

Frequency of infection associated with ventriculo-peritoneal shunt placement

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Abstract

Objective: To compare the frequency of infection in protocol-based and random ventriculo-peritoneal shunt placement in patients with hydrocephalus.

Methods: The prospective, observational study was conducted at Civil Hospital, Karachi, from October 2014 to March 2015, and comprised patients having ventriculo-peritoneal shunt placement who were randomly categorised into Group A that had protocol-based procedure and Group B that had random shunt placement. All patients were followed up for six months to record final outcomes after surgery. A pre-tested questionnaire was used to document findings. SPSS 16 was used for data analysis.

Results: Of the 210 patients, there were 105(50%) each in the two groups, overall having 117(55.7%) boys and 93(44.3%) girls. The frequency of infection was 8(7.6%) in Group A and 19(18.1%) in Group B ($p < 0.05$).

Conclusion: With a meticulous surgical technique and modifications to the pre-, intra-, and postoperative care, it is possible to significantly reduce the incidence of shunt infection.

Keywords: Hydrocephalus, Cerebrospinal fluid, VP shunt placement. (JPMA 66: 815; 2016)

Introduction

Hydrocephalus (HCP) is the abnormal accumulation of Cerebrospinal fluid (CSF) within the ventricles and subarachnoid space.¹ For treatment of this condition ventriculo-peritoneal shunt (VPS) is the procedure of choice, diverting the CSF from ventricles to the peritoneal cavity. In the United States, approximately 18,000 CSF shunts are placed per year, costing \$100 million annually² with reported incidence of 1%-15% of CSF shunt infection.² In Pakistan, nationwide data for rate of infection after VPS placement is not available but it is estimated to reach up to 16-20%.³ Infection is by far the most common cause of shunt failure that may need revision of shunt.⁴ This does not only put the patients under economic burden but also causes emotional and psychological stress and makes prognosis worse.

There is a growing concern among researchers regarding control of VPS infection worldwide. Studies showed improvement in infection rate after adapting new single or multi-step protocols.⁵ In random-based VPS placement, standard surgical protocol outlined in World Health Organisation (WHO) guideline 2009 for safe surgery] is followed.⁶ However, in protocol-based VPS placement, a few more steps are followed.² Rehman A et al. showed improvement in VPS infection rate in protocol-based placement by 3.77% in comparison with random-based

placement 16.33%.⁶

The current study was planned to compare the frequency of infection associated with VPS in protocol-based placement versus random-based placement.

Patients and Methods

The prospective, observational study was conducted at the Neurosurgery Department of Civil Hospital, Karachi, from October 2014 to March 2015, and comprised patients having VPS placement. They were categorised into two equal groups: protocol-based VPS placement Group A and random-based VPS placement Group B. The patients were selected using non-probability consecutive sampling from among those who were admitted through outpatient department (OPD) and emergency department (ED). The patients were aged one year or less of either gender who were suspected to have HCP on presence of any of clinical sign and symptoms of irritability, vomiting on feeding, convex and full anterior fontanelle, distended scalp veins, cranial suture splaying, poor head control, and "setting sun" sign in which eyes were inferiorly deviated.⁴ The suspects were confirmed on the basis of computed tomography (CT) scan report which indicated dilated brain plain and fluid-filled ventricles. However, patients who had preoperative fever $>38.5^{\circ}\text{C}$, pre-existing conditions like abdominal tuberculosis (TB) and ascitis, those who had undergone laprotomy previously and who had Infected HCP confirmed by increased white cell count ($>25\%$ polymorph nuclear leucocytes) and decreased glucose (<15 g/dl) in CSF were excluded. Sample size calculator Open Epi Version 2 was used, by taking prevalence of

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infection in protocol-based placement as 3.77% and in random-based placement as 16.33%¹ with 80% power of test and 95% confidence interval (CI).

After getting informed consent from the parents concerned, we followed standard protocol according to the WHO guideline⁶ for Group B, which included proper gloving, gowning and draping by surgeon, pre-op single dose antibiotic at induction, application of povidine-iodine over surgical site and aseptic precautions throughout the procedure. However, for Group A, we followed a few extra steps were done that included position of head away from operation theatre (OT) door,⁷ chloraprep applied to surgical field and not washed off,^[8] iodine-impregnated drapes,⁸ change gloves (to handle the implant),⁹ impregnate the shunt with gentacine-mixed saline¹⁰ and continuation of antibiotic postoperatively in twice-a-day dose (cefuroxime 30mg/kg intravenous [IV] for three days and per-oral for 10 days).¹¹ Patients were followed up for six months and those presenting with any one of the following were labelled as VPS infection: pus discharge from surgical wound, excursion of skin with exposure of the shunt, signs of inflammation including redness, warmth and tenderness along shunt track and fever (>38°C) with increased white cell count (>25% polymorph nuclear leucocytes) and decreased glucose (<15 g/dl) in CSF.

During surgery, CSF sample was taken of all patients for chemistry and culture. A pre-tested questionnaire was used to document findings.

SPSS 16 was used for data analysis. Mean and standard deviation were computed for numerical variables like age, while frequency and percentages were computed for categorical variables like gender, age distribution and VPS infection. Chi-square test was applied to compare the average frequency of postoperative VPS infection in two groups. Statistical significance was set on $p < 0.05$.

