Ventriculoperitoneal shunt infection case series

2022

Özsoy KM, Akbaba M, Oktay K, Gündeşlioğlu ÖÖ, Alabaz D, Sari MM. A single-center retrospective study of ventriculoperitoneal shunts' post-surgical infection. J Neurosurg Sci. 2022 Aug;66(4):385-386. doi: 10.23736/S0390-5616.22.05760-5. PMID: 36153887.

2016

Among more than 800 ventriculoperitoneal shunt procedures which had been performed between April 2000 and April 2011, 68 patients with shunt infection and 80 controls that fulfilled a set of meticulous inclusion/exclusion criteria were consecutively enrolled. Univariate analysis was performed for a long list of risk factors, and those with p value < 0.2 were used to create ANN and logistic regression (LR) models.

Five variables including birth weight, age at the first shunting, shunt revision, prematurity, and myelomeningocele were significantly associated with shunt infection via univariate analysis, and two other variables (intraventricular hemorrhage and coincided infections) had a p value of less than 0.2. Using these seven input variables, ANN and LR models predicted shunt infection with an accuracy of 83.1 % (AUC; 91.98 %, 95 % CI) and 55.7 % (AUC; 76.5, 95 % CI), respectively. The contribution of the factors in the predictive performance of ANN in descending order was history of shunt revision, low birth weight (under 2000 g), history of prematurity, the age at the first shunt procedure, history of intraventricular hemorrhage, history of myelomeningocele, and coinfection.

The findings show that artificial neural networks can predict shunt infection with a high level of accuracy in children with shunted hydrocephalus. Also, the contribution of different risk factors in the prediction of shunt infection can be determined using the trained network ¹⁾

Merkler et al., performed a retrospective cohort study of adult patients hospitalized at the time of their first recorded procedure code for VPS surgery between 2005 and 2012 at nonfederal acute care hospitals in California, Florida, and New York. They excluded patients who during the index hospitalization for VPS surgery had concomitant codes for VPS revision, CNS infection, or died during the index hospitalization. Patients were followed for the primary outcome of a VPS complication, defined as the composite of CNS infection or VPS revision. Survival statistics were used to calculate the cumulative rate and incidence rate of VPS complications.

17,035 patients underwent VPS surgery. During a mean follow-up of 3.9 (±1.8) years, at least one VPS complication occurred in 23.8% (95% CI, 22.9-24.7%) of patients. The cumulative rate of CNS infection was 6.1% (95% CI, 5.7-6.5%) and of VPS revision 22.0% (95% CI, 21.1-22.9%). The majority of complications occurred within the first year of hospitalization for VPS surgery. Complication rates were 21.3 (95% CI, 20.6-22.1) complications per 100 patients per year in the first year after VPS surgery, 5.7 (95% CI, 5.3-6.1) in the second year after VPS surgery, and 2.5 (95% CI, 2.1-3.0) in the

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fifth year after VPS surgery ²⁾.

A multicentre historical cohort study included consecutive patients who underwent primary ventriculoperitoneal shunting at a Hospital Authority neurosurgery centre from 1 January 2009 to 31 December 2011. The primary endpoint was shunt infection, defined as: (1) the presence of cerebrospinal fluid or shunt hardware culture that yielded the pathogenic micro-organism with associated compatible symptoms and signs of central nervous system infection or shunt malfunction; or (2) surgical incision site infection requiring shunt reinsertion (even in the absence of positive culture); or (3) intraperitoneal pseudocyst formation (even in the absence of positive culture). Secondary endpoints were shunt malfunction, defined as unsatisfactory cerebrospinal fluid drainage that required shunt reinsertion, and 30-day mortality.

A primary ventriculoperitoneal shunt was inserted in 538 patients during the study period. The mean age of patients was 48 years (range, 13-88 years) with a male-to-female ratio of 1:1. Aneurysmal subarachnoid haemorrhage was the most common aetiology (n=169, 31%) followed by intracranial tumour (n=164, 30%), central nervous system infection (n=42, 8%), and traumatic brain injury (n=27, 5%). The mean operating time was 75 (standard deviation, 29) minutes. Shunt reinsertion and infection rates were 16% (n=87) and 7% (n=36), respectively. The most common cause for shunt reinsertion was malfunction followed by shunt infection. Independent predictors for shunt infection were: traumatic brain injury (adjusted odds ratio=6.2; 95% confidence interval, 2.3-16.8), emergency shunting (2.3; 1.0-5.1), and prophylactic vancomycin as the sole antibiotic (3.4; 1.1-11.0). The 30-day all-cause mortality was 6% and none were directly procedure-related.

