection rates with shaving the scalp mainly preoperatively which led to small abrasions that can lead to wound complications.¹³

CONCLUSION

The lower the age of the child, the more the incidence of shunt infection. Fever, irritability and clinical signs such as CSF leak, erythema and fluid tracking over the shunt were strong predictors for shunt infection. Moreover, sex of the patient and type of hydrocephalus were not useful predictors.

List of abbreviations

CSF: Cerebrospinal fluid.
 CT: Computed tomography.
 ETV: Endoscopic third ventriculostomy.
 IRB: Institutional review board.
 IVH: Intraventricular hemorrhage.
 MMC: Myelomeningocele.
 MRI: Magnetic resonance imaging.
 OR : Operating room.
 VP : Ventriculo-peritoneal.
 WBC: White blood cells.

Disclosure

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