Results

A total of 210 patients were randomly divided into two equal groups, i.e. 105(50%) each in Groups A and B. The overall average age of the patients was 5.56(±3.02 months); 5.68±3.06 in Group A, and 5.45±2.98 in Group B. Of the total, 117(55.7%) were boys and 93(44.3%) were girls. There were 45(42.9%) patients in Group A and 46(43.8%) in Group B in the range of 1-4 months of age, 41(39.0%) in Group A and 43(40.0%) in Group B in 5-8 months, and 19(18.1%) in Group A and 17(16.2%) in Group B in the range of 9-12 months. Group A had 56(53.33%) boys and 49(46.67%) girls while Group B had 61(58.10%) boys and 44(41.90%) girls.

VPS infection frequency in Group A was 8(7.6%) and in

Table-1: Comparison in frequency of infection between group A and B.

VP Shunt Infection	Group A (Protocol base)	Group B (Randomly base)	Total	p-value
Present	8(7.6%)	19(18.1%)	27(12.9%)	0.023
Absent	97(92.4%)	86(81.9%)	183(87.1%)	

VP: Ventriculoperitoneal.

Table-2: Comparison of frequency of infection between male and female patients.

Gender	Group A (Protocol base)	Group B (Randomly base)	p-value
Male	7(12.5%)	11(18%)	0.407
Female	1(2%)	8(18.2%)	0.012

Table-3: Comparison of frequency of infection in patients between age groups.

Age Group (Months)	Group A (Protocol base)	Group B (Randomly base)	p-value
1-4	4(8.9%)	9(19.6%)	0.416
5-8	1(2.4%)	5(11.9%)	0.202
9-12	3(15.8%)	5(29.4%)	0.434

Group B it was 19(18.1%) ($p=0.023$) (Table-1). This difference was significant in female cases, i.e. 1(2%) in Group A vs. 8(18.2%) in Group B ($p=0.012$) (Table-2). Age stratification analysis showed that infection rate was not significant between groups in terms of age range (Table-3).

Discussion

VPS procedures are the most common ones performed by paediatric neurosurgeons, making up nearly half of all cases in this specialty. It has been estimated that more than 30,000 shunt procedures are performed in the United States annually.³ Infections are the second most common complication, being a major source of morbidity and cost. The incidence of shunt infections in modern prospective studies has ranged from 8.2% to 12% of shunt procedures.¹²

The vast majority of shunt infections appear to be acquired intra-operatively or in the immediate perioperative period. Data to support this view came from analyses of the timing of onset of infectious signs and symptoms, risk factors associated with the development of infection, and from the source of the organisms most often cultured from infected shunts. Most series do not analyse infecting organisms according to the manner in which the infection was acquired, but since most infections occur early after surgery, the conclusion can be

drawn that most infections are acquired at surgery or shortly thereafter. The probability of infection is highest in the first eight weeks after surgery, with 90% of infections becoming apparent in the first six months.¹³ However, mixed and insignificant frequencies are obtained in our study in age-wise analysis.

In our study, 55.7% were males and 44.3% were females, while in a study, there were almost an equal number of male and female patients with a slight preponderance towards female patients.¹⁴

Multiple studies have noted an inverse relationship between patient age and shunt infection risk. This is particularly true in premature infants, with the risk remaining noticeably higher than that in older children until approximately six months of age.¹⁵ In our study, a major group of the patients were from the neonate age and infant group, because one of the common causes of HCP is congenital HCP, which is most often diagnosed at birth and often requires VPS insertion early in life. Neonates and infants were at high risk of developing post-operative shunt infections;¹⁶ this is attributed to an immature immune system and to surgical technique.¹⁷ Therefore, many studies on VPS infection are concentrated in the paediatric age group. At least two recent large retrospective series did not find an association between age and infection risk, but the infection rates in these series were relatively low.¹⁸

This study shows that introduction of a relatively simple protocol for shunt implantation reduced the per-procedure infection rate to 7.6% while infection rate in random-based placement was 18.1%. The majorities of shunt infections were observed within three months of shunt insertion and are a result of direct contamination at the time of surgery. We agree with Welch¹⁹ that shunt infection is a potentially preventable complication of shunt surgery. Several approaches to reducing the incidence of shunt infections have been proposed. Some of these have been tested by studies, but most of these designs include historical controls and changing several factors simultaneously. Factors that have been associated with decreased rates of infection in single-institution series include reducing the number of people in the operating room, doing shunt surgeries as the first case of the day and with a specially trained team, shortening the duration of surgery, keeping the shunt hardware from touching the skin, use of meticulous skin preparation, and use of prophylactic antibiotics.²⁰ A previous Pakistani study²¹ revealed the frequency of shunt failure to be 23% in the retrospective analysis of six-year data. Of them, 15% were attributed to shunt blockade and only 8% failures

were caused by infections, which was inconsistent with the previously reported data in the same setting over previous 18 years (1988-2005).²² The decreased frequency of shunt infection was explained by evidence-based improvements in aseptic measures and surgical techniques, which ultimately reduced surgical site and procedure based infections.²³ Overall, these results are encouraging and lend support to the hypothesis that shunt infection is potentially preventable.

Conclusion

Shunt infections constitute a major source of morbidity and cost, and despite considerable efforts, infections have not been eliminated. However, with a meticulous surgical technique and modifications to the pre-, intra-, and post-operative care, it is possible to reduce significantly the incidence of shunt infections.

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Conflict of Interest: None.

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