This is the first Hong Kong territory-wide review of infection in primary ventriculoperitoneal shunts. Although the ventriculoperitoneal shunt infection rate met international standards, there are areas of improvement such as vancomycin administration and the avoidance of scheduling the procedure as an emergency ³⁾.

A retrospective analysis of patients who underwent ventriculoperitoneal shunt surgery between January 2010 and December 2015. Shunt tubes and cerebrospinal fluid were sent for culture and sensitivity in patients who were suspected clinically of having shunt tube infections. The processing of the samples was done by standard techniques, and the identification of the organism along with its sensitivity pattern was performed using Vitek 2 system.

A total of 1186 ventriculoperitoneal shunt surgeries were performed during this period at our institute in patients of all age groups. There were 757 (63.8%) male and 429 (36.2%) female patients. A total of 156 samples of patients were sent for culture and sensitivity during this period, out of which 79 (50.6%) samples had growth of an organism either in the cerebrospinal fluid [36 (23.1%)], shunt tubing [16 (10.2%)], or in both [27 (17.3%)]. The most common organisms grown in the cultures were Staphylococcus aureus [65 (82.3%)] or coagulase-negative Staphylococcus [22 (25.3%)] in the Grampositive group and Escherichia coli [17 (21.5%)] in the Gram-negative group. Over the last 6 years, the sensitivity pattern of both Gram-negative and Gram-positive bacteria has shown alarming decreasing sensitivity for various commonly used antibiotics.

Ventriculoperitoneal shunt infection has become an important concern in cases of hydrocephalus. Due to the development of a high proportion of antibiotic resistance, we recommend an empirical therapy

of antibiotic therapy for prophylaxis and suspected infection in ventriculoperitoneal shunt surgery ⁴).

A randomized controlled clinical trial where 60 patients up to one year old, diagnosed with congenital hydrocephalus and submitted to VP shunt insertion, were randomly assigned to one of 3 groups. The treatment groups received the conventional perioperative antibiotics in addition to vancomycin and gentamicin injection in the reservoir and around the peritoneal catheter either once (group A) or twice (group B), while the control group (C) received only the conventional perioperative antibiotics. Cases were followed-up for up to 1 year.

The majority of patients were less than 1 month old. The follow-up period ranged from 2 to 12 months with a mean of 8.9 months. The mean duration of onset of infection after surgery was 30 days. Prematurity (p=0.00236), age less than one month (p<0.0001) and duration of surgery of 90 min or more (p<0.00001) were significant risk factors for postoperative shunt infection. Significantly more cases of shunt infection occurred within one month after surgery (p=0.021). The control group had significantly more cases of postoperative shunt infection than the treatment groups (p=0.0042).

In congenital hydrocephalus patients submitted to VP shunt insertion, injection of prophylactic vancomycin and gentamicin in and around the shunt hardware significantly reduced the incidence of postoperative shunt infection ⁵⁾.

Charts from 2012 to 2015 were reviewed retrospectively. Twenty five ventriculoperitoneal shunt infected patients and 25 healthy children as the control group have been included in the study. Platelet indices were recorded.

A total of 25 VPSI and 25 healthy children were enrolled in the study. Significant differences in the MPV and PDW values between the two groups were detected (p 0.001). ROC curve analysis suggested a cut off point for MPV being below 9.2 fl (smaller values indicate patients) for diagnosis of VPSI, with sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 80%, 92%, 91% and 82%, respectively. For PDW, cut-off point was 12.25 (larger values indicate patients) for diagnosis of VPSI, with sensitivity, specificity, PPV and NPV of 68%, 80%, 77% and 71%, respectively.

The results suggest that MPV and PDW can be used for the diagnosis of VPSI in children with the accuracy of at least 75%. Moreover, MPV's specificity is higher than the other platelet parameters and leucocyte count ⁶.

2015

A retrospective analysis of 384 CSF cerebrospinal fluid (CSF) shunt procedures was undertaken from 2006 to 2010.

Infection diagnosis was established by subjecting the CSF to biochemical and microbiological parameters. The patients' demographic and clinical characteristics, various treatment procedures and outcome were evaluated. The infection rate of ventriculoperitoneal (VP) shunt was 12.5% in 2006, which dropped to 2% and stabilized at lower level from 2008. The most common causes of hydrocephalus were traumatic injury and brain tumor. Fever and consciousness disturbance were the

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major clinical symptoms. Gram-negative rods episodes was the most frequently isolated microorganisms accounting for 58%, followed by S. aureus , S. epidermidis and Staphylococcus haemolyticus. With the removal of shunt and intravenous antibiotics therapy, 82% of the patients survived. Majority of the isolates were sensitive to the carbopenem antibiotics and vancomycin. The mean length of hospital stay was 47 days. Prompt shunt removal and perioperative antibiotic prophylaxis seems to be essential for the survival of patients with VP shunt infection ⁷⁾.

2012

A retrospective cohort analysis of 333 consecutive VP shunt series was performed at Seoul National University Children's Hospital in Korea between January 2005 and February 2011. Overall, 35 shunts (10.5%) were infected, which represented an infection rate of 0.075 infection cases per shunt per year. VP shunt infection occurred at a median of 1 month (range, 6 days to 8 months) after insertion. An independent risk factor for shunt infection was undergoing an operation before the first year of life (relative risk 2.31; 95% confidence interval, 1.19-4.48). The most common causative microorganism was coagulase negative staphylococci in 16 (45.7%) followed by Staphylococcus aureus in 8 (22.9%). Methicillin resistance rate was 83.3% among coagulase-negative staphylococci and S. aureus. In this study, cerebrospinal fluid shunt infection rate was 10.5%. Infection was frequently caused by methicillin-resistant coagulase-negative staphylococci and S. aureus within two months after shunt surgery. Vancomycin may be considered as the preoperative prophylaxis for shunt surgery in a situation where methicillin resistance rate is very high ⁸.

2000

Retrospective survey of infections complicating ventriculoperitoneal (VP) shunt surgery in children with non-tumour hydrocephalus at the Kenyatta National Hospital, Nairobi.

Three hundred and forty five patients underwent V-P shunt placement for non-tumour hydrocephalus. There were 107 infection episodes involving 85 patients. The ages of these patients ranged from three months to 12 years. Most of the patients had congenital hydrocephalus. The infection rate was high (24.6%) although comparable to infection rates reported for clean surgery in the hospital. Fever, septic wounds and features of shunt malfunction were the main presenting features. Bacteriological studies confirmed Staphylococcus aureus and coagulase negative staphylococci as the two most commonly isolated micro-organisms.

This study emphasises need to reduce infection rate in ventriculoperitoneal shunt surgery at the Kenyatta National Hospital. Definitive surgical treatment for hydrocephalus was in most cases delayed and this problem was also observed during revision of infected shunts. Late presentation was often due to ignorance and the fact that many patients went for traditional forms of treatment first before going to hospital ⁹.

1999

2,325 ventriculoperitoneal shunting procedures performed on 1,193 patients with a male:female ratio of 678:515. The overall infection rate was 3.2% (74 infections). Analyzed by age, the infection rates were as follows: <1 month 9/223 (4.0%), 1-6 months 16/449 (3.6%), 6-12 months 13/297 (4.4%),

12-18 months 3/122 (2.5%), 18-24 months 7/116 (6.0%) and 24+ months 26/1, 118 (2.3%). There was no statistically significant difference between age groups (p > 0.05). Upon selectively examining premature neonates who developed hydrocephalus secondary to intraventricular hemorrhage from the figures given above, one finds that 2/44 (4.5%) of neonates became infected, which was also not significant. The infection rate was the same irrespective of whether the procedure was to insert or revise the shunt, or whether another operative procedure was done under the same anesthesia. The etiology of the hydrocephalus was not a factor, nor was the presence of an open neural tube defect. The presence of fluid accumulation along the shunt tract or at another neurological operative site was associated with a significant increase in incidence of infection 15/168 (8.9%) when compared to those with no fluid accumulation (p < 0.001). The type of infecting organism was divided roughly in thirds, with relatively equal representation from Staphylococcus epidermidis/coagulase negative and Staphylococcus aureus. The remaining third was comprised of a wide variety of organisms ¹⁰.

1991

In a study of ventriculoperitoneal shunt infections conducted retrospectively between 1983 and 1987 and prospectively in 1988 39 infections from 372 shunt procedures (incidence 10.5%) were identified. The most common organism isolated was Staphylococcus aureus (18; 47%) followed by Staphylococcus epidermidis (10; 26%). Forty-two per cent of staphylococci were methicillin-resistant. Gram-negative infections were associated with myelomeningoceles and Gram-positive infections with other forms of hydrocephalus (P = 0.048). Lymphocyte predominance was found more frequently than polymorphonuclear predominance in cerebrospinal fluid ¹¹.

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